

**MEASURING THE PROGRESS OF DIGITAL CONVERGENCE IN
MARKETS: AN EMPIRICAL STUDY ON VIDEO AND DATA
TRANSFERRING MARKET IN TAIWAN**

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Abstract

As digital convergence becoming a global vision of information societies, how to measure its progress in a society has become an important issue, as well as to figure out the factors of blocking its progress. In this study, we employ the concepts of market and industrial competition in industrial economics to explain the meanings of digital convergence and use the econometric model to investigate the progress of two digital convergence industries, the telecommunication and cable industry, in Taiwan. In addition, we also discuss the obstacles which hinder their converging progresses. Our empirical results indicate that the competition in video market between the telecommunication and cable industries in Taiwan is still not significant but the competition in internet service provision(ISP) market between them is significant, which mean that the converging progress in video market is slower than the ISP market. The obstacles hindering the converging progress in video market are the market regulations and the terms for withdrawing from the media of parties, government, and military and must be removed to boost its convergence.

Keywords: digital convergence, market competition, industrial competition, vector autoregression(VAR).

1. Introduction

The term “digital convergence” (DC) is often heard in our daily life and has become the most important policy goal. Governments in different countries propose their own national industry policies, including American government proposed “National Broadband Plan”, the “Digital Britain White Paper” formulated by United Kingdom, “Hikari no Michi”(fiber superhighway) in Japan, “Ultra-Broadband Convergence Network Plan (UBcN plan)” in South Korea, moreover, and the “Tri-networks Integration Plan” in China. Because DC is so important nowadays, to measure its progress in a country has become an important issue.

To measure DC’s progress in a country, we have to know its definition first. But ironically, the definition of DC is diverging. In Wikipedia, digital convergence refers to the convergence of four industries into one conglomerate, the information technologies, telecommunication, consumer electronics, and entertainment (ITTCE)(Wikipedia,

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2014).¹ In its policy guidance on convergence and next generation Networks, Organization for Economic Cooperation and Development(OECD) pointed out that the converged services often are appearing in markets as "triple" or "quadruple" play offers which provide data, television, fixed and mobile voice services (OECD, 2008).² Bernal(2013) pointed that there are five dimension of digital convergence: network convergence, service convergence, industry/market convergence, legislative, institutional and regulatory convergence, and device convergence, which result in, from the perspectives of economy, the entry of new players into the market, increasing competition among players operating in different markets, and requiring the necessity for traditional operators to co-operate with companies previously in other fields (Bernal, 2013). Liu (2013) also pointed out that DC takes different forms such as network convergence, market convergence, product convergence, service convergence, industry convergence, and technology convergence and the convergence of voice, video, and data has proved to be the trend.

To prevent falling behind from other countries too much, Taiwan government also announced that DC is one of the most important "policy goal" and, similar to other countries, launched the "Digital Convergence Development Program 2010-2015" in 2010 to accelerate the development of DC in Taiwan. Unfortunately, the effects of this program seem not obvious. According to a the results of Survey of Digital Convergence for Second Half of 2013" held by Taiwan's Digital Convergence Development Association(DCDA), only 16% of the total respondents heard the term "digital convergence". Otherwise, 84% of the respondents in Taiwan have never heard this term yet. Furthermore, only 7.7% of the respondents who heard the term "DC" understood the meanings of DC completely. In other words, only 1.23% of Taiwanese heard and understood the term DC after 3 year promotion of DC Development Program. As considering with the 5 dimensions of DC mentioned by Bernal (2013) and Liu(2013), it implies that the definition of DC is too complex to be understood by public and the officials and, hence, may cause the stagnation of DC policies in Taiwan. Therefore to find out some specific ways for explaining the meaning and development of DC become another important issue.

With our limited knowledge, no previous research has offered a method to investigate the progress of DC. As Liu (2013) mentioned, the convergence of voice, video, and data are the trends of DC. OECD(2008) also pointed that the converged services often are appearing in "markets" which provide data, television, fixed and mobile voice services. Therefore, the best way to analyze the progress of DC is from the perspective of market developments in voice, video, and data service. Besides, Bernal (2013) had also pointed that DC will increase the competition among players operating in different markets, no matter such competition resulted from the new entrances or the incumbent firms. Therefore, the method to measure the progress of DC must contain the meaning of competition in the "market".

¹ Wikipedia(2014), Digital convergence, http://en.wikipedia.org/wiki/Digital_convergence. Last retrieved: 08/05/2014.

² OECD(2008), OECD Policy Guidance on Convergence and Next Generation Networks, <http://www.oecd.org/sti/broadband/40869934.pdf>. Last retrieved: 08/05/2014.

In this study, we will apply the concepts of “market competition” and “industrial competition” to explain the meaning of DC from the perspective of “competition” in industrial economics. Then we will apply the econometric model vector autoregression(VAR) to capture the spirits of mutual competition and the dynamics among the converging markets by using the aggregate market data of cable and the internet service provider (ISP) industry because they offer the data and video service at the same time. We will also point out the obstacles which hinder the converging progresses in markets. Our empirical results indicate that both the DC in video and data transferring service market are progressing, but the degree of converging is higher in data transferring market than the video service market. The rest parts of this article are as follows: the literatures on market development of digital convergence are reviewed in section 2; the explanation of “market competition” and “industrial competition” and their implications for DC are shown in section 3; section 4 introduce the VAR model and the meaning of market competition of its estimated parameters; section 5 shows the origins of data and the empirical results of VAR models; finally, we conclude our discoveries and offer some suggestions for the policies and future studies in section 6.

2. Meanings of DC

To help people to understand the meanings of *Digital Convergence* (DC), we will firstly explain how does the digitalization in technology influence the market interactions among the converging related industries and how do their interactions change the competition environments in the market. With these efforts, we wish our explanation could help the mass to understand the meaning of DC.

2.1 The Influences of Digitalization

(1) Prompting the firms in communication industry to cross into the video service industry. Traditionally communications and the video industry belong to different industries. Communications industry uses the twisted copper to provide communication service only because the transmission technology is analogical and the space for voice transmission is small. Hence, it can only provide voice service. Once the twisted copper are replaced by fiber optic because of digitalization, same size cable can provide more transmission space for voice and fast up the transmission speed of traditionally communications service. In addition, the rest transmission space in fiber optic can also be used to transmit the video and data. Among them, data transmission service becomes the internet service provider market. But what the most different from communication service is the provision of video transmission service, which expand their services from traditional communications to the video services. In other word, the firms originally in the communication industry can also play roles in the video service industry. Takes for example, the Multimedia on Demand (MOD) provided by Chunghwa Telecommunications Company(CHT) service in Taiwan is a typical example. After this technological progress, CHT has become an important competitor in video market.

(2) Prompting the firms in video industry to cross into communication industry. Similar developments also have been happening in cable television (CATV) industry. Originally, the cable of CATV is in analogy and only for the purpose of video transmission. As the digitalized technology of video transmission appeared, to improve the quality of transmission, CATV operators upgraded their cable from the analogical to the digital. After this technology upgrade, the services provided by CATV operators

are expanded from the original video transmission to the communication and internet provision services and communication services. In other words, CATV operators who hold the fiber optic cable system can also operate Internet service through Cable Modem and enter the fixed-line communications services market. Therefore, the CATV operators eventually become an important competitor of fixed-line communications services and internet provision services industries.

(3) Breaking the boundaries between the communications and cable TV industry. Traditionally, due to the different transmission technologies, the market of communications industry and the cable industry was independent and do not belong to each other. But after the digitalization on their technologies, market players in these two industries can offer the service in other side to the public. Accordingly, the incumbents in communications industry can operate the video services and, conversely, the incumbents in cable TV industry can also operate services in the communications industry. In other words, they are converging in the market and hence increase the competition in the markets. As a result, the traditional classifications of industries are not adequate for the classification of the converging industries from the supply side. Only the classifications based on the demand side can identify them into communications, video, and internet service provision industries and one operator in the market might operate these three kinds of services at the same time.

(4) Increasing the competition among the converging industries. As mentioned above, the digitalization of communication and CATV industry increase the competition among the communications, video, and internet service provision industries. The operators in original industry have to face not only the market competition from other original counterparts but also the “industrial competition” from the new counterparts which original are in other industries. Therefore, digitalization brings the convergence among communications, video, and internet service industries and offers more diverse choices and lower prices because the consumers will be empowered by the higher bargaining power resulted from the increased competition. This is why the governments, such as the U.S., OECD, Japan, South Korea, and Taiwan promote DC so vigorous.

2.2 Market Competition V.S. Industrial Competition

From the classical economics, market competition refers to that, in a specific commodity/service market, there are several firms supply same or similar products to attract the interests and identifications of their commodity/service of consumers by offering favorable conditions on prices, qualities, service, and quantities. This is similar to the concept of intra-industry competition mentioned by Minniti(2009). Stigler(1968) pointed out that the concept “market competition” pertained to some basic conditions, such as numerous traders on each side of the market, independence of action, perfect knowledge, and divisibility of the commodity or service. So far as the presence or absence of monopoly power is concerned, it is not necessary to look at any other market. Furthermore, the concept of “industrial competition” is conceptualized by enlarged conditions of market competition, which insure an optimal allocation of resources by specifying the nature of the movement of resources “among markets and industries” (Stigler, 1968, p.6-7). These conditions include the resources mobility among uses and their owners are informed as to yields on these various uses. To sum up, in conventional economics, it is assumed that a firm in an industry can only offer

one specific commodity or service because of the limitation of production technology. In this firm plans to enter another industry, it has to invest construct the production line in new industry according to its technology. Therefore, such new investment for the purpose of extending the business territory needs new resources to put in, which intensifies the competition in another industry. This is the industrial competition defined by Stigler(1968). But the situations of DC industries are different. After the digitalization of firms in these industries, they can offer the similar commodities or services in another industry without enormously additional investments. Extremely speaking, they can serve the customers original in another industry without much more additional cost, or the zero marginal cost. In other words, the industrial competitions among DC industries do not need extra investment of original firms in original industries. Takes for example, addition to data transferring service, after digitalization, the firms in communication industry can also offer the video services which are originally offered by CATV industry without much further investments. Similarly, the firms in CATV industry can also offer the fixed-line voice services without much further investments after digitalization. Their across of each other’s market are the by-products of the digitalization of their original technology. Only the data transferring market is new for firms in these two industries.

2.3 Meanings of DC: Market Competition among “Converging Industries”

According to above discussion, we think the better way to define the DC is from the competitions among the DC industries. Even though they supply of new commodities/services which are supplied by the converging counterparts, all of them compete each other in the market now. In other word, from the perspective of demand side, the meaning of DC could be defined as follow: the DC means the market competition among the converging industries. Figure 1 and 2 indicate the competition structure before and after the DC. Following this definition, we can assume that, the more converge in a convergence related industries, the higher intensified market competition among the converging industries.

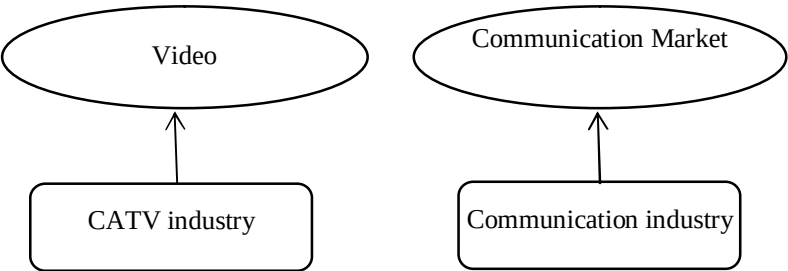


Figure 1 Competition Structure before DC

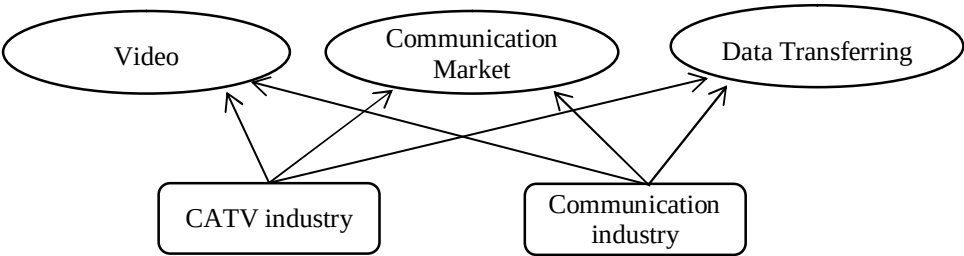


Figure 2 Competition Structure after DC

We will investigate the progress of DC in video and data transferring service market only because the DC in voice service market is still not happened in Taiwan because of piecemeal in the geographic segmentations of cable market (51 districts) which result in the operation of voice transmission services are not possible to achieve the economies of scale and of the problems of getting operation licenses in telecommunication industry from regulation authorities. Thus, no cable TV operators has entered the voice service market in Taiwan.³

3. Methodology: Vector Autoregression(VAR)

To investigate the progress of DC markets among the converging industries, we will employ the vector autoregression(VAR) model as our empirical method. The VAR model was proposed by Sim (1980), which assumes that all variables in a macroeconomic model are endogenous, without any presumed limitation on their relationships. There are three kinds of VAR models: reduced-form VAR, recursive VAR, and structural VAR. The first contains the lagged values of each analyzed endogenous variable as the explanatory variables in the regression model, and the second and third include not only the lagged endogenous variables but also the current (contemporary) period of other endogenous variables. The difference between the second and third VAR model is in the form of constraints on the parameters between contemporary values of other endogenous variables. Usually, recursive VAR is used for short-term constraints, and structural VAR is used when long-term constraints of parameters are imposed in the analytical processes. The model selected for analysis depends on the theories applied to the analyzed variables. Furthermore, the recursive VAR is a special form of structural VAR and is also called “half-structural VAR”. In this study, we apply the recursive VAR as our empirical model.

3.1 Recursive VAR (half-SVAR)

To introduce the recursive VAR (half-SVAR), we have to consider the reduced-form VAR(p) model first (where p is denoted as the lagged periods of dependent variables included in the explanatory variables). The dependent variables are the market sizes of video market, communication market, and data transferring market served by the new industry (denoted as x_{1t}) and by original industry (x_{2t}). (See Annex).

3.2 Granger Causality Test

Granger causality was proposed by Granger (1969) and is used as the prediction for causality. If variable x can offer enough information to predict variable y, we say that variable x “Granger-causes” variable y. As for applying the results of the Granger causality test, we could not conclude that x directly causes y if the test result is significant. This is because the test concept of Granger causality is based on statistical theory. We can only conclude that x Granger-causes y. We applied this test before the parameter estimation of reduced-form VAR(p). An interesting analysis of the

³ Once a cable TV in middle Taiwan got the operating license of supplying the telecommunication service, but it could not survive after a short term operation because of the limitation of geographic market.

limitations of this test, due to both multicollinearity and its lack of contemporaneous relationship, are presented in Guisan(2015) and other studies.

3.3 “Impulse Response Function” and “Variance Decomposition”

In the analysis of a recursive VAR model, we applied the concepts of impulse response function and variance decomposition to predict the mutual influences among variables. Impulse response function indicates how the changes of each endogenous variable will be influenced by a specific impulse resulting from one of the endogenous variables. Variance decomposition decomposes the predicted variances of each endogenous variable into various channels, in percentages, showing what percentage of fluctuations of an endogenous variable can be explained by itself and others. If the recursive VAR model is correct, it explains most of the predicted variances of each endogenous variable.

4. The Development of Converging Markets in Taiwan

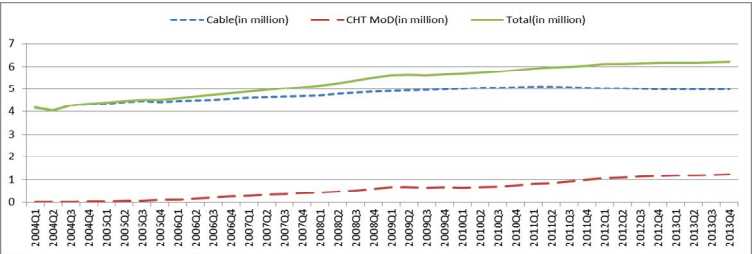
As Figure 2 shown, the markets for digital convergence include the video, communication, and data transferring market. In Taiwan, these services have been served by the firms originally in the CATV and Communication industries. Unfortunately, the digital convergences in Taiwan have happened in the video and data transferring markets only. The firms in communication industry still dominate and control the communication service market. Thus, in this section, we will only focus on the development of digital convergence in video and data transferring market in Taiwan.

4.1 The Convergence of Video Service Market

Before the entrance of IPTV service, supplied by the dominant firm in telecom industry, the Chunghwa Telecom, named as Chunghwa Telecom MoD(Multimedia on Demand)(CHT MoD hereafter) in March 2004, Taiwan's video service market was dominated by the regional cable firms with an average penetration rate over 60%(60.15% in 2004, 61.85% in 2005, and 65% in 2006). CHT MoD is a platform channel for multimedia contents. Leveraging CHT's broadband network (such as dynamic ADSL and fiber network), CHT can aggregate television channels, on-demand videos and other applications to appear on users' television via MoD set-top boxes, so that all viewers can enjoy ample and programs at the convenience of their homes. MoD's video-on-demand (VoD) function enables user to select the preferred programs for viewing at any time, as well as rewinding and forwarding the program as necessary. In addition, due to MoD's two-way networking characteristics, users are able to enjoy various entertaining and interactive activities. With the entrance of CHT MoD service, the regionally dominant cable firms began to face the challenges caused by the “new entrant” from a firm in an old industry, telecom industry, by using the newly digitalized technology.

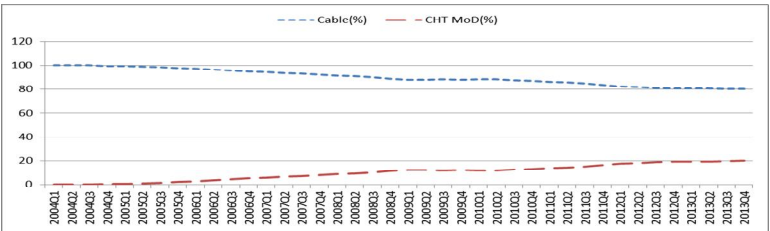
Figure 3 shows the trend of registration number in video service market from the perspective of different channels in Taiwan from 1st quarter 2004 to last quarter 2013. We find that the registration number of CHT MoD increases gradually and had passed the threshold of 1 million in the 1 quarter in 2012. Meanwhile, the registration number of Cable also increases continuously as facing the challenge of CHT MoD and over 5 million in Q1 2010, but declined to be lower than 5 million in Q3 2012. Besides, the total registration number of video service market grows continuously in the observation period. In other words, the market size of video market in Taiwan expands

continuously. Figure 4 shows the market share of cable and CHT Mod in Taiwan from 2004 Q1 to 2013 Q4. Obviously, the cable industry continuously loses its market share as facing the entrance of CHT MoD and approach to 80% gradually. On the contrary, the market share of CHT MoD climbs up continuously to almost 20% of the whole video service market in Taiwan. As the time passed, the gap between the market shares of these two video service channels is getting closer. In other words, the expansion of the size of video service market could be attributed to the expansion of registration number of CHT MoD. Even though the changes of registration number and market share indicate the mutual influences among the cable and CHT MoD, whether the levels of these influences are significant or not need further investigations. If these mutual influences are significant, we can conclude that the cable and CHT MoD service are in the status of “real” digital converging. Otherwise, the converging is still infant. We will show the empirical results for this question in next section by using the VAR model.



Resource: 1. Taiwan’s National Communications Commission(NCC), <http://goo.gl/TBzQex>; 2. Chunghwa Telecom Co., Ltd.

Figure 3 The registration number of cable and CHT Mod in Taiwan in 2004-2013



Source: calculated by authors from the data in figure 3.

Figure 4 The market share of cable and CHT Mod in Taiwan in 2004-2013

4.2 The Convergence of Data Transferring Service Market

From the dial-up Internet connections service, supplied by an internet supply providers (ISPs) in 1994, Taiwan’s data transferring service market has been dominated by Chunghwa Telecom’s HiNet service. At the same time, the ISPs also began supplying the leased line service for the enterprise internet demanders. Even though there had been other small ISP firms, they have never threatened CHT’s market position in these two kinds of Internet service. In 1998, 2 cable systems started to offer the cable modem service. This behavior not only opened the era of wideband internet connection but also started the clues of digital convergence in data transferring service in Taiwan. As facing this challenge, CHT fought back by offering the asymmetric digital subscriber line (ADSL) service to Taiwan’s Internet users in 1999. Then several

ISP firms followed the CHT to supply their own ADSL service, which resulted in the market of wideband connection in Taiwan had been dominated by this Internet connecting technology in next several years. In 2009, CHT began to supply the fiber to the x (FTTx) internet connection service. This kind of internet connection technology has largely improved the connecting speed of Internet in Taiwan and attracted a lot of ADSL users to switch their internet connection method. In 2011 August, the registration number of ADSL was dominated by FTTx. Then the FTTx has become the most popular internet connection method in Taiwan. From above short introduction of Taiwan's data transferring market, no matter the dial-up , leased line, ADSL, or the FTTx internet connections, most of them are supplied by the telecom firms and dominated by CHT Telecom, even though some small ISPs offer their similar services. From the perspectives of digital convergence, we should consider the changes of aggregate registration number of internet users in the data transferring services supplied by cable and telecom industry respectively instead of considering the numbers in different transferring technology. Figure 5 and 6, in the Annex, show the trend of aggregated registration number of internet users on the service supplied by firms in telecom and cable industry from 2nd quarter in 2003(2003 Q2) to 4th quarter in 2013(2013Q4).⁴.

In figure 5, we can find that both the registration number of data transferring service from telecom and cable industry increase gradually in the long term in spite of these numbers once decreased from 2009Q2 to 2010Q3 and from 2006Q2 to 2008Q1 in telecom and cable industry respectively. After the end of their drop on registration number, these two numbers regain their vitality to increase again. In addition, the total registration number of data transferring service continuously increases in the long time, which means that the whole data transferring market still expanding, even though the two depressed periods of registration number of telecom and cable modem industry lower its growth speed. Figure 6 shows that the market share of telecom industry on data transferring service market expanded from 2003Q3 to 2007Q3. Then it has begun to lose its market share until now. On the contrary, the market share of cable industry on data transferring service market shrunk from 2003Q3 to 2007Q3 and then has started to expand. In other words, the substitution, or the converging, phenomenon between the market share of cable and telecom industry on data transferring market is obvious. But whether the degrees of these substitutions are significant or not need further investigations.

5. The Empirical Results

5.1 The Data

Section 4 indicated that, no matter in the video or the data transferring service market, the penetration of market shares from the entrant industries are obvious from the observation of figure 4 and 6. To investigate the significances of their penetration

⁴ The earliest data we can get is in June 2003. Please refer to the website of Taiwan's National Communications Commission(NCC) for more detail information, <http://goo.gl/TBzQex>. Last retrieved: 11/08/2014. It's the monthly data. We adopted the data in March, June, September, and December in every year as the quarterly data to produce figure 5 and 6 and used the monthly data as implementing the VAR model.

level on the conventional industry in the market, we will implement the econometric model, the VAR. The data we used in the VAR models are the ones we used in section 4. For the VAR model in video service market, the quarterly registration number of cable, CHT Mod, and their totals in Taiwan are used from 2004 Q1 to 2013 Q4. The first two variables are used as the endogenous variables for the investigation of the significance of mutual influences and the last one is used as the exogenous variable for the investigation of effects of network size. As for the data transferring service market, we also will use the quarterly registration numbers of telecom, cable modem, and the totals in the VAR model from 2006 Q2 to 2013 Q4. The settings of variables in VAR model of this market are similar to the video service market. The values of all variables are taken the logarithm from the original data.

Table 1 shows the basic statistics of the variables for the VAR models. Finally, we did not apply the unit root test to investigate the stationary property for individual variable series but simply and directly estimate the VAR(p) model in levels and rely on standard t and F distribution for testing hypotheses. According to Hamilton(1994, pp.651-653), this strategy has the following features. (1) The parameters that describe the system's dynamics are estimated consistently. (2) Even if the true model is a VAR(p) in differences, certain functions of the parameters and hypothesis tests based on a VAR(p) in levels have the same asymptotic distribution as would estimates based on differenced data. (3) A Bayesian motivation can be given for the usual t or F distributions for test statistics even when the classical asymptotic theory for these statistics is nonstandard. Therefore, we follow Hamilton(1994)'s recommendation here. We implement the empirical procedures by using the statistic software Eviews 8.

Table 1 Basic Statistics for the Variables Used in VAR(p) Models (In Logarithm)

Variable		Obs.	Mean	Std. Dev.	Min.	Max.
Video Service Market	Ln(Cable)(endogenous)	38	15.38	0.053	15.27	15.44
	Ln(CHT MoD) (endogenous)	38	13.00	1.057	10.25	14.03
	Ln(Totals in Video)(exogenous)	38	15.50	0.120	15.28	15.64
Data Transferring Market	Ln(Telecom)(endogenous)	128	15.17	0.179	14.57	15.32
	Ln(Cable Modem)(endogenous)	128	13.41	0.364	12.60	13.97
	Ln(Totals in Data Transferring) (exogenous)	128	15.38	0.053	15.27	15.44

Source: Except the registration number of CHT MoD was collected from the Chunghwa Telecom, all other variables were collected from the website of Taiwan's National Communication Commission (NCC), <http://goo.gl/TBzQex>.

5.2 The Converging Progress of Video Service Market

Before we estimate the VAR(p), we have to determine the adequate lag period, p, to be included in the model. We implemented the lag-length selection procedures to find the basic lag period recommended by some statistic criterions. Table 2, in the Annex, presents the results of these statistic criterions and shows that most of the criterions indicated the most adequate lag time periods to be included in the VAR(p) model is 2 quarters, which means that $p=2$. Therefore we will include 2 lag periods in our empirical model. Table 3 lists the empirical results of VAR(2) model on Taiwan's video service market and table 4, in the Annex, shows the lag exclusion Wald tests.

From the results of table 4, it indicates that including lagged 2 periods is adequate for our empirical model from the afterwards perspective. From the empirical results in

table 3, firstly, we find that, no matter the CHT MoD or the cable industry, their registration number in previous 1 period significantly self-enforce themselves, but not the case for lagged 2nd period. In other words, the registration number of CHT MoD and cable industry in this period will attract more customers to register in next period.

Table 3 Estimated Results of VAR(2) Model for Taiwan's Video Service Market

Variable	Ln(CHT MoD)	Ln(Cable)
Ln(CHT MoD)(-1)	1.081938[8.57133]**	-0.02283[-1.69231]*
Ln(CHT MoD)(-2)	-0.23667[-1.97399]**	0.025150[1.96311]**
Ln(Cable) (-1)	2.622683[1.65610]*	1.159504[6.85195]**
Ln(Cable) (-2)	-3.21869[-1.93160]*	-0.19921[-1.11880]
Constant	-4.34198[-0.75017]	1.30561[2.11098]**
Ln(Total)(exogenous)	1.005094[2.81710]**	-0.04635[-1.21581]
R-squared	0.998093	0.992958
Adjusted R-squared	0.997775	0.991784
F-statistic	3139.495	846.0387
Log likelihood	67.28339	147.7893
Log likelihood for Joint Model	220.9529	
Observations	38(36 after adjustments)	

Note: Numbers in [.] are the t-statistics. * and ** represent the estimated parameter is significant at 10% and 5% significant level respectively.

In addition, the effects of registration numbers in lagged 2nd period are not as strong as the lagged 1st period, which means the net self-own effects are positive respectively. In addition, the registration number of CHT MoD significantly in last period lowers down the cable's registration number in present quarter, but the number in previous 2 periods significantly increases the registration number of cable industry in this period. Such converse influences between the registration number of CHT MoD in lagged 1 and 2 period indicated the unstable and disloyal on CHT MoD. The net effect of CHT MoD on cable industry is positive in these two periods if we sum up their estimated parameters. As for the influences of lag periods of cable's registration number on the ones of CHT MoD, we find that the cable's registration number in lagged 1 period increases the one of CHT MoD and lower it by the lagged 2 period number. Again the unstable viewing behaviors happened. It implies that the expansion of registration number of cable will help the CHT MoD to expand the registration numbers at t+1 and win some back in t+2. The net effect of cable industry on CHT MoD is negative in these two periods if we sum up their estimated parameters. The converse effects among the mutual influences terms indicate that the CHT MoD might attract more registers from cable industry than the numbers of CHT MoD register attracted by the by the cable industry. Finally, the effect of market size seems favor the expansion of CHT MoD more than of Cable because the its estimated parameter on Ln(CHT MoD) is positively significant. To make sure that our inference of empirical results in table 3, we implemented the recursive-VAR to investigate the temporal influence of Ln(CHT MoD) on the Ln(Cable). Table 5 shows the estimated results and indicates that the expansion of registration number of Ln(CHT MoD) at time t lowers down the counterparts of Ln(Cable). Therefore, as combining the estimated results of VAR(2) in table 3, we might conclude that the net influence of CHT MoD on cable is negative. Table 6, in the Annex present results in matrix form.

Table 5 Estimated Results of Recursive VAR model

Estimated Restriction	Coefficient	Std. Error	z-Statistic	Prob.
D_0^{21}	-0.05641**	0.015126	-3.72946	0.0002
B_{11}	0.040894**	0.004819	8.485281	0
B_{22}	0.003711**	0.000437	8.485281	0
Log likelihood	214.3893			

Note: * and ** represent significant at 10% and 5% significant level respectively.

To investigate our integrated inference above, we furthermore implemented the Granger Causality Test to investigate the overall influence of Ln(CHT MoD) on Ln(Cable) and vice versa. Table 7 list the test results and indicate that the Ln(CHT MoD) Granger causes the Ln(Cable) at 10% significant level but not the inverse direction. To sum up, in Taiwan’s video service market, the digital converging is progressing, but the strength of converging is not strong enough because the overall penetration power of entrant (CHT MoD) seems not strong enough to shake the market position of cable because its Granger Causality test is significant at 10% only.

Table 7 Granger Causality Test of Variables (Block Exogeneity Wald Tests)

Dependent variable	Ln(CHT MoD)			Ln(Cable)			Degrees of Freedom
	Excluded	X^2	$P(X^2)$	Excluded	X^2	$P(X^2)$	
Test	Ln(Cable)	3.9930	0.1358	Ln(CHT MoD)	5.0762	0.079*	2
	All	3.9930	0.1358	All	5.0762	0.079	2

Note: * and ** represent the estimated parameter is significant at 10% and 5% significant level respectively.

Finally, to investigate the mutual long term influences of endogenous variables, we also implemented the estimation of impulse response and variance decomposition of Ln(CHT MoD) and Ln(Cable) for 30 time periods. They are shown in figure 7 and 8, in the Annex, and showed the numerical values of variance decomposition in table 8 for details. In figure 7, we find that, no matter the CHT MoD or the cable industry, their registration numbers positive response by themselves in the long run. The registration number of CHT MoD will positively be influenced by the registration number of cable in 5 periods but negatively be influenced later. As for the registration number of cable industry, we find that it will always be negatively influenced by the impulses resulted from CHT MoD, but the levels are very small. Furthermore, from the results of variance decomposition in figure 8 and table 8, in the Annex, we find that the most of the variances of Ln(CHT MoD) and Ln(Cable) are explained by themselves, about 73%. Only 27 % of their variances are explained by their competitor in the long run. In other words, the digital convergence in Taiwan’s video service market is progressing, but in a relative smooth way in the long run, as comparing with Taiwan’s data transferring service market, the one we will discussed in next subsection.

5.3 The Converging Progress of Data service Market

As for the selection of lagged periods included in the VAR(p) model in Taiwan’s data transferring service market, table 9, in the Annex, shows that most of the criterions indicates 2 lagged period to be included is adequate. Therefore, the p for this market is also 2. The empirical results are list in table 10 and table 11 ([in the Annex](#))

shows the adequateness of including 2 lagged periods from the perspective of afterwards.

Table 10 Estimated Results of VAR(2) Model for Taiwan’s Data Transferring Service Market

Variable	Ln(Cable Modem)	Ln(Telecom)
Ln(Cable Modem) (-1)	0.863028[6.23999]**	-0.10743[-5.51207]**
Ln(Cable Modem) (-2)	-0.23097[-2.00351]**	0.012039[0.74105]
Ln(Telecom) (-1)	-2.98211[-3.63371]**	0.467100[4.03884]**
Ln(Telecom) (-2)	1.011531[1.72988]*	-0.12221[-1.48304]
Constant	-3.05647[-1.69723]*	0.453771[1.78805]*
Ln(Total)(exogenous)	2.470037[4.24429]**	0.70212[8.56116]**
R-squared	0.984105	0.998061
Adjusted R-squared	0.981834	0.997784
F-statistic	433.3815	3602.979
Log likelihood	69.40317	149.7446
Log likelihood for Joint Model	241.4275	
Observations	43(41 after adjustments)	

In table 10, we also find the self-enforcing effects happened in the Internet registration numbers of cable modem and telecom industry; the increases of the registration numbers in period t will expand their registration numbers in period t+1. Only the expansion of Internet registration number of cable modem in t-2 period will lower down its number in t period. No matter the cable modem or the telecom, the net effects from previous periods are positive for the Internet registration numbers in present period. As for the mutual effects of exogenous variables, the increases of Internet registration number of cable model at time t-1 will significantly decrease the ones of telecom industry at time t. Similar, the increases of Internet registration number of telecom industry at time t-1 also significantly decreases the ones of cable modem at time t, with smaller positively effects resulted from its Internet registration number at t-2. In other word, the net effects of lagged 2 periods from opponents industry are negative in Taiwan’s data transferring service market. From this perspective, we might infer that the progressive of digital convergence in this market might be sharper than the status in the video service market because they self-enforcing their Internet registration number and lower down the numbers of opponents. Finally, the network size effects resulted by the market size favor both industries but more on cable modem than the telecom industry.

We also implemented the recursive VAR model to investigate the influence of the Internet registration number of cable modem at present period on the ones of telecom industry. Tables 12 and 13 (in the Annex) show the empirical results and indicated that the Internet registration numbers of cable modem significantly negatively influence its counterparts in telecom industry (estimated parameter of D_{021}^{21}) in the present period. In other word, cable modem significantly penetrates Taiwan’s data transferring service market which originally is most served by telecom industry in the short run.

We also implemented the Granger causality test to investigate the overall mutual influences of Ln(Cable Modem) and Ln(Telecom). From the test results list in table 14, we can find that, overall, not only the Internet registration number of cable model “Granger cause” the numbers of telecom industry, but also the vice versa. In other

words, these two industries mutually penetrate deeply. As compared with the test results in video market, we can conclude that, overall speaking, the progress of digital convergence in data transferring service market is deeper than in the video service market in Taiwan.

Table 12 Estimated Results of Recursive VAR model

Estimated Restriction	Coefficient	Std. Error	z-Statistic	Prob.
D_0^{21}	-0.11472**	0.012782	-8.9754	0
B_{11}	0.048191**	0.005322	9.055385	0
B_{22}	0.003944**	0.000436	9.055385	0
Log likelihood	234.9403			

Note: * and ** represent the significant at 10% and 5% significant level respectively.

Table 14 Granger Causality Test between Endogenous Variables (Block Exogeneity Wald Tests)

Dependent variable	Ln(Cable Modem)			Ln(Telecom)			df
	Excluded	X^2	$P(X^2)$	Excluded	X^2	$P(X^2)$	
Test	Ln(Telecom)	18.9782	0.0001	Ln(Cable Modem)	63.17	0.00	2
	All	18.9782	0.0001	All	63.17	0.00	2

Finally, the impulse response functions of Internet registration number in cable modem and telecom industry are shown in Figure 9, in the Annex. We can find that, no matter cable modem and telecom industry, both of them positively response to their own impulses but negatively response to the impulses caused by their opponents but in different response levels. In the Internet registration number of cable modem, we find that the positive levels it responses to its own impulse is much larger than the negative responses to the impulses from telecom industry. On the contrary, the positive response levels of telecom industry to its own impulse are much smaller than the negative responses to the impulses from cable modem industry. In addition, all the responses for the different impulse origins are diminishing in the long run. Finally, from the estimated results in figure 10 and table 15, in the Annex, we find that their variance will be explained by different factors. Most of variance in the cable modem will be explained by itself about 96.60% (table 15). On the contrary, most of the variance of Internet registration number in telecom industry will be explained by the variations of cable modem(94.15%). Once more, we can infer that the degree of digital convergence in data transferring service market is much higher than the video service industry as comparing their estimated results of impulse responses and variance decomposition.

6. Conclusions and Discussions

In this study, we applied the concepts of “market competition” and “industrial competition” to explain the meaning of “digital convergence” (DC) from the perspective of “competition” in industrial economics. The markets we investigated are the video and data transferring service market only because the voice service market in Taiwan still controlled by the firms in conventional telecom industry. Then we apply the vector autoregression(VAR) to capture the spirits of mutual competition and dynamics among industries in the converging markets by using the aggregate market data in video and Internet service provider (ISP) industry because they offer the data transferring and video service at the same time. In each market, we investigated the mutual influences and dynamics between 2 industries, they are: the registration

numbers of cable and CHT Mod in video service market and ones of internet connection through cable modem and telecom industry in data transferring service market.

Our empirical results indicate that both the DC in video and data transferring service market are progressing from the estimated results of recursive-VAR, but the degree of converging is higher in data transferring market than the video service market from the perspective of testing results of Granger Causality and the estimated results in impulse responses and in variance decomposition. The net influences of CHT MoD on cable and of cable modem on telecom are negative and vice versa according to the empirical results of VAR(p) and recursive VAR. Besides, the testing results of Granger Causality indicate that CHT MoD Granger causes the cable industry but not the vice versa but the cable modem and telecom mutually Granger cause. In addition, the predicted response of CHT MoD to the impulses caused by cable industry will be positive firstly and then become negative after 5 periods. On the contrary, the response of cable to the impulses caused by CHT MoD will be negative all the time, but the level is diminishing. As for the cable modem and telecom industry, both of them positively response to their own impulses but negatively response to the impulses caused by their opponents but in different response levels. In addition, all the responses for the different impulse origins are diminishing in the long run. Finally, most of the variances of registration number of CHT MoD and Cable are explained by themselves, about 73%. Only 27% of their variances are explained by their competitor. In addition, the variances of registration number of cable modem and telecom will be explained by different factors. Most of variance in the cable modem will be explained by itself about 96.60% but most of the variance of internet registration number in telecom industry will be explained by the variations of cable modem (94.15%).

According to our empirical results, the DC of video and data transferring service market in Taiwan are progressing, but the degree of in data transferring service market is much higher than the video service industry as comparing their estimated results of impulse responses and variance decomposition. But why the progress DC in Taiwan's video service market is left behind than the data transferring service market needs further investigate. According to our observations, at least two factors hinder the speed of DC in video service market in Taiwan. Firstly, according to the Taiwan's Broadcasting and Television Act, political parties, the government, and the military must withdraw from the media industry (Article 19 in Cable Broadcasting and Television Law, Article 9 in Satellite Broadcasting and Television Act, Article 5 in Broadcasting and Television Act). CHT MoD is operated by CHT Telecom, a partially privatized telecom company which Taiwan's government is the biggest stockholder(35%), and thus violets these terms. To fit these legal regulations, CHT MoD has been asked to transform as a pure platform which operates of voice, data and image transmission only. It is not allowed to operate the normal business of a media firm. Secondly, firms in cable TV prevent the important channels they supplied to be also broadcasted by CHT MoD. Therefore, the CHT MoD platform has to supply the channels that are totally different from the ones supplied by cable TV, which result in the customers to consider that they are different video services. Finally, as for the undeveloped DC of voice market, the limitation and piecemeal of geographic markets

and problem of getting the operating license of cable TV operators are the main reasons to hinder its progress of DC in Taiwan.

Thus, to speed up the progress of DC in video service market and start up the DC in voice service market in Taiwan, the remove or deregulation of terms which require the political parties, government, and the military to withdraw from the media industry is necessary for the DC of video service market. Besides, the segmentations of geographic operating districts is not necessary anymore because of the minimum network sizes of operating the telecommunication service. Finally, the regulation authorities also have to require the cable operators to give up controlling the channels which can be transformed by CHT MoD platform. By these measures, we consider that the DC in video service will speed up and the DC in voice service market might start up. Through the competition among the converging industries, the welfare of consumers could be promoted directly.

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¹ on line at: <http://www.usc.es/economet/aeid.htm>

Annex on line at the Journal Website: <http://www.usc.es/economet/eaat.htm>

Annexes

Annex to section 3.

3.1 Recursive VAR (half-SVAR) To introduce the recursive VAR (half-SVAR), we have to consider the reduced-form VAR(p) model first (where p is denoted as the lagged periods of dependent variables included in the explanatory variables). The dependent variables are the market sizes of video market, communication market, and data transferring market served by the new industry (denoted as x_{1t}) and by original industry (x_{2t}). The most important difference between the VAR(P) and an autocorrelation(AR) model is that VAR(p) considers the cross-variable dynamics between the variables. The complete model of reduced-form VAR(p) may be written as Equation (1):

$$X_t = \Phi_1 X_{t-1} + \dots + \Phi_p X_{t-p} + e_t \quad (1)$$

where $X_t = [x_{1t}, x_{2t}]'$ $X_{t-i} = [x_{1t-i}, x_{2t-i}]'$ $i = 1, 2, \dots, p$ $e_t = [e_{1t}, e_{2t}]'$ and

$$\Phi_i = \begin{bmatrix} \Phi_i^{11} & \Phi_i^{12} \\ \Phi_i^{21} & \Phi_i^{22} \end{bmatrix}, i = 1, 2, \dots, p. \quad (2)$$

We denote Φ_i^{jk} as the effect of variable k on variable j in the lagged i period. If Φ_i^{12} and Φ_i^{21} are both significant, the variables x_1 and x_2 are the mutual influences in lag period i. Therefore, the error terms of each regression (denote as e_t) are correlated, as shown in Equation (3).

$$\Sigma_e E(e_t e_t') E \left(\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \begin{bmatrix} e_{1t} & e_{2t} \end{bmatrix} \right) = \begin{bmatrix} \text{Var}(e_{1t}^2) & \text{Cov}(e_{1t}, e_{2t}) \\ \text{Cov}(e_{2t}, e_{1t}) & \text{Var}(e_{2t}^2) \end{bmatrix} \quad (3)$$

In Equation (3), the parameters in reduced-form VAR are considered difficult to estimate because of the correlations between various equations, i.e.

$\text{Cov}(e_{1t}, e_{2t}) \neq 0$. However, Enders (2010) points out that the system of reduced-form VAR is a seemingly unrelated regressions (SUR) model with identical regressors and therefore each equation in the system can be individually estimated by the ordinary least square (OLS). In addition, OLS estimates are consistent and asymptotically efficient. Even though the errors are correlated across equations, SUR do not add to the efficiency of the estimation procedure, because all regressions have identical right-hand-side variables. We can observe that the reduced-form VAR(p) in Equation (1) considers the lagged periods of dependent variables only. To investigate the concurrent effects between endogenous variables, the equation must be modified as follows:

$$X_t = D_0 X_t + D_1 X_{t-1} + D_2 X_{t-2} + \dots + D_p X_{t-p} + B u_t \quad (4)$$

Equation (4) is the structural VAR model and $u_t \approx WN(0, 1)$ represents the vector of structural shocks. Therefore, Equation (4) is modified as

$$X_t = (I - D_0)^{-1} D_1 X_{t-1} + \dots + (I - D_0)^{-1} D_p X_{t-p} + (I - D_0)^{-1} B u_t \quad (5)$$

Let $\Phi_j \equiv (I - D_0)^{-1} D_j$, $e_t \equiv (I - D_0)^{-1} B u_t$ and $\Sigma_e = (I - D_0)^{-1} B B' (I - D_0)^{-1}$, then we can rewrite Equation (5) as

$$X_t = \Phi_1 X_{t-1} + \dots + \Phi_p X_{t-p} + e_t \quad (6)$$

Equation (6) is similar to Equation (1), but their estimation processes are different. Equation (6) could not be directly estimated by OLS because of the endogeneity problem between the simultaneous equations. The elements in matrixes $\{D_0, D_1, \dots, D_p, B\}$ are unidentified. If we assume B is a diagonal matrix and D_0 is

a lower triangular matrix: $B = \begin{bmatrix} B_{11} & 0 \\ 0 & B_{22} \end{bmatrix}$ and $D_0 = \begin{bmatrix} 0 & 0 \\ D_0^{21} & 0 \end{bmatrix}$, then a structural

VAR with such identifications, called “short-run recursive conditions”, is called the *recursive VAR*. Such recursive conditions imply that x_1 is the most exogeneity-oriented variable, and can influence x_2 . In contrast, x_2 is assumed to have no influence on x_1 . In this study, we set x_1 as the market sizes of new industry in DC because it can directly influence as the market sizes of original industry, according to the evolutionary history of different markets. We set x_3 as the employment variable for the same reason. By applying the Choleski decomposition, we can directly estimate the matrix $(I - \hat{D}_0)$ and $\hat{B}$ and determine that $\hat{D}_j = (I - \hat{D}_0)^{-1} \hat{\Phi}_j$ and $\hat{u}_t = \hat{B}^{-1} (I - \hat{D}_0) \hat{e}_t$, where $\hat{\Phi}_j$ is the matrix estimated from reduced-form VAR(p).

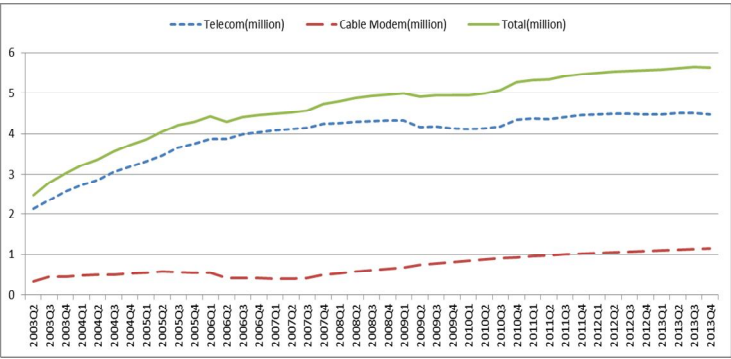
Another problem is the lag length that must be included in the reduced-form VAR(p) and recursive VAR model. In this paper, we will apply the Akaike information criterion (AIC), the Schwarz information criterion (SC), and the Hannan-Quinn information criterion (HQ) as the basic conditions to determine the lag length. However, the estimated parameters of lagged variables with the length we adopted from these tests were not significant. Therefore, we applied the lag exclusion test in advance to reduce the lag length included in the reduced-form VAR(p) model.

Table 2 Lag-Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	137.579	NA	4.65E-07	-8.90527	-8.71844	-8.8455
1	198.4855	105.5713	1.05E-08	-12.699	-12.3254	-12.5795
2	211.621	21.01675*	5.76e-09*	-13.3081	-12.74758*	-13.12876*
3	214.8571	4.746306	6.15E-09	-13.2571	-12.5098	-13.0181
4	217.4713	3.485595	6.93E-09	-13.1648	-12.2306	-12.8659
5	219.4858	2.417399	8.25E-09	-13.0324	-11.9114	-12.6738
6	224.653	5.511732	8.12E-09	-13.1102	-11.8024	-12.6918
7	233.4788	8.237413	6.43E-09	-13.4319	-11.9373	-12.9538
8	240.7867	5.846278	5.86E-09	-13.65244*	-11.971	-13.1145

Note: * indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

Annex to section 4



Resource: 1. Taiwan’s National Communications Commission(NCC), <http://goo.gl/TBzQex>.
Note: The registration number of telecom includes the registration number of dial-up , leased line, ADSL, and the FTTx connection service.
Figure 5 The registration number of internet connection service from telecom and cable modem in Taiwan in 2003-2013

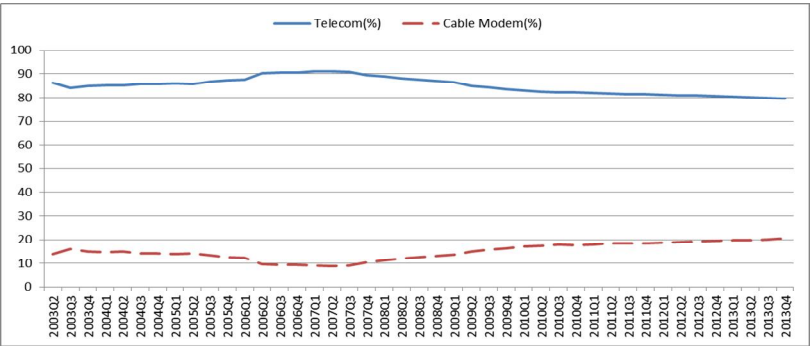


Figure 6 The market shares of telecom and cable modem in Taiwan’s data transferring service market in 2003-2013

Annex to section 5

Table 4 Lag exclusion Wald tests (X^2 test)

Lag	Ln(CHT MoD)	Ln(Cable)	Joint
1	74.44269[1.11e-16]	62.58609[2.56e-14]	157.5692[0.00000]
2	5.821664[0.054430]	7.158403[0.027898]	16.0146[0.003000]
Degree of Freedom	2	2	4

Note: Numbers in [.] are p-values.

Table 6 Estimated Results of Recursive VAR model in Matric Form

Estimated $(I - \hat{\pi}_0)$ matrix		Estimated $\hat{\pi}_0$ matrix	
0	0	1	0
-0.05641**	0	0.05641**	1
Estimated B matrix:			
0.040894**		0	
0		0.003711**	

Note: * and ** represent significant at 10% and 5% significant level respectively.

Table 9 Lag-length Selection Criteria for Taiwan's Data Transferring Service Market

Lag	LogL	LR	FPE	AIC	SC	HQ
0	44.43639	NA	0.000303	-2.42494	-2.33606	-2.39426
1	157.7518	207.2053	5.88E-07	-8.67153	-8.404900*	-8.57949
2	162.8352	8.714502	5.54e-07*	-8.733443*	-8.28906	-8.580041*
3	163.9975	1.859605	6.57E-07	-8.57129	-7.94915	-8.35652
4	166.5896	3.851142	7.21E-07	-8.49084	-7.69094	-8.21471
5	167.3789	1.082412	8.84E-07	-8.30736	-7.32972	-7.96988
6	167.6635	0.357828	1.13E-06	-8.09506	-6.93966	-7.69621
7	178.6293	12.53237*	7.91E-07	-8.49311	-7.15995	-8.0329
8	182.1618	3.633429	8.63E-07	-8.46639	-6.95548	-7.94483

Note: * indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

Table 11 Lag Exclusion Wald Tests (X^2 test) for VAR(2) model

Lag	Ln(Cable Modem)	Ln(Telecom)	Joint
1	74.00215[1.11e-16]	67.65441[2.00e-15]	79.44779[2.22e-16]
2	6.794407[0.033467]	2.681831[0.261606]	9.174027[0.056894]
Degree of Freedom	2	2	4

Note: Numbers in [.] are p-values.

Table 13 Estimated Results of Recursive VAR model in Matric Form

Estimated $(I - \hat{\pi}_0)$ matrix		Estimated $\hat{\pi}_0$ matrix	
0	0	1	0
-0.11472**	0	0.11472**	1
Estimated B matrix:			
0.048191**		0	
0		0.003944**	

Note: * and ** represent significant at 10% and 5% significant level respectively.

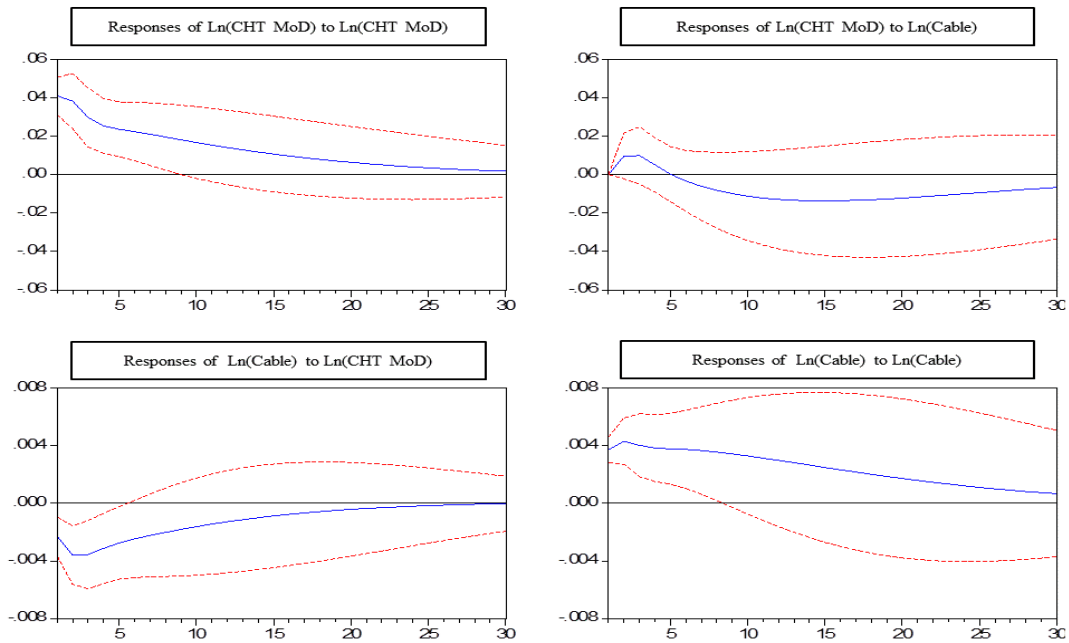


Figure 7 Impulse Response Functions of Endogenous Variables in Taiwan's Video Service Market

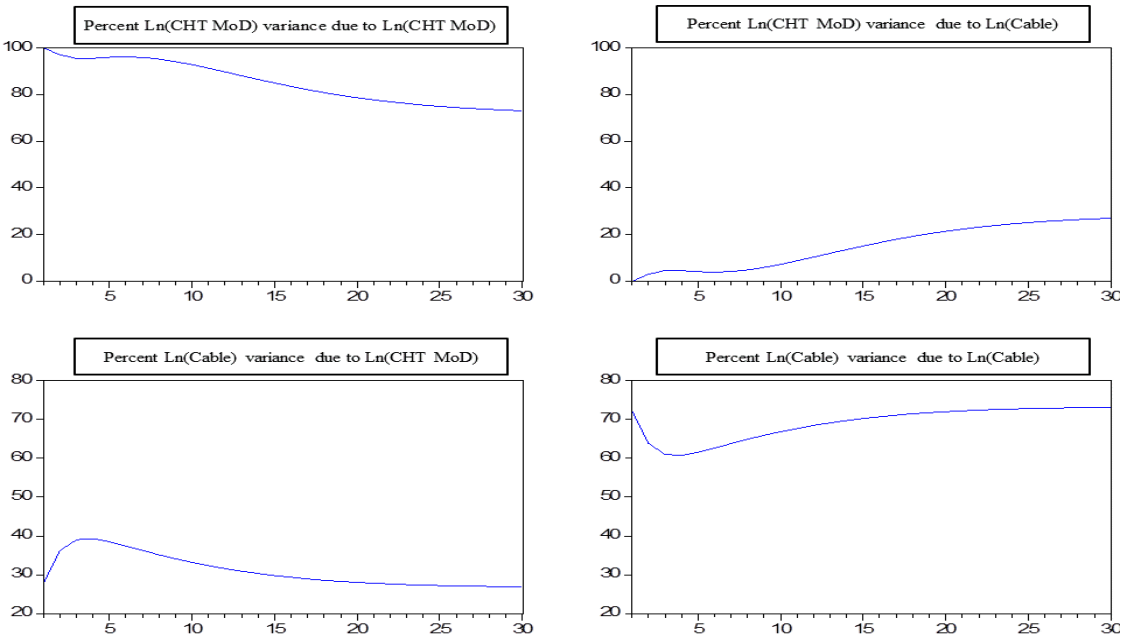


Figure 8 Variance Decomposition for Endogenous Variables in Taiwan's Video Service Market

Table 8 Variance Decomposition of Endogenous Variables in Taiwan's Video Service Market(%)

Period	Ln(CHT MoD)		Ln(Cable)	
	Ln(CHT MoD)	Ln(Cable)	Ln(CHT MoD)	Ln(Cable)
1	100	0	27.86849	72.13151
2	97.06314	2.936858	36.22378	63.77622
3	95.42406	4.575941	39.03789	60.96211
4	95.51556	4.484439	39.27724	60.72276
5	95.97443	4.025568	38.49201	61.50799
6	96.1317	3.868303	37.38982	62.61018
7	95.84906	4.150945	36.24475	63.75525
8	95.14755	4.852452	35.14734	64.85266
9	94.09327	5.90673	34.12642	65.87358
10	92.77223	7.227766	33.19215	66.80785
11	91.27408	8.725921	32.34726	67.65274
12	89.67948	10.32052	31.59022	68.40978
13	88.05443	11.94557	30.91684	69.08316
14	86.44961	13.55039	30.32156	69.67844
15	84.90187	15.09813	29.79819	70.20181
16	83.43654	16.56346	29.34038	70.65962
17	82.06961	17.93039	28.94189	71.05811
18	80.8099	19.1901	28.59672	71.40328
19	79.66079	20.33921	28.29919	71.70081
20	78.62176	21.37824	28.04401	71.95599
21	77.68948	22.31052	27.82626	72.17374
22	76.85874	23.14126	27.64141	72.35859
23	76.12317	23.87683	27.48534	72.51466
24	75.4757	24.5243	27.3543	72.6457
25	74.90893	25.09107	27.24491	72.75509
26	74.41546	25.58454	27.15414	72.84586
27	73.98803	26.01197	27.07931	72.92069
28	73.61967	26.38033	27.01801	72.98199
29	73.30381	26.69619	26.96816	73.03184
30	73.03432	26.96568	26.92791	73.07209

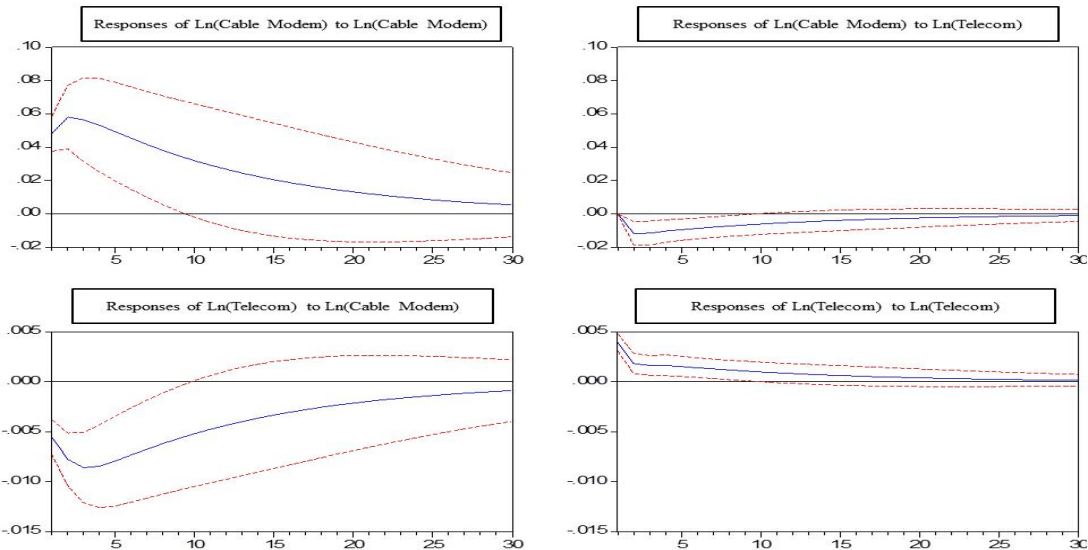


Figure 9 Impulse Response Functions of Endogenous Variables in Taiwan's Data Transferring Service Market

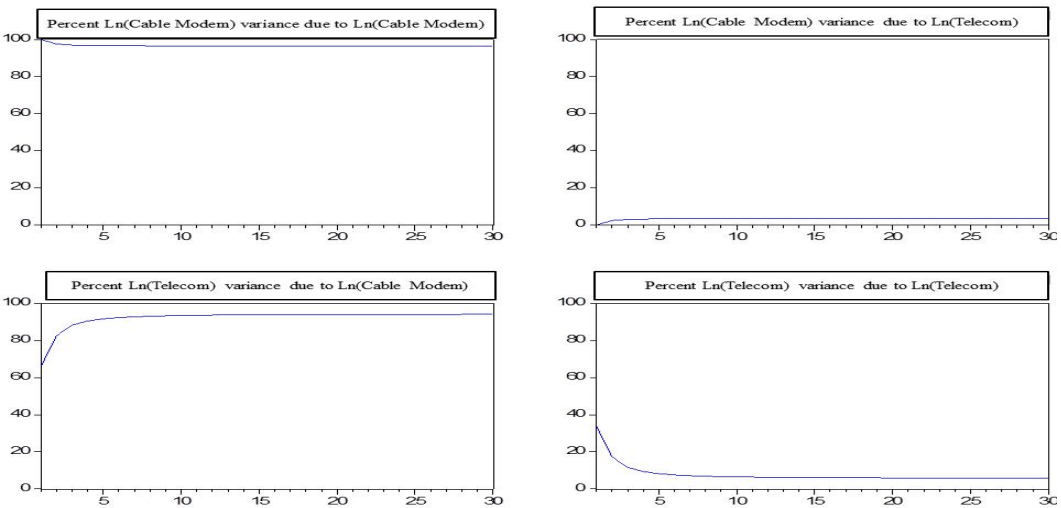


Figure 10 Variance Decomposition for Endogenous Variables in Taiwan's Data Transferring Service Market

Table 15 Variance Decomposition of Endogenous Variables in Taiwan's Data
Transferring Service Market (%)

Period	Ln(Cable Modem)		Ln(Telecom)	
	Ln(Cable Modem)	Ln(Telecom)	Ln(Cable Modem)	Ln(Telecom)
1	100	0	66.27119	33.72881
2	97.62862	2.371375	82.72994	17.27006
3	97.00883	2.991174	88.39473	11.60527
4	96.84553	3.154469	90.64634	9.353655
5	96.76936	3.23064	91.78642	8.213579
6	96.72302	3.276981	92.45912	7.54088
7	96.69279	3.307207	92.89287	7.107132
8	96.67189	3.328108	93.19028	6.809716
9	96.65674	3.343262	93.40359	6.596405
10	96.64539	3.354613	93.56173	6.438269
11	96.63669	3.363315	93.68191	6.318087
12	96.6299	3.370102	93.775	6.224996
13	96.62453	3.375468	93.84819	6.151813
14	96.62024	3.379756	93.90639	6.093605
15	96.61679	3.383211	93.95312	6.046876
16	96.61399	3.386014	93.99092	6.009083
17	96.6117	3.3883	94.02167	5.97833
18	96.60983	3.390174	94.04682	5.953185
19	96.60829	3.391714	94.06746	5.932541
20	96.60702	3.392984	94.08446	5.915537
21	96.60597	3.394035	94.09851	5.901493
22	96.60509	3.394905	94.11013	5.889868
23	96.60437	3.395628	94.11977	5.880228
24	96.60377	3.396228	94.12778	5.872221
25	96.60327	3.396728	94.13444	5.865562
26	96.60286	3.397144	94.13998	5.860018
27	96.60251	3.39749	94.1446	5.855399
28	96.60222	3.39778	94.14845	5.851547
29	96.60198	3.398021	94.15167	5.848334
30	96.60178	3.398223	94.15435	5.845651