SPECTRUM CAP AND MOBILE OPERATORS' PERFORMANCE: THAILAND'S EXPERIENCE

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Abstract

Spectrum auction has been accepted as an efficient tool for allocating the radio spectrum and increasing competition level among service providers in the telecommunication market. Most of National Regulatory Authorities (NRAs) use spectrum cap as an incentive instrument to facilitate new entrants and to reduce a chance of natural monopoly in acquiring spectrum. These two different regulatory instruments seem to provide contradictory results. On one hand spectrum auction should allow Mobile Network Operator (MNO) to obtain as much as spectrum bandwidth. It may lead to one MNO may gain most of spectrum bandwidth in the market or being a dominant player in the market. On another, spectrum cap limits amount of bandwidths where the MNO could obtain. It aims to provide an opportunity to smaller and/or new comer operator to gain spectrum bandwidths as well as its competitive advantage. The National Broadcasting and Telecommunications Commission (NBTC) has followed the practices from other NRAs by implementing spectrum auctions together with setting spectrum cap for each bidder in an event of auction. This paper aims to investigate the impact on mobile operators' performance, i.e. data share to spectrum share ratio, subscriber share to spectrum share ratio, etc., in Thailand. The findings show that 40% sub-1GHz cap produces a better output in term of spectrum efficiency. It is somehow contrast with other studies. However, this may result from a long term implementation of spectrum cap. Mobile operator needs to prepare itself to handle the limitation of spectrum.

Keywords : Spectrum cap, Mobile operators' performance, Thailand

บทคัดย่อ

การประมูลถือเป็นเครื่องมือในการจัดสรรคลื่นความถี่ที่มีประสิทธิภาพมากที่สุด และยังเป็นการเพิ่มระดับการแข่งขันในการให้บริการโทรคมนาคมอีกด้วย การกำหนดเพดานการถือครองคลื่นความถี่เป็นเครื่องมือในการกำกับดูแลอีกเครื่องมือหนึ่งที่หน่วยงานกำกับดูแลกิจการโทรคมนาคมใช้ประกอบกับการประมูลคลื่นความถี่ ทั้งนี้เนื่องจากการประมูลคลื่นความถี่อาจส่งผลให้ผู้ประกอบการรายใดรายหนึ่งสามารถเข้าถือครองคลื่นความถี่ได้เป็นจำนวนมากเท่าที่ต้องการได้ แต่อาจจะเป็นผลให้ผู้ประกอบการรายนั้นสามารถเป็นผู้มีอำนาจเหนือตลาดได้ การกำหนดเพดานการถือครองคลื่นความถี่จึงเป็นเครื่องมือที่จำเป็นในการป้องกันไม่ให้ผู้ประกอบการรายใดรายหนึ่งถือครองคลื่นความถี่มากเกินไป และช่วยให้ผู้ประกอบการรายเล็กและ/หรือรายใหม่สามารถถือครองคลื่นความถี่ได้ ซึ่งส่งผลให้ผู้ประกอบการดังกล่าวมีความสามารถในการแข่งขันที่เพิ่มสูงขึ้น สำนักงาน กสทช. ได้ดำเนินการกำหนดเพดานการถือครองคลื่นความถี่สำหรับแต่ละครั้งในการประมูล งานศึกษาชิ้นนี้มีวัตถุประสงค์เพื่อศึกษาผลกระทบต่อผลการดำเนินการของผู้ประกอบการโทรคมนาคมเคลื่อนที่หากมีการเปลี่ยนแปลงรูปแบบของการกำหนดเพดานการถือครองคลื่นความถี่โดยใช้การวิเคราะห์สถานการณ์ (Scenario analysis) ผลการศึกษาพบว่า หากมีการกำหนดเพดานการถือครองคลื่นความถี่ไว้ที่ร้อยละ 40 ของปริมาณคลื่น ความถี่ต่ำกว่า 1GHz จะส่งผลให้ผู้ประกอบการโทรคมนาคมเคลื่อนที่มีการใช้งานคลื่นความถี่ที่มีประสิทธิภาพมากกว่าการกำหนดเพดานการถือครองคลื่นความถี่แบบอื่น ทั้งนี้อาจเป็นผลมาจากการกำหนดเพดานการถือครองคลื่นความถี่ในประเทศไทยที่ได้เริ่มดำเนินการมาตั้งแต่มีการประมูลคลื่นความถี่ครั้งแรก อันส่งผลให้ผู้ประกอบการโทรคมนาคมเคลื่อนที่ได้มีการปรับตัวกับเครื่องมือการกำกับดูแลดังกล่าวเพื่อรับมือกับความมีจำกัดของคลื่นความถี่

คำสำคัญ : การกำหนดเพดานการถือครองคลื่นความถี่ ผลการดำเนินการของผู้ประกอบการโทรคมนาคมเคลื่อนที่ ประเทศไทย

Spectrum Cap and Mobile Operators' Performance: Thailand's Experience

1. Introduction

All of telecommunications services including fixed telephony, mobile telephony, and Internet services in Thailand used to be provided by state-owned enterprises and private companies under concession system. However, Thai's telecommunications industry has been transformed to licensing scheme in a recent decade. Mobile services, particularly, have been changed adequately. Radio spectrum has been allocated by means of auction as mentioned in the Act on the Organization to Assign Radio Frequency and to Regulate the Broadcasting

and Telecommunications Services B.E. 2543 (called NBTC Act). Therefore, three events of auction had conducted by the National Broadcasting and Telecommunications Commission (NBTC) in less than a decade.

The first spectrum auction in 2100 MHz had been conducted in 2012. Three existing mobile network operators, AIS, DTAC, and True Mobile, have obtained the 2x15 MHz spectrum license. The spectrum bandwidths of 1800 MHz and 900 MHz have also distributed to the existing ones, AIS and True Mobile, in the later auctions. They earn 2x15 MHz and 2x10 MHz respectively. The NBTC, recently, has announced that there will be 1800 MHz auction of 45 MHz bandwidths and 700 MHz auction in 2018 and 2020 respectively. If the NBTC remains setting the same spectrum design by implementing spectrum cap for an auction event, it will create non-competitive environment to smaller operators as well as new entrants. The existing operators in particular will gain most of the spectrum released by auction since they have significant budget to place bid from auctions. This raises the concern of radio spectrum distribution to the NBTC and Thai mobile industry. The telecom regulator should implement a more intervention spectrum cap regulatory instrument, i.e. overall cap, sub 1 GHz cap, or set aside, to ensure that the market stays healthy.

This paper intends to analyze impacts of spectrum cap regulatory instrument, in particular event-related cap and sub 1GHz cap, on firms' performance and employs scenario analysis as a method of study. Next section presents literature reviews on spectrum cap study. An overview on Thai market situation is displayed in the third section. Method of study is shown in section 4. Conclusion and policy recommendation is presented at the end of this paper.

2. Prior Studies

Definition and Types of Spectrum Cap

Spectrum cap is a regulatory instrument where a quantity of spectrum is allowed to be held by a mobile operator in any market (Cramton, 2001; Cramton et al., 2011; Cave, 2009). The main benefit of implementing spectrum cap is to ensure a specific number of mobile operators in each market (Cramton, 2001). Therefore, the ultimate goal of implementing spectrum cap is to promote competition.

There are two different types of spectrum cap. Spectrum cap, on one hand, concerns with a limited amount of bandwidths where one mobile operator or separate mobile operators in the same group can hold (Cave, 2009). In the past decades, there are many

countries implementing this type of spectrum cap including the United States, Canada, Mexico, Chile, India, and the United Kingdom (Little, 2009)[1].

Nowadays, only few countries are continue implementing this type of spectrum cap. UK telecom regulator (Ofcom), for instance, has imposed an overall cap of 340 MHz on total spectrum holding or 37 percent of all spectrum in play by 2020 (Mobile Europe, 2017). India is another example. Telecom Regulatory Authority of India (TRAI) has set a 50 percent of any spectrum band as its spectrum cap. It also sets a 25 percent of all bands as another cap. In November 2017, TRAI has recently recommended that caps in individual bands should be removed and an overall ceiling for spectrum holding should be increased to 35 percent (Philipose, 2017).

The US telecom regulator (FCC) has removed spectrum cap since 2004 to a spectrum screen process which is a case-by-case assessment. The spectrum screen provides a spectrum threshold which can be used as an additional review. It is unlike spectrum cap and can vary market to market. Spectrum screen will be utilised when new spectrum bands become available. FCC implements the amount of spectrum an operator can hold to a third of the spectrum available in the market as spectrum screen, ensuring that at least three operators are in any market (Nichiforov-Chuang, 2015).

Spectrum cap on amount of spectrum which can be held by any mobile operator is considered as a direct intervention instrument from NRA. It can be a penalty for efficiency because a mobile operator is prevented meeting its demand and gaining market share by improving quality of service (Cave, 2009). Therefore, only few regulators have implemented this type of spectrum cap in the markets.

On another hand, NRA can intervene the market by imposing spectrum cap on licensing award to a mobile operator (Cave, 2009). This gives an opportunity to NRA to set a specific number of mobile operator and ensure entry to new comer to enhance competition in the market (Little, 2009). Spectrum cap on licensing award aims that enough spectrum is allocated to a sufficient number of operators generating effective infrastructure competition (Cave & Webb, 2013). Thus, cap at spectrum awards may provide an effective outcome that can benefit end users (Cave, 2009). This spectrum cap is widely implemented in the countries where auctions have been taken place. It could also use in a single band and multi-bands auction (Little, 2009; Cave, 2009; Cave & Webb, 2013).

[1] Useful information about spectrum cap can be found in Mobile Broadband, Competition and Spectrum Cap: An Independent Paper Prepared for the GSM Association, by Arthur D. Little (2009, January).

Impacts of Spectrum Cap on Industry and Firms' Performance

Spectrum cap often promotes competition both in the auction and in the market for mobile services by bringing new comer(s) to the market (Cave, 2009; Cave & Webb, 2013; Cramton, 2013), however, it does not necessary increase auction revenues. Canada, UK, and some European countries represent a case where the spectrum cap[2] can enhance competition as well as increase auction revenues (Cave & Webb, 2013).

There are also some critics that spectrum cap could harm auction efficiency as well as revenues, and could be unsuccessful in promoting competition (Cave & Webb, 2013). In the case of Germany and Austria shows that setting a spectrum cap could not ensure the same results if market conditions are different (Cramton, 2013). Earle and Sosa (2013) supports that European countries were initially successful in attracting new entrants through a spectrum cap and set-aside, however, it fails to sustain the number of mobile operators in these countries a decade later. A similar result was presented by Nichiforov-Chuang (2015). Some of ten mobile operators who entered and launched services since 2010 have been out of their business or merged with other operators. In other words, most of new entrants emerged by set-aside play less significant impact on market structure, a number of factors, excluded the spectrum cap, instead involving on the success and lifespan of new entrants.

3. An Overview of Thai Mobile Market Situation

Concession Era

Thai telecommunications sector was reformed since the two telecom state enterprises, TOT and CAT, allowed private companies to participate in both fixed and mobile services by mean of concession in 1986. Private companies, AIS, DTAC and True Mobile, has become mobile operator providing mobile services since then.

AIS started its business by signing a concession on 900 MHz band with TOT in 1986. In the flowing year, DTAC signed another concession with CAT on 1800 MHz and 800 MHz bands. True Mobile is considered as a late comer in Thai mobile market. CAT and True Mobile agreed on concession on 1800 MHz. It started the mobile business with Orange[3], a French mobile operator, in 2002.

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[2] UK had set five licenses, two large licenses and three smaller licenses. No bidder could win more than one license. Canada used set-aside for new entrants as a spectrum cap.

[3] After a few years of operation, Orange sold its share back to True Corporation.

The concession agreements as well as Telecommunications Business Acts (2001) allow private operators providing mobile services until the agreements are ended. The right over radio frequency using by those mobile operators will be terminated to hands of NBTC when the concession agreements are finished (Srinuan et al., 2013).

Though True Mobile entered the market later than AIS and DTAC, its concession agreement was ended the first in September 2013. The other concessions are due in 2015 and 2018 respectively. True Mobile could temporarily use this spectrum band for one year due to the auction had not taken place before the date of expiration. AIS also got the same scheme but a shorter duration. NBTC recently has announced that the spectrum from DTAC's concession will be auctioned in August 2018, one month before the expiration.

Emergence of Mobile Licenses

After the establishment of the NTC (NTC, the former of NBTC) in late 2004, licensing scheme is started to implement in every telecommunications service. NTC attempted to issue 3G licenses on 2100 MHz band. The first attempt was in 2010. There were four licenses where would be allocated to one 15 MHz license and three 10 MHz licenses. The initial bidding price was set at 12.8 billion baht. Though the auction day was set on September 20, 2010, the auction was cancelled by the administrative court's order a few days before the scheduled date. The main reason of the court order is a lack authority of the NTC. Therefore, the allocation of 3G spectrum should wait until the authorized organization, the National Broadcasting and Telecommunications Commission, NBTC, is established (Srinuan et al., 2012).

The second effort was promoted after the NBTC was established in 2012. The auction design in this round was somewhat different from the first attempt. Spectrum cap was set at 15 MHz for each license. The reserved price was at 4.5 billion baht per 5 MHz (Sambandaraksa, 2012). All existing private mobile operators obtain the 3G licenses.

In 2014 and 2015, the NBTC organized two separate auctions for 1800 MHz with 2 licenses of 2x15 MHz and 900 MHz with 2 licenses of 2x10 MHz respectively. In these events, JAS Mobile participated in both events and won one license of 900 MHz, but it failed to pay the first installment. The military government got involved on, then the NBTC could redo an auction for 900 MHz later 2016. AIS was an only participant in the latest auction and it obtains a left-over spectrum package at the price of JAS mobile should pay.

Table 1 Mobile operator, subscribers, spectrum bands and holding

Operator (1st year of operation)	Subscribers in Mil. at the end of 2017 (Shares)	Frequency band (Expired year)	Spectrum holding (MHz)
AIS (1986)	25.88 (43. 9%)	2100 MHz (2027) 1800 MHz (2033) 900 MHz (2031)	2x15 2x15 2x10
DTAC (1987)	14.91 (25.3%)	900 MHz* (2018) 1800 MHz* (2018) 2100 MHz (2027)	2x10 2x45 2x15
True Mobile (2002)	16.98 (28.8%)	2100 MHz (2027) 1800 MHz (2033) 900 MHz (2031)	2x15 2x15 2x10
TOT3G (2002)	0.06 (0.1%)	2100 MHz (2027) 2300 MHz** (2025)	2x15 60
CAT MY (2010)	1.12 (1.9%)	850 MHz (2025)	2x15

Source : Office of NBTC and compiled by authors
Note : *this spectrum band was granted to DTAC by mean of concession from CAT.
** TDD spectrum

Market Structure and Spectrum Holding

Mobile market structure in Thailand is somewhat different from other countries. Private companies play an important role in this market. All participants have foreign ownership involve. AIS, a Singaporean own operator, gains highest market share and obtain 80 MHz of spectrum in 2100 MHz, 1800 MHz, and 900 MHz. DTAC who owned by Telenor, Norwegian state enterprise, has 25.3% share of the market. It used to be the second largest in term of market for a few decades. DTAC holds 30 MHz of spectrum through 2100 MHz license. It has over 100 MHz spectrum via concession expiring by September 2018. This puts DTAC in pressure and it just losses its competitive advantage to the follower, True Mobile, due to fierce competition. True Mobile has become the second rank in this market. It earns almost 30% of market share and has the same amount of spectrum with AIS. It also has an agreement to rent out CAT's mobile capacity through MVNO agreement. It is no surprise that two unfinished privatized stated-owned companies have very less impact to the market. TOT owns 90 MHz of spectrum in 2100 MHz and 2300 MHz bands, however, its market is less than 0.5%. CAT is also in a similar position with a slightly better market with 30 MHz spectrum holding (See Table 1).

By the end of 2017, the total amount of spectrum in Thai mobile market is 420 MHz. DTAC owned 33.33% of it. However, 80% of its current spectrum will be returned and auctioned by August 2018. TOT, a state-owned enterprise who gains less than 1% market share, has 90 MHz. AIS and True Mobile have the same amount of spectrum at 80 MHz. CAT has the smallest amount of spectrum (see Table 2).

Table 2 Spectrum holding for each mobile operator by the end of 2017

Operator	850 MHz	900 MHz	1800 MHz	2100 MHz	2300 MHz	Total
AIS	-	20	30	30	-	80
DTAC	-	20*	90*	30	-	140
True Mobile	-	20	30	30	-	80
TOT	-	-	-	30	60	90
CAT	30	-	-	-	-	30
Total	30	60	150	120	60	420

Source : NBTC
Note : * will be expired and return back for auction

Market and Operators' Performance

Mobile subscriber in Thailand is growing in the past few years. The number increases from 80 million subscribers at the end of 2012 to 120 million subscribers by the end of 2017. With the same growth, it will reach almost 130 million by 2018 (see Figure 1).

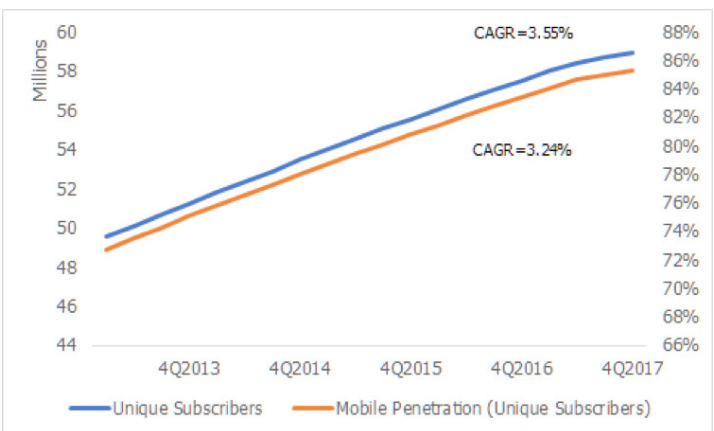

Figure 1 Unique Subscribers and Mobile Penetration

Source : NBTC and authors.
Note : Compound Annual Growth Rate, CAGR, is annual calculation.
Sim register is required for all people in 2015.

Mobile data usage is growing along with mobile subscriber growth. A mobile subscriber, on average, spent less than one Gigabytes per month at the end of 2012, however, it reached 7 Gigabytes per month within five years and it continues grows (see Figure 2). A significant growth of data consumption in recent years may come from tremendous demand on streaming contents as well as high quality of video on demand.

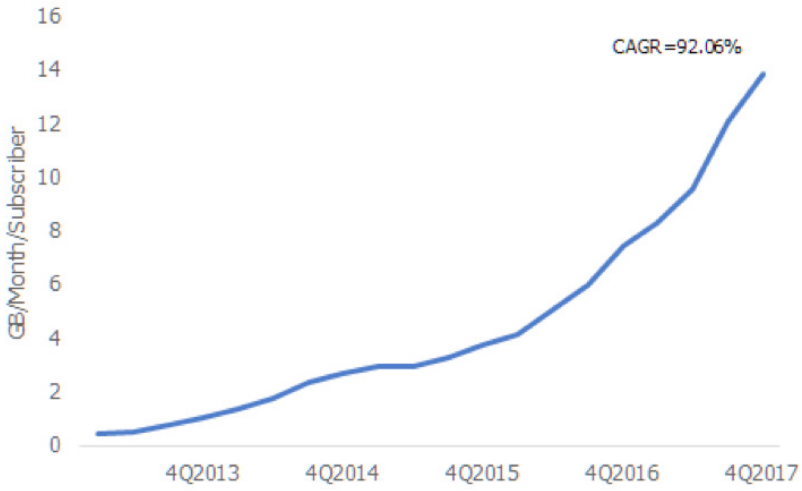

Figure 2 Average Data per Unique Subscriber

Source : NBTC and authors.
Note : CAGR is annual calculation.

Implementation of Spectrum Cap and Spectrum Release Plan

Thailand first implementation of spectrum cap was in the 2100 MHz auction, so called event-related cap. NBTC implemented a spectrum cap of 15 MHz out of 45 MHz available. This resulted each existing private mobile operator to earn 15 MHz each. In the later auctions, NBTC also implemented event-related cap. In 1800 MHz auction in 2016, there was 30 MHz spectrum available. NBTC divided into two blocks, 15 MHz each, and allowed each bidder to bid only one block. Similar setting was implemented again in 900 MHz auction in 2016. Spectrum of 20 MHz was divided into two 10 MHz blocks.

Spectrum release plan 2020 has been implicitly taken place. Various spectrum holders will both voluntary and forced to return some of their occupied spectrum to the NBTC. DTAC, for example, will return 100 MHz spectrum of 900 and 1800 MHz as a result from concession expiration. However, the NBTC will only do an auction of 90 MHz in 1800 MHz band in 2018. The rest will be on hold for high speed rail communication where it needs field trail ensuring

no significant interference will be made. NBTC also expects to do spectrum refarming of 2600 MHz from a dominant broadcaster, MCOT, in 2019. In addition, the digital TV switch off, where the TV channels will shift from analogue technology to the digital technology in broadcasting terrestrial television, will be completed by the end of 2019, and some digital TV broadcasters will return their licenses as well as spectrum to the NBTC. Hence 90 MHz of 700 MHz band will be available for mobile services in 2020. The spectrum release plan is summarized in Table 3.

Table 3 Spectrum release plan 2020

Current Holder	Broadcasters	DTAC		MCOT/PRD
Year/Band	700 MHz	900 MHz	1800 MHz	2600 MHz
2018	-	2x5**	2x45	-
2019				2x70*** + 40****
2020	2x45*	90		

Source : NBTC

Note : * depending on digital TV switch over plan and negotiations

** The original amount is 2x10, however, it will be allocated to State Railway of Thailand at 2x5 MHz for high speed rail project. Another 2x5 MHz is on hold for implementing field trail on interference, *** FDD, **** TDD

4. Methodology

Scenarios

This paper employs scenario analysis to evaluate the impacts of different set spectrum caps on mobile operators' performance in particular spectrum usage efficiency. There are a few assumptions in the scenario analysis. The first assumption is that the NBTC will impose no set-aside in next auctions. Next, the amount of 1800 MHz, which will take place soon in 2018, will be allocated equally to three existing mobile operators[4]. The third one is spectrum holding is counted by right to use rather than actual owned spectrum. The analysis also assumes that the market structure remains unchanged and the growth rate of mobile subscribers and data traffic are at three-year annual average (CAGR 2015-2017). Two scenarios are constructed as following;

[4] This paper was written before the 1800 MHz auction had taken place in mid of 2018 (August 19, 2018). The authors view that the existing mobile operators will join the auction and willing to take them all. However, the results of the late 1800 MHz auction reveal that only 20 MHz out of 90 MHz of 1800 MHz were taken by two existing mobile operators, AIS and DTAC.

Scenario 1 (Event-related cap)

This scenario is used as a base case. Most of NRAs, include NBTC, usually implement event-related cap in an event of auction. NBTC applies this spectrum cap since its first auction in 2012. In this scenario, 700 MHz band is allocated to three existing mobile operators equally. True Mobile obtains 170 MHz out of 490 MHz. DTAC and AIS gain 150 and 140 MHz respectively (see Table 4).

Table 4 Spectrum holding for each mobile operator by implementing event-related cap

Operator	700 MHz	850 MHz	900 MHz	1800 MHz	2100 MHz	2300 MHz	Total
AIS	30	-	20	60	30	-	140
DTAC	30	-	-	30	30	60	150
True Mobile	30	30	20	60	30	-	170
TOT	-	-	-	-	30	-	30
CAT	-	-	-	-	-	-	0
Total	90	30	40	150	120	60	490

Source : NBTC and authors

Note : Spectrum refers to right to use with license or concession. Amount of spectrum is already calculated in 2x X MHz for FDD bands except 2300 MHz.

Scenario 2 (40% sub-1GHz cap)

Spectrum bands which are sub-1GHz bands are also known as coverage band. Bands include 450 MHz, 700 MHz, and 900 MHz. These bands are normally scarce resource and high demand. Mobile operators will invest less amount of money in rolling out their network if they could gain these bands. Many NRAs have set sub-1 GHz cap recently and they tend to cap between 30-40% vary by markets. This paper employs 40% sub-1GHz cap as another scenario. It aims to show the maximum impact on mobile operators' performance. 700 MHz band is divided to AIS (30 MHz) and DTAC (60 MHz) in this scenario. As a result, DTAC obtains 180 MHz, while True Mobile has 140 MHz.

Table 5 Spectrum holding for each mobile operator by implementing 40% sub-1GHz Caps

Operator	700 MHz	850 MHz	900 MHz	1800 MHz	2100 MHz	2300 MHz	Total
AIS	30	-	20	60	30	-	140
DTAC	60	-	-	30	30	60	180
True Mobile	-	30	20	60	30	-	140
TOT	-	-	-	-	30	-	30
CAT	-	-	-	-	-	-	0
Total	**90**	**30**	**40**	**150**	**120**	**60**	**490**

Source : NBTC and authors

Note : Spectrum refers to right to use with license or concession. Amount of spectrum is already calculated in 2x X MHz for FDD bands except 2300 MHz.

Mobile Operators' Performance Indicators

Six indicators of mobile operators' performance will be employed in the analysis. Indicators consist of:

A. Share of mobile traffic

B. Share of subscribers

C. Share of spectrum

D. Data share per spectrum share ratio

E. Subscriber share per spectrum share ratio

F. Data share per subscriber share ratio

The first three indicators represent the structure of market, while the last three parameters represent performance of mobile operator. Market share of a mobile operator will be calculated by share of mobile traffic and share of subscribers (A and B). Market share can also determine by share of spectrum holding (C). Data share to spectrum share ratio (D), subscriber share to spectrum share ratio (E), and data share per subscriber share ratio (F) are created to compare mobile operators' efficiency. The method was earlier employed by Ofcom in 2017.

5. Findings

For both scenarios, AIS has the highest amount of market share and spectrum share, while True Mobile and DTAC are in the second rank of scenario 1 and 2 respectively. The Scenario 2 produces a better result in data share to spectrum share ratio (D) and subscriber share to spectrum share (E) compared to scenario 1. This means that one unit of spectrum could produce higher unit of data consumption and subscribers. It suggests that imposing 40% sub-1GHz cap tends to give a mobile operator efficiency in using spectrum. It is, in fact, contradict with the hypothesis that more intervention will produce a worse outcome. However, in the case of Thailand, NBTC has intervene by using spectrum cap since the first auction in 2012. The later auctions also limited the amount of spectrum where bidders could bid. This also implies that an efficiency use in spectrum may be a long term outcome since this market is treated by spectrum cap where three existing mobile operators could have almost the same amount of spectrum to produce mobile services. Hence, higher degree of intervention, i.e. 40% sub-1GHz cap, will strengthen an efficiency in spectrum usage.

From the analysis, AIS, who has least percentage of spectrum share (but highest market share in term of mobile data and subscribers), is the most efficient in using of spectrum in both scenarios. This may suggest that in the market where spectrum cap is seriously implemented, the largest mobile operator needs to plan their business carefully in order to handle the limitation it would face.

Table 6 Scenarios' results

Operator	Share of mobile data (%) (A)		Share of mobile data (%) (A)		Share of mobile data (%) (A)		Data share per spectrum share ratio* (D)		Subscriber share per spectrum share ratio** (E)		Data share per subscriber share ratio*** (F)	
	1	2	1	2	1	2	1	2	1	2	1	2
AIS	41.70	41.70	43.65	43.65	28.57	28.57	2.29	2.75	1.89	2.27	2.29	1.21
DTAC	19.48	19.48	24.69	24.69	30.61	36.73	1.00	1.00	1.00	1.00	1.00	1.00
True Mobile	38.82	38.82	29.66	29.66	34.69	28.57	1.76	2.56	1.06	1.54	1.76	1.66

Source : Calculation

Note : 1 = Scenario 1, 2 = Scenario 2

* Data share per spectrum share ratio is calculated by dividing share of mobile data with share of spectrum and normalize by using the mobile operator who provides the lower figure.

** Subscriber share per spectrum share ratio is calculated by dividing share of subscribers with share of spectrum and normalize by using the mobile operator who provides the lower figure.

*** Data share per subscriber share ratio is calculated by dividing share of mobile data with share of subscriber and normalize by using the mobile operator who provides the lower figure.

6. Conclusion

This paper aims to investigate the impacts of different spectrum cap regulation on mobile operators' performance. A scenario analysis has been employed. The results show that 40% sub-1GHz cap produces a better output in term of spectrum efficiency. Data share to spectrum share ratio and subscriber share to spectrum share ratio are higher in scenario 2 compared to scenario 1. It contrasts with other studies. However, this may result from a long term implementation of spectrum cap since Thailand is a country where spectrum cap in particular an event-related has been implemented since its first spectrum auction. Therefore, mobile operator needs to prepare itself to handle the limitation of spectrum.

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Annex

Operator	Below 1 GHz		Above 1 GHz		Total	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
AIS	50 (31.25%)	50 (31.25%)	90 (27.27%)	90 (27.27%)	140 (28.57%)	140 (28.57%)
DTAC	30 (18.75%)	60 (37.50%)	120 (36.36%)	120 (36.36%)	150 (30.61%)	180 (36.73%)
True Mobile	80 (50.00%)	50 (31.25%)	90 (27.7%)	90 (27.7%)	170 (34.69%)	140 (28.57%)
TOT	-	-	30 (9.09%)	30 (9.09%)	30 (6.12%)	30 (6.21%)
CAT	-	-	-	-	-	-