

The Changes and Trends in Telephone Household Coverage

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Overview

- ✚ Mobile Telephone Penetration Rate(MTPR)
- ✚ Fixed Telephone Penetration Rate(FTPR)
- ✚ MTPR / FTPR in Selected Countries
- ✚ Fixed Telephone Households Coverage(FTHC)
in Selected Countries
- ✚ Using Hierarchical Multivariate Linear Model
for FTHC
- ✚ Unrestricted Model
- ✚ Basic Quadratic Growth Model for FTHC
- ✚ Advanced Quadratic Growth Model 1 for FTHC
- ✚ Advanced Quadratic Growth Model 2 for FTHC
- ✚ Conclusion

Mobile Telephone Penetration Rate (MTPR)

■ Mobile Telephone Subscribers(MTS) :

Users of portable telephones subscribing to an automatic public mobile telephone service

■ MTPR :

$$(\text{\# of MTS} / \text{Population Size}) \times 100$$

- Mobile subscribers per 100 inhabitants

Fixed Telephone Penetration Rate (FTPR)

■ Main Telephone Lines(MTL) :

Telephone lines connecting the subscriber's terminal equipment to the public switched network

■ FTPR :

$$(\text{\# of MTL} / \text{Population Size}) \times 100$$

- Main telephone lines per 100 inhabitants

MTPR / FTPR in Selected Countries

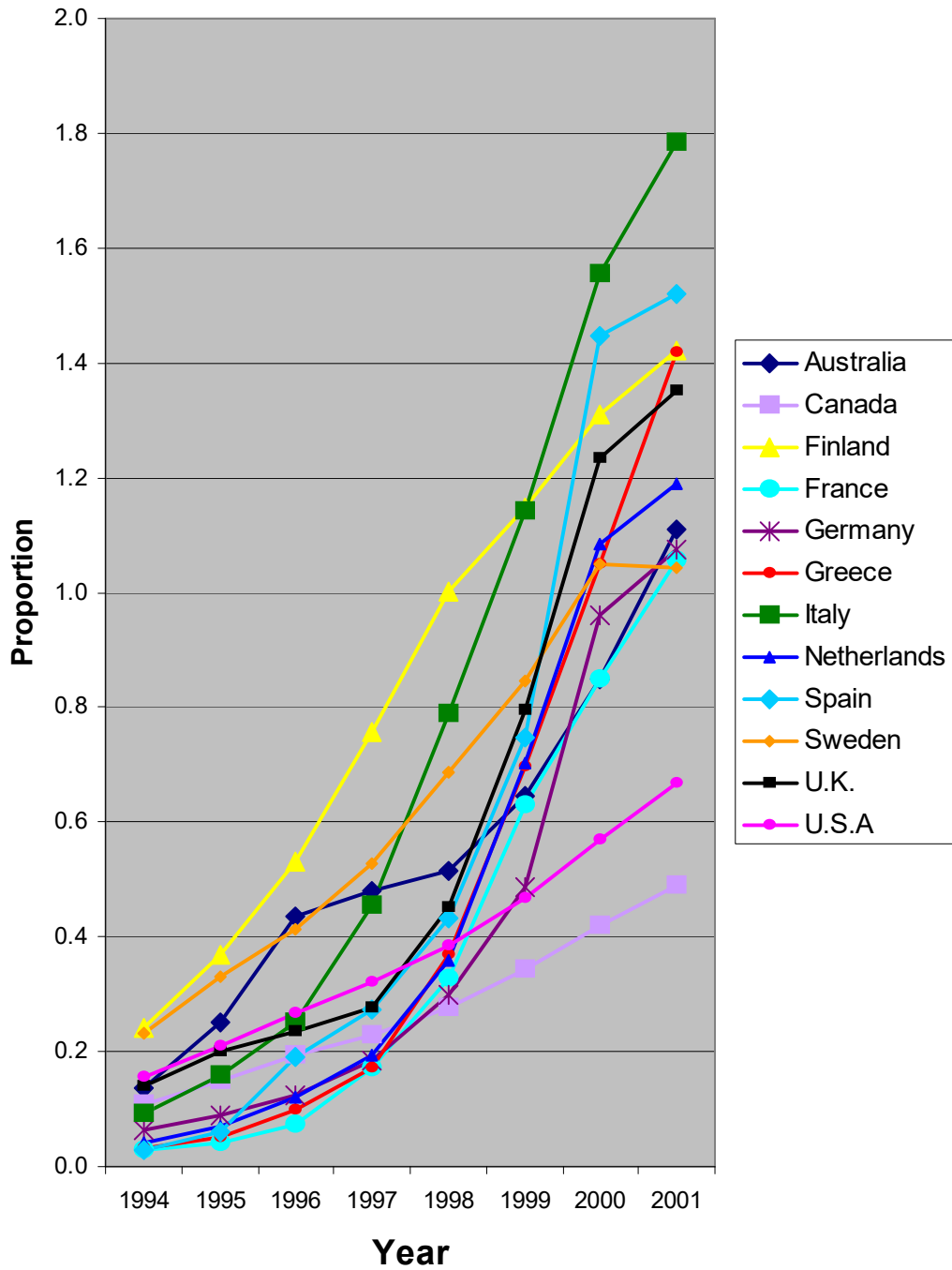
- $\text{MTPR} / \text{FTPR} = \# \text{ of MTS} / \# \text{ of MTL}$

- **Cross-over Point :**

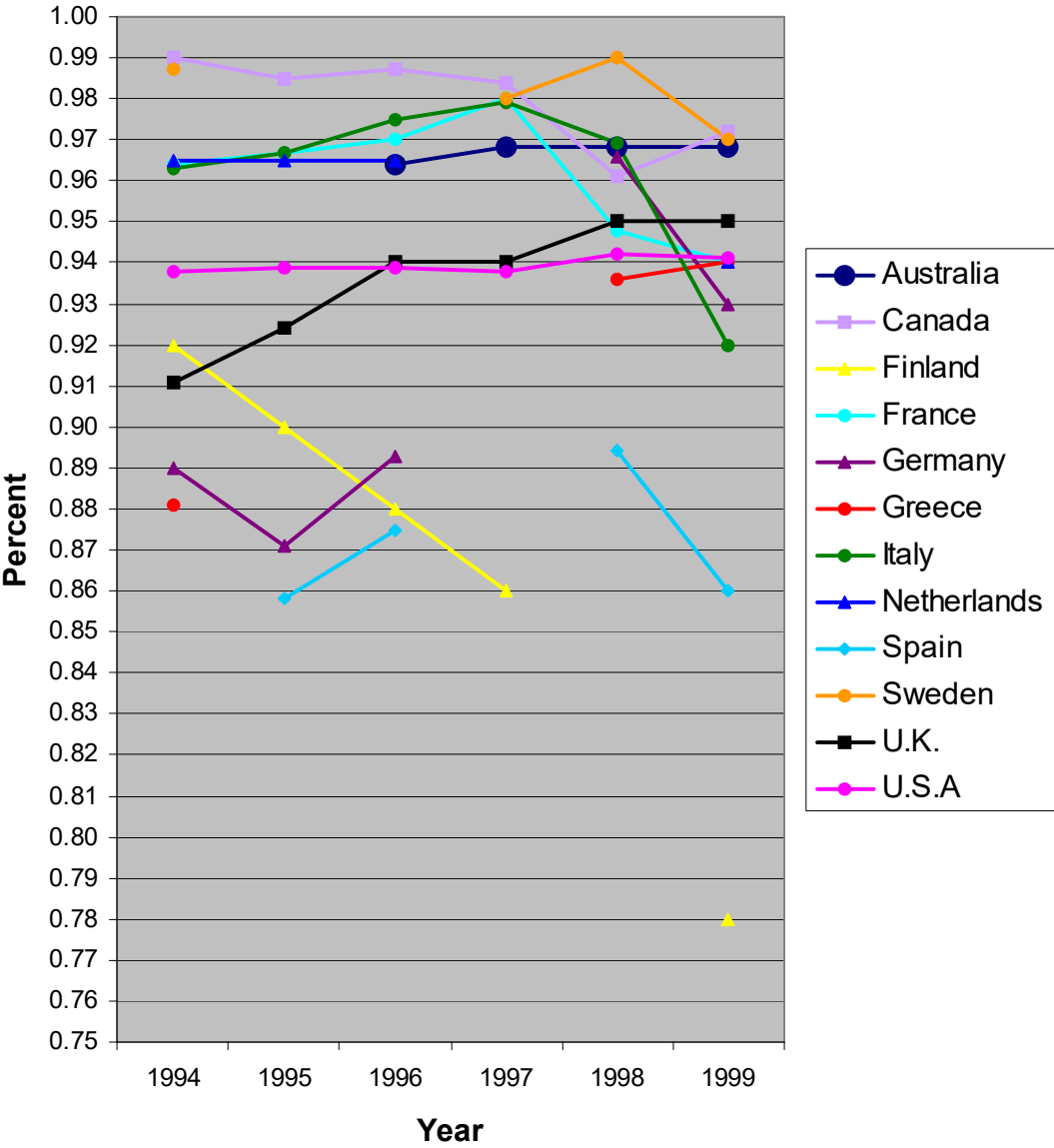
Certain Year that Mobile Telephone
Subscription overtakes Fixed Telephone
Subscription, that is,

$$\text{MTPR} / \text{FTPR} > 1$$

MTPR/FTPR



Telephone Household Coverage in Selected Countries



Using Hierarchical Multivariate Linear Model(HMLM) for FTHC

- Application of Growth Model at Level 1 and Level 2 on the Changes of FTHC for 12 Countries
- Allowing Estimation of Multivariate Normal Models from Incomplete Data
- Development of Some Main Factors to verify the Trends for FTHC due to Mobile Effects

✚ Unrestricted Model

■ Level-1 Model

: model for the within-subject variation

$$Y_{ti} = \pi_{0i} + \sum_{q=1}^Q \pi_{qi} X_{qti} + e_{ti}$$

where Y_{ti} : t -th observed status for subject i ,
 $t = 1, \dots, T$

π_{qi} , $q = 0, 1, \dots, Q$: level-1 coefficients

X_{qti} : level-1 predictor q

or, in matrix notation

$$Y_i = X_i \beta_i + e_i, \quad e_i \sim N(0, \Sigma)$$

■ Level-2 Model

: model for the variation between subjects

$$\pi_{qi} = \beta_{q0} + \sum_{s=1}^{S_q} \beta_{qsi} W_{qsi}, \quad q = 0, 1, \dots, Q$$

where β_{qsi} , $s = 0, 1, \dots, S_q$: level-2 coefficients

W_{qsi} : level-2 predictor s

All random variation absorbed into Σ

Basic Quadratic Growth Model for FTHC

(Level-1 Model)

$$Y_{it} = \pi_{0i} + \pi_{1i}(a_{it} - L) + \pi_{2i}(a_{it} - L)^2 + e_{it}$$

where Y_{it} : t -th observed FTHC for country i ,
 $t = 1, \dots, 6$

a_{it} : t -th observed year for country i

L : specific centering year

\Rightarrow

$$Y_{it} = \pi_{0i} + \pi_{1i}(Year_{it} - 1994) + \pi_{2i}(Year_{it} - 1994)^2 + e_{it}$$

(Unconditional Level-2 Model)

$$\pi_{0i} = \beta_{00},$$

$$\pi_{1i} = \beta_{10},$$

$$\pi_{2i} = \beta_{20}$$

Table 1. Basic Quadratic Growth Model for FTHC

Fixed Effect	Coefficient	Standard Error	T-ratio	P-value
Mean FTHC in 1994, β_{00}	0.915	0.010	93.044	0.000***
Mean Growth Rate in 1994, β_{01}	0.020	0.004	5.477	0.000***
Mean Acceleration, β_{02}	-0.003	0.001	-6.038	0.000***

*** : P-value < 0.001

Table 2. Growth Rate at Certain Year

Year	$\pi_{1i} + 2 \pi_{2i}(\text{Year}_{ii} - 1994)$
1995	0.014
1996	0.007
1997	0.000
1998	-0.006
1999	-0.013

Advanced Quadratic Growth Model 1 for FTHC

(Level-1 Model)

$$Y_{ti} = \pi_{0i} + \pi_{1i}(\text{Year}_{ti} - 1994) + \pi_{2i}(\text{Year}_{ti} - 1994)^2 + e_{ti}$$

(Level-2 Model)

$$\begin{aligned}\pi_{0i} &= \beta_{00} + \beta_{01} W_{01i} = \beta_{00} + \beta_{01} (\text{SYSTEM}), \\ \pi_{1i} &= \beta_{10} + \beta_{11} W_{11i} = \beta_{10} + \beta_{11} (\text{SYSTEM}), \\ \pi_{2i} &= \beta_{20} + \beta_{21} W_{21i} = \beta_{20} + \beta_{21} (\text{SYSTEM})\end{aligned}$$

where **SYSTEM** : Indicator for Mobile System

Single Mobile System(SMS) : 1
- European Countries

Multiple Mobile System(MMS) : -1
- Non-European Countries

**Table 3. Advanced Quadratic Growth Model 1
for FTHC**

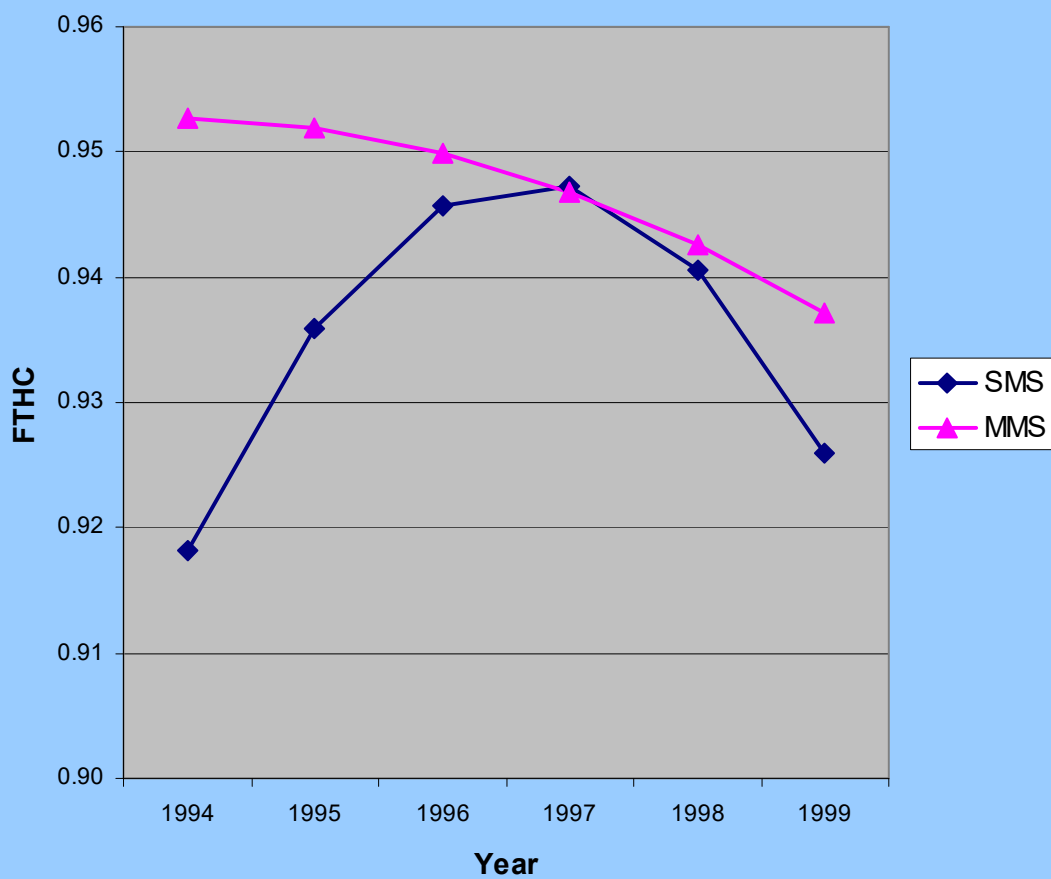
Fixed Effect	Coefficient	Standard Error	T-ratio	P-value
Model for FTHC in 1994				
Intercept β_{00}	0.935	0.003	355.937	0.000***
Slope β_{01}	-0.017	0.003	-6.578	0.000***
Model for Growth Rate				
Intercept β_{10}	0.011	0.002	4.572	0.001**
Slope β_{11}	0.011	0.002	4.694	0.001**
Model for Acceleration				
Intercept β_{20}	-0.002	0.000	-4.950	0.000***
Slope β_{21}	-0.002	0.000	-3.741	0.004**

** : P-value < 0.05 , *** : P-value < 0.001

Table 4. Growth Rate at Certain Year

Year	$\pi_{1i} + 2 \pi_{2i}(Year - 1994)$	
	SMS	MMS
1995	0.014	-0.001
1996	0.006	-0.003
1997	-0.003	-0.004
1998	-0.011	-0.005
1999	-0.019	-0.006

Advanced Quadratic Growth Model 1



Advanced Quadratic Growth Model 2 for FTHC

(Level-1 Model)

$$Y_{ti} = \pi_{0i} + \pi_{1i} (Year_{ti} - 1994) + \pi_{2i} (Year_{ti} - 1994)^2 + e_{ti}$$

(Level-2 Model)

$$\begin{aligned}\pi_{0i} &= \beta_{00} + \beta_{01} W_{01i} = \beta_{00} + \beta_{01} (\text{SYSTEM}), \\ \pi_{1i} &= \beta_{10} + \beta_{11} W_{11i} = \beta_{10} + \beta_{11} (\text{REVENUE}), \\ \pi_{2i} &= \beta_{20} + \beta_{21} W_{21i} = \beta_{20} + \beta_{21} (\text{MTPR/FTPR})\end{aligned}$$

where **SYSTEM** : Indicator for Mobile System

REVENUE : Average Earnings per HH from the provision of all types of mobile communication services between 1994 and 1999

**Table 5. Advanced Quadratic Growth Model 2
for FTHC**

Fixed Effect	Coefficient	Standard Error	T-ratio	P-value
Model for FTHC in 1994				
Intercept β_{00}	0.963	0.007	140.819	0.000***
Slope β_{01}	-0.020	0.000	-226.775	0.000***
Model for Growth Rate				
Intercept β_{10}	0.010	0.003	3.820	0.003**
Slope β_{11}	-0.000	0.000	-20.407	0.000***
Model for Acceleration				
Intercept β_{20}	0.001	0.000	2.750	0.019**
Slope β_{21}	-0.010	0.000	-248.292	0.000***

** : P-value < 0.05 , *** : P-value < 0.001



Conclusion

1. Dramatic Growth in Mobile Telephone Subscribers in Many Countries

2. Decrease in FTHC due to Unexpected Increase in Mobile Only Households

3. Fitting HMLM to analyze the Relationship between Coverage and Mobile service

4. Some Significant Factors to fit HMLM for FTHC

Difference of Mobile System between European Countries and Non-European Countries

Revenue in Mobile Communications Service

MTPR, FTPR etc.

5. Necessity and Usefulness of Sustained Studies concerning Mobile Effects for More Years and Countries