

# **PARTIAL ADJUSTMENT MODEL IN TELECOMMUNICATION SECTOR<sup>1</sup>**

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*It is widely accepted nowadays that telecommunication has become one of the important sectors in a country's economy. Using the Partial Adjustment Model, this paper mainly investigates how nine different countries i.e. India, Indonesia, Japan, Malaysia, Netherlands, Philippines, Singapore, Thailand, and USA, have adjusted their telecommunication expansion policy toward the equilibrium level of telephone density for the 1979-1995 period. The result shows that Japan, Indonesia, Malaysia, USA and Singapore adjusted faster than other countries. Also, developing countries had greater influenced of per capita income to telephone density compared to the developed countries. Surprisingly, not all countries show that an increase in per capita income affects the telephone density.*

## **A. INTRODUCTION**

Telecommunications has had a considerable impact in the modern society. Enhancement in telecommunication technology coupled with the advanced computer and information systems makes the potential scale of its social, economic, and political impact unprecedented.

Telecommunications has provided benefits to society. Saunders et.al. (1994) note that the benefits from better telecommunications are instant availability of market information, higher efficiency of transportation, better regional development, easier access in opening isolated areas, better emergency security facilities, and easier coordination of international activities. Also, telecommunications has been widely used to improve health care and education sector.

However, there remain vast differences in telecommunications facility throughout the world nowadays. People in developed countries enjoy of

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having easy access and advanced services in telecommunications, while in some part of the world people have to wait for uncertainty of getting new telephone line.

The objective of this paper is to introduce the Partial Adjustment Model in telecommunication sector and to examine how several countries such as India, Indonesia, Japan Malaysia, Netherlands, Philippines, Singapore, Thailand and USA different in their telecommunication expansion policy for the period of 1979 to 1995.

The paper is divided into section. The next section (Section B) explains briefly the role of telecommunications in economic development. This is followed by an overview of empirical works in telecommunication sector and the introduction of Partial Adjustment Model (PAM). Methodology and Data used in this paper are explained in Section D. Section E. analyzes the use of PAM and attempts to relate the result of the time series regression with telecommunication expansion policy for nine selected countries. The last part (Section F) describes the conclusion and takes some lesson of the introduction of PAM in telecommunication sector.

## **B. TELECOMMUNICATIONS IN ECONOMIC DEVELOPMENT**

### Views on Telecommunications

The role of telecommunications in economic development has been widely recognized. Hornik (1990) postulates that telecommunications can be considered as a complement to development. Using telecommunications, the benefits from development policies can be

rapidly facilitated and distributed throughout economy. ITU (1990) remarks that telecommunications is essential for the development process which can raise productivity and efficiency of other sectors, and has enhancing the quality of life. Wellenius et. all. (1992) show that telecommunications is a fundamental factor of production in conjunction with the labor force and capital. They emphasize that telecommunications actually facilitates market entry, reduce costs, improves customer services, and increases productivity.

Among infrastructure projects funded by The World Bank, telecommunication projects has higher economic rate of return compared to other sector such as transportation, power, and irrigation (World Bank, 1994). The United States' vice president highlights that information and telecommunication technology bring economic progress, strong democracy, better environmental management, and improved health care (Gore, 1994). Meanwhile Emmot (1995) concludes that the marriage of information, creativity, telecommunications, and empowerment, will enable people across the world to electronically access, create, control and communicate any information anywhere and in anyway via multimedia applications combining digital video, graphics, sound and text.

However, there are also views suggesting that telecommunications brings social, economic, and political problems unless it is wisely managed. Tyler (1981) shows that in certain environments, telecommunications was considered counter-productive. Benefits accrued to the more wealthy and commercial sectors at the expense of

the whole economy. Lunstedts (1990) questions government's regulation in anticipating the complicated legal, ethical, and philosophical problems of surveillance technology in the United States.

Brooks (1990) suggests that information technology and telecommunications may worsen the present social structure class of the United States, leading to higher inequality. By invoking the Rawlsian concept of justice and Aristotelian concept of happiness, Daleiden (1990) addresses some of the philosophical implications of the controversy in the telecommunications industry nowadays. He argues that as human welfare is enhanced by the new services, multiplicity of those services may involve significant social cost in terms of investment and consumer confusion.

In spite of different views on telecommunications, the previous paragraphs show us that telecommunications has provided more benefits as long as the development policy in this sector is aimed to the welfare of the society.

### Recent Development in Telecommunications

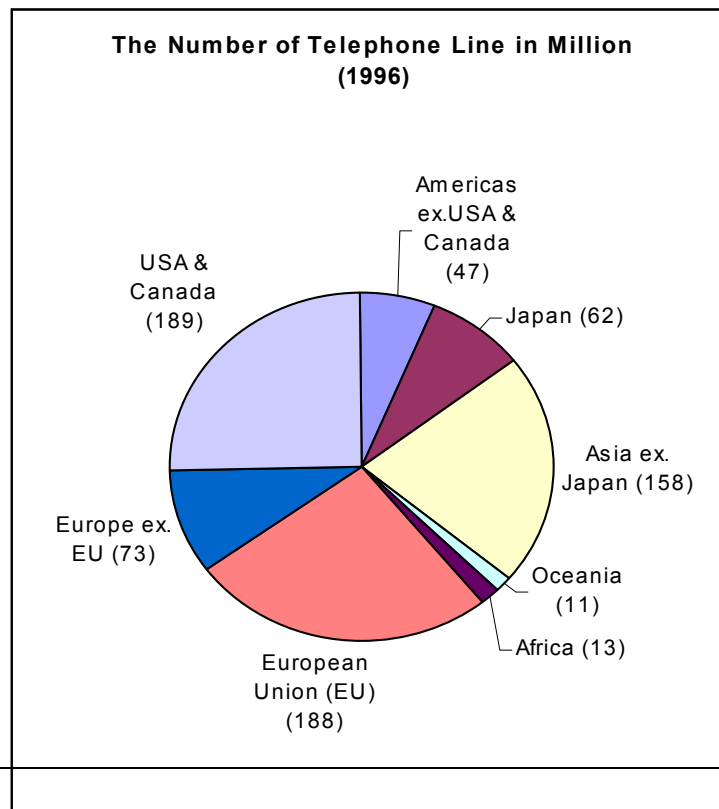
As the twentieth century winds to a close, there remain considerable differences in access to telecommunications all over the world. ITU (1998) shows that *teledensity*<sup>2</sup> in 1996 varied from 0.07 in Cambodia to 99 in Monaco, which indicates the wide range of telecommunication development around the world. Other dimensions of

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<sup>2</sup> Teledensity is the most common measure of telecommunication access that shows the number of main telephone line per 100 habitants. While main line refers to the number of the telephone lines connecting a customer's equipment (e.g. telephone set, facsimile machine) to the Public Switched Telephone Network (PSTN) and which have a dedicated port on a telephone exchange (ITU, 1995).

the contrast in access are just as dramatic, for example: (a) In early 1997, 62 % of total main lines were installed in just 23 developed countries, even though these countries account for less than 15 % of population; (b) More than 90 % of households in high income countries have a telephone compared to 16 % in the rest of the world; and (c) In terms of new networks and services, 84 % of mobile cellular phones and 97 % of internet host computer in the world are also in developed countries.

In addition, one of the most quoted statistics from the report of the Independent Commission for Worldwide Telecommunication Development headed by Maitland was that " *Tokyo has more telephones than the whole of African continent*". The latest data from World Visual Data Book (1999) shows the distribution of 741 million lines in 1996 in the following chart.



For the past four decades, the telecommunications network has grown at constant rate of between 4 and 7 per cent annually. Despite war and peace, or economic expansion and decline, the size of the world's telephone network has also grown more than eight-fold from less than 100 million lines in 1960 to around 800 million lines by the end of 1997 (ITU, 1998). There have been three distinct phases for that period:

- Period of 1960 to 1975, growth was driven mainly by Western Europe and Japan catching up with the high level of teledensity already achieved in Nordic countries and North America. Japan in this period rose its teledensity from 3.9 to 30.6. Innovative financing scheme, such as subscriber bonds purchased by customer when their telephones were installed, was a major factor to help finance the large investment program. However, there was a minimal growth in developing country.
- Between 1975 and 1985, the overall growth rate began to decline. Most developed countries had already attained a high level of access. During this second phase, Republic of Korea, Singapore, and Taiwan had their telecommunication access rise dramatically. They also showed that the transition from a teledensity of 10 to 30 could be completed more rapidly than previously expected.
- The last period, particularly from 1990 on, was marked by rapid growth in a number of developing countries. In Latin America, countries that privatized their operators such as Argentina, Chile and Venezuela have generally done well. East Asian countries, especially China, also achieved impressive development. China itself contributed

one fifth of the 300 million lines added during the period 1990-1997, rising its teledensity to over five.

Despite the tremendous strides that a number of countries have accomplished, there remain immense variations between regions and countries. However, one encouraging sign is, that as a country's teledensity rises, the number of years to reach the next level is shortened.

### The Reason for the Differences

Income is suspected as main factor affecting telecommunications access. Jipp firstly introduced the relationship between teledensity and Gross National Product (GNP) or Gross Domestic Product (GDP) in 1963. He used a single equation to show the strong correlation between telephone density and the "wealth" of a nation measure by GNP. His model then, has been widely used for planning purposes. Using his model, the Communication Committee for International Telecommunication and Telegraph (CCITT-a division of ITU) used cross-sectional data and found the result for 1965 as follows,

$$\ln d = -3.1329 + 1.405 \ln g \quad (1)$$

where  $d$  is teledensity and  $g$  is per capita GDP with an R-square is 0.91. The result shows that teledensity increases faster than per capita GDP. It is expected to grow at approximately 1.4 times of the growth rate of per capita GDP.

However, the passage of time has confused the relationship in two ways. On one hand, it appears to be less strong than it used to be. This

is perhaps because of the increase in complexity of measuring and comparing wealth among countries. Changing in currency rate and differences in national purchasing power have also become more pronounced. On the other hand, a change in GNP can now bring about a greater change in teledensity than in the past. This may be the result of the improvement in technology which allow telephone networks to be constructed more efficient as well as the growing use of telecommunication services as a factor of production (ITU, 1998).

However, the latest finding of ITU (1998) shows that wealth alone is insufficient to explain the differences between countries in telecommunications access. Two other factors that are very significant in affecting correlation between wealth and telecommunications access are income distribution and country size.

In reality, economic growth and telecommunications development affect each other. They are connected in a complicated open system. Also they might influence each other, either positively or negatively, by a range of other interconnected factors. For example, telecommunication prices, technology, and the regulatory environment all influence telecommunication development.

### **C. EMPIRICAL WORKS IN TELECOMMUNICATION EXPANSION POLICY AND PARTIAL ADJUSTMENT MODEL**

#### Empirical Works in Telecommunication Expansion Policy

Even though the role of telecommunications on economic development is widely accepted, empirical works relating economic

development and telecommunications in particular is rather limited. Following Jipp's work as mentioned in the previous chapter, another related study was done by Bebee and Gilling (1976). They examined the relationship between "telephone index" and development support index" in terms of measure of capital expansion and quality of manpower. They found that as countries become more developed, telephone availability and use appear to increase faster than other development support factors.

A similar study was also carried out by CCITT. CCITT tried to rank the "utilization factor" which is defined as the number of telephone per \$ 100,000.0 GDP for 55 economies in 1961 and 1971. The result shows that industrialized countries have higher utilization factor than developing countries. This implies that developing countries should raise their priority for telecommunication investment.

In assessing the role of telecommunication in economic development, we can also use structural economic analysis that relies mainly on classical tool of input-output analysis as outlined by Gillis et.all. (1996). However, this approach suffers from many problems, such as the difficulty of separating telecommunication contribution from other similar sectors like transportation, post or telegraph.

There are other shortcomings for the previous empirical works if we want to use it to examine how a country performs its telecommunication policy compared to the rest of the world. With cross-sectional data as Jipp and CCITT used in their approaches, we can only predict the teledensity for a given level of a country's income at specific time period.

We have to update all of the GDP and teledensity every year in order to be able to find a new international regression line. Then, based on the difference between its position and international line, we can only see the gap of teledensity. In addition, we can not capture the trend of country's expansion policy.

### Partial Adjustment Model

Partial Adjustment Model (PAM) is firstly introduced by Marc Nerlove in rationalizing Koyck Model to explain distribution lags (Gujarati, 1995). This model assumes that there is equilibrium, desired, or long-run relationship between capital stock needed to produce a given output under the given state of technology, interest rate, etc.

For simplicity assume that this desired level of capital  $Y_t^*$  is a linear function of output  $X_t$  as follows:

$$Y_t^* = \beta_0 + \beta_1 X_t + \mu_t \quad (2)$$

Since the desired level of capital is not directly observable, Nerlove postulates partial adjustment hypothesis:

$$Y_t - Y_{t-1} = \delta (Y_t^* - Y_{t-1}) \quad (3)$$

Where  $0 < \delta < 1$ , and  $\delta$  is known as the coefficient of adjustment.

Equation (3) postulates that the actual change in capital stock in any given time  $t$  is some fraction  $\delta$  of the desired change for that period. If  $\delta = 1$ , it means that actual stock adjusts to desired stock instantaneously (in the same time period). On the other hand, if  $\delta = 0$ , it means that nothing changes since actual stock at time  $t$  is the same as the previous one.

Now, substituting equation (2) into (3) will give:

$$Y_t = \delta\beta_0 + \delta\beta_1 X_t + (1 - \delta) Y_{t-1} + \delta\mu_t \quad (4)$$

Equation (4) is called Partial Adjustment Model. While equation (2) shows the long-run relationship, equation (4) gives the short-run relationship between capital  $Y_t$  and output  $X_t$ .

## **D. METHODOLOGY AND DATA**

### **Methodology**

As this paper tries to introduce PAM in telecommunication sector and to examine how countries have experienced their telecommunication expansion policy as described in Chapter B., we begin with the assumption that the number of main telephone line in a country is a function of country's income, population, revenue from telecommunications services, and country size. However, due to the complicated nature of telecommunication planning and the purpose of this paper, we simplify the assumption that only income and population of country determine telephone line. This can be stated as follows,

$$Tel = F(GDP, Pop) \quad (5)$$

Where  $Tel$  is telephone line; GDP represents country's income; and Pop is total population of the country. Equation (7) can be simplify into,

$$d_t = F(g_t) \quad (6)$$

Where  $d_t$  is teledensity at time t and  $g_t$  is per capita GDP at time t. This relationship can be expressed in exponential regression model as follows,

$$d_t^* = \beta_0 g_t^{\beta_1} e^{\mu t} \quad (7)$$

Now, applying the same procedure of PAM in equation (2), (3) and (4) to equation (7) will give the desired or **long-run** relationship between teledensity and per capita income as follows,

$$\ln d_t^* = \ln \beta_0 + \beta_1 \ln g_t + \mu_t \quad (8)$$

while the **short-run** relationship between teledensity and per capita income is as follows,

$$\ln d_t = \delta \ln \beta_0 + \delta \beta_1 \ln g_t + (1 - \delta) \ln d_{t-1} + \delta \mu_t \quad (9)$$

Therefore, we can use  $\delta$  as the coefficient of adjustment to determine how a country has performed its telecommunication expansion policy for certain period in catching up its teledensity with international density line. Besides that, t-values of the coefficients will show whether income and lag values of teledensity contribute significantly to the current teledensity. In addition, having the short-run equilibrium of teledensity with respect to income, we can find the long-run relationship or desired level of teledensity for a specific country

### **Data**

This paper examines time series data from 9 countries i.e., India, Indonesia, Japan, Malaysia, Netherlands, Philippines, Singapore, Thailand, and The United States (USA) for the period of 1979 to 1995. Countries are chosen from some Southeast Asian region to represent the group from developing countries. While developed countries are chosen from three different continents, i.e. Japan, USA, and Netherlands. Meanwhile India is also selected to represent country that is large in size and big in population.

The main data used in the regression is the number of main telephone line. Next is country's income stated in per capita GDP. The last is the number of population.

Number of telephone line is derived from *Yearbook of Public Telecommunication Statistics* published by ITU. Per capita GDP is downloaded directly via internet from Penn World Table using Laspeyres Index for 1985 international prices (dollar). Meanwhile the number of population is taken from The World Bank's "World Tables 1995".

## **E. ANALYSIS**

We start the analysis by recalling the short-run and long-run equation as written in equation (8) and (9) as follows,

$$\mathbf{Long -Run} : \ln d_t^* = \ln \beta_0 + \beta_1 \ln g_t + \mu_t$$

$$\mathbf{Short-Run} : \ln d_t = \delta \ln \beta_0 + \delta \beta_1 \ln g_t + (1 - \delta) \ln d_{t-1} + \delta \mu_t$$

The result of regression for all selected countries are summarized in Table - 1. Part A and Part B shows coefficients for  $\ln g_t$  and for  $\ln d_{t-1}$  including the constants both for long-run and short-run equation. Both R-square and F-values turn out to be favorable figures. Part C of the table gives the coefficient of adjustment for related country.

All coefficients for lag values of density ( $\ln d_{t-1}$ ) are statistically significant at 5 percent level. Coefficient of income ( $\ln g_t$ ) for Netherlands, Philippines, Singapore, USA and Thailand are found not statistically significant, but for India it is significant at 10 percent level. While for Indonesia, Japan, Malaysia, and this coefficient is statistically significant at 5 percent level.

These results imply that for the period of 1979 to 1995, telecommunication expansion policies in Indonesia, Japan and Malaysia, are strongly correlated with the income, while for India it is somewhat correlated. In the short run, one percent increase in per capita GDP will give an increase of 1.01%; 0.3%; and 0.76% of teledensity for Indonesia, Japan, and Malaysia respectively. On the other hand, the increase in teledensity is not strongly influenced by the growth of per capita GDP for Netherlands, Philippines, Singapore, Thailand and USA.

Coefficients of adjustments ( $\delta$ ) on the other hand, turn out to be interesting. Indonesia, Japan, Malaysia, Singapore, and USA have positive values i.e., 0.318; 0.413; 0.308; 0.100; and 0.271 respectively and follow the condition that lie between zero and one. While for India, Netherlands, Philippines, and Thailand, these coefficients are negative.

The results show that the actual increase in teledensity in any given time from 1979 to 1995 in Indonesia, Japan, Malaysia, Singapore and USA is some fraction of the desired change for that period. For example, Indonesia in average adjusted about 32 percent of its actual change in teledensity with respect to the desired change every year. While Japan has the highest coefficient of adjustment i.e. 0.413. Meanwhile for India, Netherlands, Philippines, and Thailand, the actual increase in teledensity is not a fraction of the desired change. This implies that annual increase in telephone line for Netherlands, India, Philippines, and Thailand did not have a smooth pattern for the given period. In other words, the supply of telephone lines for these countries has fluctuated.

The summary of long run relationship between teledensity and country's income, and the degree of correlation, coefficient of adjustments can be seen in the following table.

**SUMMARY OF LONG-RUN EQUATIONS AND  
COEFFICIENT OF ADJUSTMENT**

<b>Country</b>	<b>L-R Equation</b>	<b>Level of Significance</b>	<b>Delta</b>
1. Japan	$\ln d_t^* = -3.301 + 0.745 \ln g_t$	Strong (5 percent)	0.4134
2. Indonesia	$\ln d_t^* = -24.105 + 3.155 \ln g_t$	Strong (5 percent)	0.3189
3. Malaysia	$\ln d_t^* = -18.506 + 2.462 \ln g_t$	Strong (5 percent)	0.3087
4. U S A	$\ln d_t^* = -15.774 + 2.029 \ln g_t$	Less strong	0.2717
5. Singapore	$\ln d_t^* = -2.329 + 0.681 \ln g_t$	Weak	0.1007
6. Netherlands	$\ln d_t^* = -23.104 + 2.706 \ln g_t$	Weak	-0.0201
7. Thailand	$\ln d_t^* = -13.476 + 1.635 \ln g_t$	Weak	-0.1582
8. India	$\ln d_t^* = -12.049 + 1.536 \ln g_t$	Less strong	-0.1813
8. Philippines	$\ln d_t^* = -3.064 + 0.389 \ln g_t$	Weak	-0.3580

**F. CONCLUSION**

After introducing the Partial Adjustment Model (PAM) into telecommunication expansion policy and analyzing the result of all regression for time series data from 1979 to 1995 for 9 different countries, we can draw some lessons and conclusion as follows,

- All coefficients for lag values of teledensity ( $\ln d_{t-1}$ ) are statistically significant. However, the positive coefficients of adjustment ( $\delta$ ) are only found for Japan, Indonesia, Malaysia, USA and Singapore.

Therefore, these five countries adjusted their actual increase in

teledensity to the desired change for the given period, but not for India, Thailand, Philippines and Netherlands.

- The increase in telephone density for Japan, Indonesia, Malaysia, and USA are influenced by country's income. Indonesia and Malaysia have higher growth rate of teledensity for one percent increase in per capita GDP i.e., 3.1 percent and 2.5 percent respectively, followed by USA and Japan with the lower rate.
- Developed countries like Japan and Singapore increase their telecommunication access with slower rate compared to developing countries like Indonesia, Malaysia, and Thailand for any increase in their income. However, USA is still expanding their telecommunication access with higher rate. This tells us that country's size is also another factor to be considered in telecommunication expansion policy.
- Even though having some shortcoming in dealing with negative coefficient of adjustment, the use of Partial Adjustment Model in telecommunication field to some degree can explain why countries different in their telecommunication expansion policy.

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