# Technological Migration: The Case of Thai Digital Terrestrial Television

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This study analyzes the business strategies of entrepreneurs during a technological transition. The particular technological transition is the switch from analogue to digital TV in Thailand. The estimated net present values of the broadcasting operators' net profit over a 15-year license period indicate that a long transition period reduces the benefit from upgrading to a better technology. The incumbents would like to join the technological migration from day one. The faster the transition process, the higher the new platform is worth in present value. The government should terminate the old platform as soon as possible and stimulate a rapid transition.

*Keywords:* Technological migration, digital television, net present value

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## Introduction

Innovations in broadcasting technology have changed the way we watch television. There have been two significant changes in the history of broadcasting. The first was the change from black and white to color television during 1950-1980; color television had taken some thirty years to be globally adopted as a standardized broadcast ("Lesson from History: The Adoption of Color TV", 2000). The second change – from analogue to digital – has been going on in many countries since the early part of the twenty-first century.

Most of the developed countries including the most recent, New Zealand, have passed through the technology of broadcasting in digital format. The process starts from

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managing the allocation of spectrum range for digital television to returning the spectrum used by analogue television to government. The countries that have completely switched off broadcasting in analogue are The Netherlands and Luxembourg, which did so by 2006; Finland, Andorra, Sweden, Norway and Switzerland by 2007; Belgium and Germany by 2008; the U.S.A. by 2008; and Japan by 2011. Many developing countries are midway through the process. One of these is Thailand. Thailand is holding the auction for broadcasting licenses, scheduled for September 2013. It is also collecting the spectrum used by analogue television, which it expects to complete by 2020.

Since each country's broadcasting industry operates under different economic and political environments, the digital switching processes also vary among countries. Thailand has its own way of switching off analogue and transitioning to digital, which provides an opportunity for each Thai broadcaster to work out its own business strategy. In Thailand, the multiplex operators cannot allocate the spectrum to the broadcasting operators by themselves, rather the broadcasting licenses on commercial channels will be distributed to the operators by auction. This differs from the procedure in England and the U.S., where the multiplex operators can manage freely the usage of their multiplexes. A second feature in Thailand is that broadcasting licenses on commercial channels are distributed through auction while licenses on non-commercial channels are distributed by a "beauty contest". But in Sweden, for instance, broadcasting licenses for both commercial and non-commercial channels are distributed by a beauty contest. Therefore, the experiences of foreign countries are not a useful guide for Thailand. It is worthwhile to study the broadcast operators' decision during the transition under some possible circumstance not only for predicting the market outcome but also for an efficient adoption of future technology.

Thai broadcasting went digital under Digital Video Broadcasting Terrestrial (DVB-T) for the first time in 2001. While DVB-T functioned well at that time, there has not been any policy support to this new technology until 2010 with the promulgation of the Act on Organization to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services B.E. 2553 (2010). The National Broadcasting and Telecommunications Commission (NBTC), the sole regulator of Thailand's telecommunications and broadcasting sector came up with the "digital roadmap" in 2012. The roadmap set the policy for the

allocation of broadcasting licenses, timeframe for switching off analogue TV, and technical issues in broadcasting.

After the NBTC recalled all Thai television and radio broadcasting licenses in 2011, the newly issued digital broadcasting licenses were distributed to both public and private broadcasting operators through an auction in 2012 following the new policy. The license grants the winning operators the right to broadcast on their own bandwidth over the next fifteen years. The incumbents are allowed to broadcast in digital and analogue simultaneously; nevertheless, the broadcast contents in digital were the same as the contents in analogue. The allowed transition period that the incumbents can broadcast their programs in digital and analogue simultaneously is ten years from the issuance of license. They would then switch off the analogue standard.

Thailand has recently adopted the European digital video broadcasting terrestrial 2 (DVB-T2) standard for commercial digital service. This new technology dominates the first generation of DVB or DVB-T in the way that DVB-T2 uses the new digital code, which is 1.5 times more efficient than DVB-T. DVB-T2 also allows for broadcasting in high definition (HD). DVB-T2 is the extension of the television standard used in 38 countries, mostly in Europe. It enables the broadcasting operators to broadcast content in both high definition and standard definition (SD).

There were six channels broadcasting in analogue terrestrial TV during the pre-digital era. Thai viewers have a choice between watching programs on free TV or pay TV. Pay TV requires viewers to subscribe for a monthly or annual membership fee. Most of the pay TVs broadcast via cable and satellite, while free TVs broadcast through terrestrial transmission and satellite. The majority of viewers still watch free TV even though the market share for free TV has declined in the last five years. The transition to digital TV would have impacts on the households who are watching free TV. They would have to install a set-top-box as well as have access to a wider variety of programs and content.

The social and other benefits from digital broadcasting have been recognized, largely by governments. Firstly, radio frequency is used efficiently. Some radio frequency bandwidths are freed up and some leftover bandwidths can be assigned to the new technology such as 4G. In addition, the public safety organizations and the broadband and wireless

companies can use any leftover bandwidth. The broadcasters would hold the largest fraction of the spectrum, even if the spectrum is allocated by the market mechanism (Cambini & Garelli, 2011). Secondly, digital broadcast has become a global standard; digital TV is broadcast in widescreen with a width-to-height ratio of 16:9 (the image is a third wider than that of the old analogue format). Thirdly, the picture quality of HD-TV has a higher resolution than that of the picture broadcast in analogue. Fourthly, the license reallocation process creates competition among broadcast operators. Lastly, the teenage viewers benefit from multi-channel (Adda & Ottaviani, 2005).

How much the broadcast operators value the license on digital broadcast varies with the expected circumstances. One such circumstance is the transition procedure provided by the NBTC policy. There are potential twists in the transition procedure that might influence the broadcast operators' valuation of the digital broadcasting license, which would in turn influence their business strategies.

This paper offers a projection of the strategies adopted by the broadcast operators under two different circumstances on the digital switch over, with ten years transition period and seven years transition period. These two scenarios lead the broadcast operators to carry out different approaches to obtaining the licenses. The results from this study benefit the country by informing a future policy on the adoption of a new technology in favor of an existing one. The suggestion will direct the relevant institutions to develop an efficient plan of action. In next section, the theoretical concept is described. The methodology including the model and assumptions on the market condition is then presented, followed by the results of the projected outcomes and policy recommendations.

## Concepts

The digital broadcasting signal is non-rival, there is no distortion in its quality from many simultaneous viewers, but is excludable by the decoder requirement. Government or the nominated regulator has maintained control over the radio spectrum either in the allocation process or in the content and has allowed the licensed broadcasters to exploit their rights for profit maximization. The right to use bandwidth, i.e. the license, is tradable and has a secondary market for trading after the official allocation or auction. Thus, the signal cannot qualify as a public good.

This study focuses on the projected outcomes of the regulator's chosen switch over process. The outcome comprises the broadcasters' reaction to the transition from analogue to digital standard.

The success in the spectrum auction can be presumed to have moved Thailand more than half way through the digital-switching-over process. The success of an auction is the function of legal and economic theory as well as auction principles. Coase (1959) supported the idea that auction is an efficient way to allocate the rights on using the radio spectrum not the government determining the allocation. The right to use radio spectrum must be defined as a property right to be declared as a tradable right. The secondary market for the right would also be legally allowed without any administrative cost or fines. Nevertheless, most regulators have intervened before and after issuing broadcasting licenses because of quality, pluralism and democratic values, which are non-economic goals. Adda and Ottaviani (2005) called the main implication of these non-economic goals as the policy of universality.

Since this study covers the transition process from analogue to digital, the model begins with the criteria used by the regulator in switching off the analogue standard. The regulator considers the digital coverage ratio as an indicator of success of digital switch-over. In many countries, the regulator delayed the switching off until consumers' adoption of digital television sets has reached a critical threshold. This allows the full benefit from the digital to be enjoyed after the analogue signal is switched off. However, some countries set and an exact date for the switch off.  Adda and Ottaviani (2005) simulated the consumer transition from analogue to digital television based on either committed or conditional switch off. The simulation parameters were derived from a survey in the U.K. They found that most households would adopt the digital before the committed date. On the other hand, households would wait until the broadcasting in analogue is over. Thus the full benefit from switching over is dependent on the regulator's switch-off policy.

Broadcast operators would have three strategy options: First, if the regulator allows for a 10-year transition period, the potential broadcasting operators might withhold their entry in the auction for licenses if they expected that only a small number of viewers would adopt digital TV. Since only the broadcasting operators with high fixed costs enter the auction, some of them might not be able to retain their businesses before the license end-date. In

such case the license would be traded to another and likely more capable broadcaster. However, the secondary market would not exist in the model constructed under this study. Second, should the regulator decide to hold the auction and then suddenly switched off the analogue TV and completely shifted to digital TV nationwide, all the potential bidders would engage in a highly competitive auction. The viewers adopt the new technology right away under this circumstance. This expectation is shared, with some certainty, among broadcasting operators. Third, there is a chance that the regulator might just decide to extend the licenses, or offer a take-it-or-leave-it option to the previous license holders (as in the case of the digital TV switch over in New Zealand), or hold a beauty contest to find the qualified broadcasting operators (as in Sweden). In any of these cases, the auction would not be held and the potential broadcasting operators would go ahead with the digital standard to gain their own market share.

The outcome under a specific circumstance may be different from any of the above according to auction mechanism. However, the merits of an auction cannot be assessed without evaluating the NBTC's intellectual property policy, which is beyond the scope of this study. Whether a broadcaster places a bid that is higher or lower than the others' under the same auction procedure depends on its expected future net income and the price that it is willing to pay for a license. A firm's maximum willingness to pay has a strong positive correlation with the actual bid via a complex process of decision making rather than with the auction mechanism (Cave, 1989). The economic theory predicts that expected auction revenue remains reasonably equivalent across a range of competitive auction processes (Klemperer, 2004).

## Methodology

The model is constructed from the net present value concept. It contains two financial flows, revenue and cost. The future flows of revenue and cost are based on numerous assumptions. The market demand-supply framework constructed under simultaneous equation model, as applied by Xing, Hanhui and Chong (2009) to estimate the social value of the digital cable TV in China, is an alternative model. Unfortunately, that model requires several historical data, which are not available for this study. The internal rate of return

(IRR) concept, which is close to the NPV concept, is not suitable to this study because of its multiple answers with non-conventional cash flows. The model constructed around the concept of net present value is an appropriate model for operating with various forecasted variables.

*Revenue*

The major source of broadcasting revenue is advertising. The non-advertising revenue is approximately less than 10 percent of the total revenue for an average size broadcasting operator.[1] Advertising on television has a particular immediacy, which sets it apart from advertising on non-video traditional media such as radio, newspapers and billboards. Accordingly, it is normal to define it as a separate market. The study assumes that the advertising revenue is the sole source of revenue for the broadcasting operators.

In the Thai broadcasting industry advertising revenue depends on market condition, broadcasting operator, and license condition. These three factors are conflated into one ultimate driver of revenue, viewer number. This number is applied as a factor that drives the revenue. See Anderson and Coate (2005) and Doyle (1998) for instance. Nevertheless, it would be more meaningful to sort out the sources of viewers according to the three factors rather than simply using viewer number.

The market is defined as the market for the DTT licenses restricted to free-to-air transmission for commercial purpose only. The first auction will open for the 24 free-to-air licenses. The pay TV might be subsequently regulated. During the ten-year period after the license auction, DTT will broadcast simultaneously in analogue. DTT licensees will then be competing with analogue channels for advertising revenues. They will also be competing with pay TV channels to the extent that the latter are also advertiser-financed.  In this study the pay TV market is not considered in the scenarios.

When the switch-over process has covered a period of time, any incumbent broad-casting operator holding a digital license will reach viewers either through an analogue or a digital TV. There is no competition over these two audience groups; the households that have adopted digital TV would not switch back to analogue.

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[1] Data from the financial statements from 2010-2012 of BEC-TERO Entertainment Public Company Limited (http://www.set.or.th).

In mature DTT markets in Europe, the potential incumbent operators bid for more than one license. The priority is on the license for the general interest channel. Nevertheless, the incumbent broadcasting operators might extend their coverage through their special interest channels such as sport channel, children's channel, and news channel. However, NBTC plans, as of May 2013, to license a total of 24 channels. The conditions on the holder to broadcast a particular genre of programming are as follows: Seven general interest channels in SD, seven general interest channels in HD, three children's channels in SD, and seven news channels in SD. Each operator is allowed to hold a maximum of three licenses and one license per program genre. If an operator holds one license for general interest channel in HD, it cannot be granted a license for news channel in SD.

The Thai broadcasting industry currently comprises six broadcasting operators. Three operators have led the market by covering 70 percent of the total audience (MCOT, 2011). Two out of six broadcasting operators have been awarded the license to broadcast in public program but not the commercial program. This current situation in the industry suggests that the leading incumbents are only the three that plan to own as many as three licenses. They would likely separate their special interests in sports and children from other channels. The HD channel is the technology showcase for the leaders. The other incumbents might aim for one or two licenses at the most. Nevertheless, there may be new entries from new domestic operators and the international brand name operators.

Some domestic company that is producing programs for the incumbent operators might take a chance at becoming a DTT broadcasting operator. However, the high fixed costs faced by new companies limit the entry of newcomers into the market. For foreign operators, NBTC is not planning on granting licenses to foreign operators during the first auction.

There is not enough demand for available licenses so that there is an excess supply of the DTT licenses on the first auction, which will likely result in the auction prices for the licenses being lower than the price that the incumbents are willing to pay.

An operator's revenue depends on the size of its audience. The audiences of all operators start from zero at the beginning of a DTT license. However, the new channels could gain a larger share of the viewers at the expense of the incumbents in their early years of digital rolling out. Nonetheless, the majority of viewers would remain with the incum-

bents due to viewer loyalty and content quality. The eventual number of DTT viewers would depend on the migration pattern.

The base case forecast on the digital migration is illustrated in Figure 1. The transition curve is S-shaped: Viewers will jump into the digital in the first year, the conversion process is slow between year five and seven, the  analogue viewers will change to digital faster as the analogue switch off date gets closer, and all families shall have converted to digital by year 10. The conversion is relatively slow and switch off is achieved at the end of Year 10, which is consistent with the study of the U.K. digital transition by Adda and Ottaviani (2005). There are two assumptions behind this: 1) the population, which is 67.10 million in the first year, grows at 0.56 percent per year over the next 15 years, and 2) pay TV has a constant market share at 20 percent of the total viewers with the same growth rate as the population growth rate and the market for pay TV is saturated.
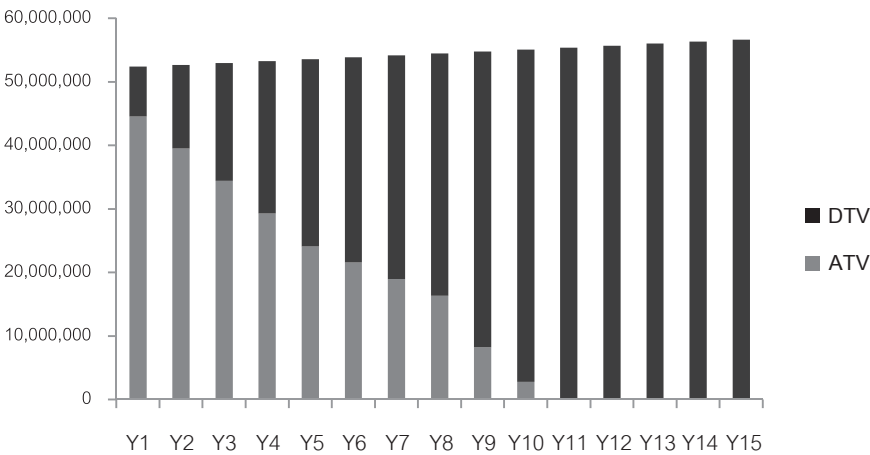


Figure 1  Digital migration pattern over 15 years in Thailand

Thus, an operator's revenue function can be represented by the equation below:

$$TR_i = r(n_{FTV}, s_i, q_i, GDP, p)$$
(1)

where $TR'_{n_{FTV}}, TR'_{s_i}, TR'_{q_i}, TR'_{GDP}, TR'_p > 0$   and   $TR''_{n_{FTV}}, TR''_s, TR''_q < 0$.  $n_{FTV}$ denotes the total number of free TV viewers, $s_i$  denotes the audience share of operator $i$, $q_i$ denotes the quality of the content of the programs from operator $i$, GDP denotes gross domestic product per capita, and $p$ denotes number of population. The audience share

would imply the total revenue share by operator *i* over the total market revenue, since these two have a correlation close to one.

*Cost*

Cost is divided into two types, program generating cost and transmission cost. Transmission cost including multiplexer operating cost and network sharing cost is fixed. All operators incur the same transmission cost because technology and air time are the same. On the other hand, the program generating cost depends on the revenue. For lack of data on program generating cost, we assume that it has a particular relationship to revenue. In broadcasting the fixed cost to lure the first viewer is high, while the marginal cost of showing a program to the next viewer is virtually zero. There are also economies of scope in running channels. These explain why the leaders earn a higher profit margin than the followers.

Its cost structure of broadcasting industry has a special characteristic. The fixed cost is high but the marginal cost is close to zero. If the contents attract many viewers the broadcasting operator is able to charge more for its advertising. To make a program attractive the operator requires talented program director, writers and actors who have to be paid. Therefore, the advertising price and the costs of creating content are determined by the market structure. Several evenly matched operators are expected to incur higher costs than, say, one or two large operators dominating the market.

$$TC_i = c(TR_i, fc_i, m_i) \tag{2}$$

where $TC'_{TR_i}, TC'_{fc_i} > 0$, $TC'_{m_i} < 0$ and $TC''_{TR_i}, TC''_m < 0$. $TC_i$ denotes the total revenue of free operator *i*, $fc_i$ denotes the fixed cost of operator *i*, and m denotes the size of operator *i*, which is determined by the number of broadcasting license held by that operator.

As part of NBTC regulation, licensees are required to pay the government four percent of their revenue as an annual fee. The annual fee is collected as the percentage of revenue; this fee can be added by the mean of the total cost from a part of $TR_i$.

Having constructed the broadcasting revenues and costs, we proceed to estimate the financial flows of incomes and costs over the license period of 15 years. All financial flows will be generated under the concept of net present value and assumptions as described next.

*Net Present Value*

The key task in this section is to design a reliable method of evaluating the willingness to pay price for the 15-year license by each broadcasting operator. These values are required for assessing each operator's strategy in response to government's policy. Notwithstanding these complications, a conceptual framework must provide the willingness to pay price on the spectrum license based on its expected future value. The value of a license can be estimated by the summation of the discounted net cash flows over the license period, i.e. the net present value (NPV). The license net present value or willingness to pay price by operator *i* for a 15-year license is given by:

$$Willingness\ to\ pay\ price_i = (TR_{i,0} - TC_{i,0})\sum_{t=1}^{15} \frac{(1+g)^t}{(1+r)^t} \tag{3}$$

where *r* is the discount rate. The simplest scenario is where the operator *i* revenue and cost have the same growth rate per year over the 15-year period. The net cash flow in the subsequent period will be:

$$CF_{i,t+1} = (1+g)CF_{i,t} = (1+g)(TR_{i,t} - TC_{i,t}) \tag{4}$$

where *g* is the growth rate of the net cash flow per year. Under this assumption, the willingness to pay price as described by equation (3) is:

$$Willingness\ to\ pay\ price_i = (TR_{i,0} - TC_{i,0})\sum_{t=1}^{15} \frac{(1+g)^t}{(1+r)^t} \tag{5}$$

Equation (5) implies that the willingness-to-pay price by operator i is a proportion of the current net cash flow. In reality, however, the net cash flows do not grow at a constant rate so that the profit margins vary over the period.

Costs and revenues are made commensurate over the 15-year license period. The adjustment, where values are comparable over the period, can be done by means of a discount rate. The discount rate must reflect the cost of capital faced by the broadcasting operator. Approximately seven percent discount rate over the long-run period is applied in this study, which is an average of the minimum loan rate in Thailand.[2]

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[2]  According to the Bank of Thailand, the average minimum loan rate (mid-rate) between January 2005 and May 2013 is 6.84 percent.

The industry revenue is simplified to be 600 hundred million at the beginning of the license period.[3] Even though this approximate value is not the true value for the industry revenue, this study affects the estimated willingness to pay pattern not the ranking and the study outcomes. The total revenue can be estimated in the following:

$$TR_{t+1} = (1 + GDP_t)(1 + p_t)TR_t \qquad (6)$$

Equation (6) implies the industry revenue depends on the number of viewers, which grows at the same rate as that of the population, and the country's economic expansion, which grows at the same rate as nominal GDP. The growth in nominal GDP does not only reflect the economic growth but also implies the growth in market prices. It is important to consider how far NBTC imposes conditions on the holder to broadcast a particular genre of programming. Even if NBTC licenses channels on these following genres, general interest in SD, general interest in HD, news and children, the market share of each operator would not change much. According to the historical observations in U.K. and other matured countries, an incumbent operator tends to acquire more than one license to spin around its core brand. Hence, this study makes the assumption base on the current market shares.

This study considers three tiers of the licensed operators: Market leaders, incumbent operators and new entries. The three market leaders benefit fully from the declining average fixed cost (transmission cost, broadcasting cost, and management cost) over the number of channels because there are more channels under the roof of the same company. Therefore, this group goes for the maximum three licenses including licenses for broadcasting variety programs in HD (VHD), variety programs in SD (VSD), and children's programs in SD (KSD). This group is assumed to be dominant in the DTV market even if they lose some viewers to the others; they are expected to keep most of their audiences. The second tier is the incumbent operators or incumbent content providers, such as RS PCL and Workpoint Entertainment PCL, who are willing to hold two licenses each, since there are only three licenses for KSD. Two licenses are those for broadcasting VHD and VSD. The last tier is the group of new domestic and international operators. They face a high fixed cost because they do not have more than one channel sharing the fixed cost since each operator holds

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[3] The Nielsen Company (Thailand) reported 68,105 million baht in the total revenue from advertising on television in 2012. The revenue is estimated from the rated card that does not represent the correct value.

only one license each for broadcasting news program in SD (NSD). The market shares are assumed to be constant over the license period. Since NBTC has 24 licenses for the up-coming auction, this following might be the outcome (Table 1). Nevertheless, the predicted outcome is subject to the future changes in NBTC regulation.

Table 1  Predicted number of licensed operators and number of licenses per operator

| Tier | No. of operators | Licenses per operator | % Market share | Licenses by categories |
|---|---|---|---|---|
| Market leaders | 3 | 3 | 38 | VHD, VSD, KSD |
| Second tier | 4 | 2 | 33 | VHD, VSD |
| New entries | 7 | 1 | 29 | NSD |

Total revenue earned by operator $i$ at year $t$ and the growth of total revenue of operator $i$ over a period are shown below:

$$TR_{i,t} = s_i TR_t \tag{7}$$

$$TR_{i,t+1} = (1 + GDP_t)(1 + p_t)TR_{i,t} \tag{8}$$

The market share or revenue share for operator $i$ is assumed to be constant over a license period, therefore, the operator $i$'s total revenue grows with the same rate as that of the market revenue. The market shares are simply assumed to be equal on any license type. The market shares are not different among program types as well as with picture and content qualities. Thus, market leaders with nine licenses in total, the second tier with 8 licenses in total, and the new entries with seven licenses have their market shares at 38 percent, 33 percent and 29 percent, respectively.

The transition process from analogue to digital has a crucial impact on the estimated license value. Since the advertising revenue is determined by the number of viewers, the faster the switching over, the higher is the advertising revenue for the digital TV industry. The rate of switching over also influences operators' bidding strategy.

The switching over rate depends on how fast the viewers acquire the set-top-box as shown by the study of McConnell (cited in Fu & Atkin, 2013, p.2). The set-top-box has to be paid for and if the government or NBTC subsidizes the cost of the set-top-box, the switching over period could take a shorter time than if viewers had to pay for it.  In this study, the switch over period is limited by the maturity date of the analogue license, which

is 10 years after issue of the digital license. This is the slow transmission case. The comparison scenario is a 5-year transmission period (see Table 2). This 5-year scenario is an ambition set by NBTC. The switching over rate is usually rapid in the beginning of the process because many viewers are excited and eager for the change. The rate becomes moderate in the middle of the process, as in Brazil and France. Once analogue is switched off viewers would not be able to watch TV unless they switched to DTV. This assumption is consistent with the case of U.K. as described by Adda and Ottaviani (2005). The switch over in New Zealand took only 22 months because of the presence of an already equipped infrastructure.

Table 2  Switching over rates

| Year | Slow transmission | Fast transmission |
|------|-------------------|-------------------|
| 1 | 0.15 | 0.30 |
| 2 | 0.25 | 0.40 |
| 3 | 0.35 | 0.50 |
| 4 | 0.45 | 0.60 |
| 5 | 0.55 | 0.80 |
| 6 | 0.60 | 1.00 |
| 7 | 0.65 | 1.00 |
| 8 | 0.70 | 1.00 |
| 9 | 0.80 | 1.00 |
| 10 | 0.90 | 1.00 |
| 11 | 1.00 | 1.00 |
| 12 | 1.00 | 1.00 |
| 13 | 1.00 | 1.00 |
| 14 | 1.00 | 1.00 |
| 15 | 1.00 | 1.00 |

Broadcasting costs have been separated into programming and annual fee costs and broadcasting cost. The programming cost is a variable that is determined by the revenue. If an operator earns a lot of income from advertising, then the content quality must be high enough to attract more viewers. An operator can improve content quality only by hiring talented but highly paid screen-writer, director, actors and so on. The cost of these special talents is an economic rent borne by an operator who would like to attract more viewers. The cost is assumed as the proportion of the total revenue. However, the viewer share and market revenue share are assumed to be equal among different channels. The programming cost and annual fee for the market leaders and second tier operators are 50 percent of

total revenue. This comes from the four percent annual fee and 46 percent programming cost (the percentage of programming cost on total revenue is from BEC-TERO 2010-2012 financial statements). The operator with more than one license can rerun programs on its channels, which saves costs. The new operators, broadcasting on only one channel, would not have the same opportunity. The programming cost for new operators is 51 percent of total revenue; another four percent of the total revenue is for the annual fee.

The broadcasting cost is similar to the fixed cost of production. Every operator is charged with the same price for sending the digital signal to viewers' receivers throughout the country. Each operator sends the signal 24 hours a day through the same infrastructure owned or rented by the same company. Therefore, it is reasonable to assume that all operators face the same cost. This cost for multiplex and network services is fixed at 50 million baht per SD channel per year and 150 million baht per HD channel per year. HD broadcasting cost is three times higher than that of SD because HD requires three to four times more multiplex than SD. The broadcasting operator must pay this fixed cost to another company for the services. However, the broadcasting operator has its internal team to manage its own broadcasting unit and infrastructures such as building and equipment. This cost is also fixed at 625 million baht per year with a growth rate of 6 percent per year, as estimated from BEC-TERO data. The internal broadcasting cost does not depend on the number of licenses that a broadcasting operator holds.

A market leader, who has three licenses in VHD, VSD and KSD, faces a total of 875 million baht per year in broadcasting cost; broadcasting two channels in SD costs 100 million baht per year and broadcasting one channel in HD costs another 150 million per year. Therefore, a market leader must pay 250 million baht to another company who services multiplex and network. The internal cost for broadcasting is another 625 million baht per year, even if it broadcasts through three channels.

All the assumptions and methodology have been described above. This knowledge enables us to perform the prediction on operators' strategies acquiring the broadcasting license over the next 15 years. The results would be useful for NBTC in efficient regulating the broadcasting industry.

## Results

This section provides an estimated wiliness-to-pay price from each operator and its strategy. There are two scenarios, which differ on the switching over rate, slow and fast transition from analogue to digital. The speed of transition is the key factor driving the industry's total revenue from advertising in DTV and the proportion to total cost. Therefore, the faster the switching over rate, the higher the broadcasting operators value the broadcasting licenses in digital. Table 3 provides the estimated willingness-to-pay price for the 15-year digital license. See the calculation in appendices 1 and 2.

Table 3  Willingness-to-pay prices per license by each group of operator

| Group | Number of operators | Licenses per operator | Prices per license (hundred million baht) | |
| --- | --- | --- | --- | --- |
| | | | Slow transmission | Fast transmission |
| Market leaders | 3 | 3 | 78.12 | 101.6 |
| Second tier | 4 | 2 | 62.91 | 86.40 |
| New operators | 7 | 1 | 15.12 | 36.27 |

Table 3 shows the willingness-to-pay prices per license by three market leaders. The willingness-to-pay price is the maximum amount of money an operator offers for a license. The values are calculated by applying the concept of the net present value of the financial flow over the license period of 15 years. The market leaders offer the highest value for nine licenses, 3 VHD, 3 VSD and 3 KSD. This group earns the highest revenue per license owing to its management cost and infrastructure cost from operating three channels with one management team and one infrastructure. The second tier incumbents do not perform as well as the leaders due to their higher fixed cost. The new operators would have the lowest revenue per license as a result of high content operating cost and fixed cost.

The license values increase from 30.07 percent for the license held by market leaders to 37.34 percent for the license held by second tier operators. The revenue from the digital broadcasting has fully transferred from the analogue broadcasting with the completion of the switching over process. Most operators realize a positive profit after the period of accumulated deficit in year 5 to year 10.  The faster speed of transition enhances the value of the license considerably.

Incumbents are most likely to acquire the digital license on day one, despite being allowed to broadcast in analogue until its maturity in year 10. If an incumbent receives a license or licenses, it will simulcast in both analogue and digital over the next 10 years. For the analogue viewers, it is obvious that they will keep their preference on their favorite programs in analogue. There is no change on the non-digital-licensed incumbent's market share in analogue TV but it will see a decrease in its total viewers following the switching over process. An incumbent with licenses will lose some of its viewers in analogue and digital channels to new competitors.

The comparison becomes unambiguous with a few additional assumptions. Firstly, there is no change in the market share of each incumbent in analogue market after the beginning of digital. Secondly, new operators fulfill the leftover licenses instead of the incumbent who is not willing to join the auction. Lastly, NBTC allows the incumbent to obtain the licenses from the licensed operators after analogue is switched over. An incumbent has two alternatives: Acquire the digital license at the beginning or acquire the digital license later from the secondary market in year 10. Nevertheless, acquiring the digital license at the beginning is a dominant strategy for the incumbent. Since the incumbent broadcasts in ATV the same content as the one it broadcasts in DTV, the cost of operating ATV during the simulcast is negligible. Therefore, the revenue is equal to the profit received by a simulcast incumbent.

A market leader incumbent earns from simulcast in analogue and digital a profit of 940.91 hundred million baht in the net present value from broadcasting in digital over the first 10 years before analogue is turned off.  In contrast, the revenue from broadcasting in analogue is 756.69 hundred million baht from acquiring the licenses in year 11.  A second tier might not do as well as the leaders over the first 10 years in digital broadcasting.  It earns 365.89 hundred million baht from broadcasting in digital over the first 10 years before ana-logue is turned off compared to 243.22 hundred million baht from acquiring the licenses in year 11. See Appendix 3.

The willingness-to-pay prices offered by broadcasting operators for the digital license depend on the switching over rate. The faster the process, the higher is the value they place on the digital license. Incumbents have no incentive to delay bidding for the licenses and obtaining the licenses in the secondary market because of decreasing in their

returns. Having the digital licenses at the beginning would enable them to earn revenue from two sources, analogue and digital TV.

## Conclusion

This study predicts how a company reacts to the different technological transition periods and whether an incumbent would join the new technological platform on day one. The business model with net present value approach is applied to answer these two queries. The model requires assumptions on projecting the flows of revenues and costs. Since the technological transition from analogue TV to digital TV is a timely issue debated in Thailand, this transition is an instructive case study for the sector. The study is relevant to technological transition in general.

These following outcomes are drawn from this study. Firstly, the switchover time interval determines the value of the new technological platform. The faster the transition process, the higher the new platform is worth in present value. Secondly, incumbents would consider entering the new platform after its official launch. Market leader incumbents recognize the benefit from joining the new platform and keeping their market share in the old platform.

As a number of technologies require the transition from an old to a new platform, transitions cannot occur without a motivating force or a stimulus. The failure of the market to effectively facilitate technological transition has some recent examples: The transition from black and white to color broadcasting, benzene-to gasohol-consuming cars, and 2G to 3G mobile phone signals. In the situation that the old and new platforms have been simultaneously functioning until the maturity of the old platform, the government should terminate the old platform as soon as possible. The sooner the termination dated, the stronger the motivation of users to adopt the new platform.

NBTC and the broadcasting operators could actively influence a faster transition by subsidizing the cost of the set-top-box.  If viewers have to bear the cost of the set-top-box on top of the installation costs, they might delay their transition to digital. NBTC or the broadcasting operators can stimulate a rapid transition by distributing coupons to viewers for redeeming set-top-boxes.

Network infrastructure has an effect on the speed of the digital switching over process. Up to July 2013, there were four network providers with unequal coverage range and different service fees. Even if they merged their network infrastructure, their coverage range would not come close to serving 100 percent of Thai viewers. The expansion can take several years, which could take longer than the time all viewers can be equipped with set-top-boxes.

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Appendix 1  The estimated net present value of each broadcasting operator by groups under slow switching over rate

Unit: Hundred million baht

| Item | \_Year\_ 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | NPV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industry total revenue (ATV + DTV) | 600.0 | 636.0 | 674.2 | 714.6 | 757.5 | 802.9 | 851.1 | 902.2 | 956 | 1,014 | 1,075 | 1,139 | 1,207 | 1,280 | 1,357 | 7,883 |
| Transmission (% of total viewer) | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | 0.60 | 0.65 | 0.70 | 0.85 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 5.62 |
| DTV industry total revenue | 90.00 | 159.0 | 236.0 | 321.6 | 416.6 | 481.8 | 553.2 | 631.5 | 812.9 | 963 | 1,075 | 1,139 | 1,207 | 1,280 | 1,357 | 5,428 |
| 3 market leaders with 3 channels each | 33.75 | 59.63 | 88.48 | 120.59 | 156.23 | 180.66 | 207.46 | 236.82 | 304.82 | 361.13 | 402.94 | 427.12 | 452.74 | 479.91 | 508.70 | 2,035 |
| 4 second tier with 2 channels each | 30.00 | 52.99 | 78.64 | 107.18 | 138.86 | 160.57 | 184.39 | 210.49 | 270.93 | 320.97 | 358.13 | 379.62 | 402.40 | 426.54 | 452.14 | 1,809 |
| 7 new operators with 1 channels each | 26.25 | 46.38 | 68.83 | 93.80 | 121.53 | 140.53 | 161.37 | 184.22 | 237.11 | 280.91 | 313.43 | 332.24 | 352.17 | 373.31 | 395.70 | 1,583 |
| Industry total cost (DTV only) | 152.8 | 193.6 | 238.7 | 288.7 | 343.9 | 384.0 | 427.8 | 475.5 | 576.7 | 662.4 | 728.6 | 771.2 | 816.3 | 864.2 | 914.9 | 4,116 |
| Operating cost | | | | | | | | | | | | | | | | |
| 3 market leaders | 16.88 | 29.81 | 44.24 | 60.30 | 78.12 | 90.33 | 103.73 | 118.41 | 152.41 | 180.56 | 201.47 | 213.56 | 226.37 | 239.95 | 254.35 | 1,018 |
| 4 second tier | 15.00 | 26.50 | 39.32 | 53.59 | 69.43 | 80.29 | 92.19 | 105.24 | 135.46 | 160.48 | 179.07 | 189.81 | 201.20 | 213.27 | 226.07 | 905 |
| 7 new operators | 14.44 | 25.51 | 37.86 | 51.59 | 66.84 | 77.29 | 88.76 | 101.32 | 130.41 | 154.50 | 172.39 | 182.73 | 193.70 | 205.32 | 217.64 | 871 |
| Broadcasting cost | | | | | | | | | | | | | | | | |
| 3 market leaders | 26.25 | 27.38 | 28.57 | 29.83 | 31.17 | 32.59 | 34.10 | 35.69 | 37.38 | 39.18 | 41.08 | 43.09 | 45.23 | 47.49 | 49.89 | 315 |
| 4 second tier | 33.00 | 34.50 | 36.09 | 37.78 | 39.56 | 41.46 | 43.46 | 45.59 | 47.85 | 50.24 | 52.77 | 55.46 | 58.30 | 61.32 | 64.52 | 401.3 |
| 7 new operators | 47.25 | 49.88 | 52.66 | 55.61 | 58.73 | 62.05 | 65.56 | 69.28 | 73.23 | 77.41 | 81.85 | 86.55 | 91.53 | 96.82 | 102.41 | 606.7 |
| DTV total profit | -62.81 | -34.57 | -2.78 | 32.88 | 72.77 | 97.76 | 125.42 | 156.0 | 236.1 | 300.6 | 345.9 | 367.8 | 391.0 | 415.6 | 441.7 | 1,312 |
| 3 market leaders | -9.38 | 2.44 | 15.67 | 30.46 | 46.94 | 57.74 | 69.63 | 82.72 | 115.0 | 141.4 | 160.4 | 170.5 | 181.1 | 192.5 | 204.5 | 703 |
| 4 second tier | -18.00 | -8.00 | 3.23 | 15.81 | 29.87 | 38.83 | 48.73 | 59.65 | 87.62 | 110.25 | 126.3 | 134.4 | 142.9 | 151.9 | 161.5 | 503.3 |
| 7 new operators | -35.44 | -29.00 | -21.68 | -13.40 | -4.05 | 1.19 | 7.06 | 13.61 | 33.47 | 48.99 | 59.20 | 62.96 | 66.94 | 71.17 | 75.65 | 105.8 |

Appendix 2  The estimated net present value of each broadcasting operator group under fast switching over rate

Unit: Hundred million baht

| Item | | Year | | | | | | | | | | | | | | NPV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| Industry total revenue (ATV + DTV) | 600.0 | 636.0 | 674.2 | 714.6 | 757.5 | 802.9 | 851.1 | 902.2 | 956 | 1,014 | 1,075 | 1,139 | 1,207 | 1,280 | 1,357 | 7,883 |
| Transmission (% of total viewer) | 0.30 | 0.40 | 0.50 | 0.60 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 7.07 |
| DTV industry total revenue | 180.0 | 254.4 | 337.1 | 428.8 | 606.0 | 802.9 | 851.1 | 902.2 | 956 | 1,014 | 1,075 | 1,139 | 1,207 | 1,280 | 1,357 | 6,556 |
| 3 market leaders with 3 channels each | 67.50 | 95.40 | 126.41 | 160.79 | 227.25 | 301.10 | 319.17 | 338.32 | 358.62 | 380.13 | 402.94 | 427.12 | 452.74 | 479.91 | 508.70 | 2,458 |
| 4 second tier with 2 channels each | 59.99 | 84.79 | 112.35 | 142.91 | 201.98 | 267.62 | 283.68 | 300.70 | 318.74 | 337.86 | 358.13 | 379.62 | 402.40 | 426.54 | 452.14 | 2,185 |
| 7 new operators with 1 channels each | 52.51 | 74.21 | 98.33 | 125.07 | 176.77 | 234.22 | 248.27 | 263.17 | 278.96 | 295.69 | 313.43 | 332.24 | 352.17 | 373.31 | 395.70 | 1,912 |
| Industry total cost (DTV only) | 199.1 | 242.7 | 290.8 | 343.9 | 441.3 | 549.3 | 581.1 | 614.8 | 650.6 | 688.5 | 728.6 | 771.2 | 816.3 | 864.2 | 914.9 | 4,696 |
| Operating cost | | | | | | | | | | | | | | | | |
| 3 market leaders | 33.75 | 47.70 | 63.20 | 80.4 | 113.6 | 150.6 | 159.6 | 169.2 | 179.3 | 190.1 | 201.5 | 213.6 | 226.4 | 240.0 | 254.4 | 1,229 |
| 4 second tier | 30.00 | 42.40 | 56.17 | 71.45 | 100.99 | 133.8 | 141.8 | 150.3 | 159.4 | 168.9 | 179.1 | 189.8 | 201.2 | 213.3 | 226.1 | 1,092 |
| 7 new operators | 28.88 | 40.81 | 54.08 | 68.79 | 97.22 | 128.82 | 136.55 | 144.74 | 153.43 | 162.63 | 172.39 | 182.73 | 193.7 | 205.3 | 217.6 | 1,052 |
| Fixed cost per channel | | | | | | | | | | | | | | | | |
| 3 market leaders | 26.25 | 27.38 | 28.57 | 29.83 | 31.17 | 32.59 | 34.10 | 35.69 | 37.38 | 39.18 | 41.08 | 43.09 | 45.23 | 47.49 | 49.89 | 315 |
| 4 second tier | 33.00 | 34.50 | 36.09 | 37.78 | 39.56 | 41.46 | 43.46 | 45.59 | 47.85 | 50.24 | 52.77 | 55.46 | 58.30 | 61.32 | 64.52 | 401.3 |
| 7 new operators | 47.25 | 49.88 | 52.66 | 55.61 | 58.73 | 62.05 | 65.56 | 69.28 | 73.23 | 77.41 | 81.85 | 86.55 | 91.53 | 96.82 | 102.41 | 606.7 |
| DTV total profit | -19.13 | 11.74 | 46.31 | 84.92 | 164.7 | 253.7 | 270.0 | 287.4 | 305.7 | 325.2 | 345.9 | 367.8 | 391.0 | 415.6 | 441.7 | 1,860 |
| 3 market leaders | 7.50 | 20.33 | 34.64 | 50.56 | 82.45 | 118.0 | 125.5 | 133.5 | 141.9 | 150.9 | 160.4 | 170.5 | 181.1 | 192.5 | 204.5 | 915 |
| 4 second tier | -3.00 | 7.90 | 20.08 | 33.68 | 61.43 | 92.35 | 98.37 | 104.76 | 111.5 | 118.7 | 126.3 | 134.4 | 142.9 | 151.9 | 161.5 | 691 |
| 7 new operators | -23.62 | -16.48 | -8.41 | 0.67 | 20.81 | 43.35 | 46.16 | 49.14 | 52.30 | 55.65 | 59.20 | 62.96 | 66.94 | 71.17 | 75.65 | 253.9 |

Appendix 3  The estimated net present value from analogue TV and digital TV of each broadcasting operator by groups

Unit: Hundred million baht

| Item | Year | | | | | | | | | | NPV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| Industry total revenue (ATV + DTV) | 600.0 | 636.0 | 674.2 | 714.6 | 757.5 | 802.9 | 851.1 | 902.2 | 956.3 | 1,014 | 7,908 |
| Transmission (% of total viewer) | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | 0.60 | 0.65 | 0.70 | 0.85 | 0.95 | |
| ATV industry total revenue | 510.0 | 477.0 | 438.2 | 393.0 | 340.9 | 321.2 | 297.9 | 270.7 | 143.4 | 50.68 | 3,243 |
| 3 market leaders (market share 38%) | 357.0 | 333.9 | 306.7 | 275.1 | 238.6 | 224.8 | 208.5 | 189.5 | 100.4 | 35.48 | 2,270 |
| 4 second tier (market share 33%) | 153.0 | 143.1 | 131.5 | 117.9 | 102.3 | 96.35 | 89.37 | 81.20 | 43.03 | 15.21 | 973 |
| 7 new operators (market share 29%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DTV industry net profit | -62.81 | -34.57 | -2.78 | 32.88 | 72.77 | 97.76 | 125.42 | 156.0 | 236.1 | 300.6 | 921.4 |
| 3 market leaders (market share 38%) | -9.38 | 2.44 | 15.67 | 30.46 | 46.94 | 57.74 | 69.63 | 82.72 | 115.0 | 141.3 | 552.6 |
| 4 second tier (market share 33%) | -18.00 | -8.00 | 3.23 | 15.81 | 29.87 | 38.83 | 48.73 | 59.65 | 87.62 | 110.3 | 368.0 |
| 7 new operators (market share 29%) | -35.44 | -29.00 | -21.68 | -13.40 | -4.05 | 1.19 | 7.06 | 13.61 | 33.47 | 48.99 | 0.76 |