

Telephone Household Non-Coverage and Mobile Telephones

Sun Woong Kim and James M. Lepkowski, University of Michigan

Sun Woong Kim, Survey Research Center, 426 Thompson Street, Ann Arbor, Michigan, 48104

Key Words: Cross-over, Mobile Only Households, Fixed Telephone Households

1. Introduction

Two-stage RDD sample designs devised by Mitofsky (1970) and Waksberg (1978) contributed to the widespread of telephone surveys. But coverage of the telephone household population is seldom complete, varies across countries, and changes over time. Several studies have examined coverage properties of telephone surveys, including Collins (1987) who dealt with the non-coverage in the United Kingdom (UK), the United States (US), Canada and other countries. Trewin and Lee (1988) compared fixed line telephone coverage rates across a large number of countries, finding that most countries would suffer significant non-coverage rates by sampling only telephone households.

Since the 1980's, telephone survey methodology has matured globally due to a rapid spread of fixed telephone lines across the world. The development of more efficient sampling techniques for telephone surveys has also encouraged the development of reliable commercial telephone sampling systems that provide good coverage of telephone households.

More recently, telecommunications technology has rapidly developed a mobile sector. The number of mobile subscribers in most countries has grown rapidly since the early 1990's, and the percentage of households with a mobile telephone has dramatically increased in many countries over the last few years.

With this growth, there have been concerns that telephone households would abandon fixed lines and move to a mobile only status. Kuusela and Vikki (1999) showed that in Finland the percentage of households having fixed lines has seriously decreased since the mid-1990's, resulting in only 78 percent fixed line coverage in 1999, down from 94 percent in 1990. Nathan (2001) has found that countries such as Finland, the UK, and Israel show a strong tendency to use mobile telephones as an alternative to fixed lines. Steeh and Cannon (2000) have shown how mobile telephone ownership is widespread in the state of Georgia in the US.

In this paper, we consider the impact of convenience and remarkable decreases in service price on mobile telephone service in many countries. This is especially the case in the European Union (EU) that has experienced or is facing a 'cross-over' when mobile telephone subscription overtakes fixed

line subscription, particularly since 1998. Recent fixed line non-coverage rates in several EU countries have reached the level where new telephone sampling techniques are being introduced to add mobile telephones to sampling frames. We analyze the extent to which fixed line non-coverage may be due to mobile only households, and present some characteristics of mobile only households.

The findings are based on collections of materials on telecommunications services and a telecommunication survey in the EU. We examine mobile telephone service in North America and Asia, although the available data is comparatively limited at present.

2. Mobile telephone penetration in the EU

We define two penetration rates for telephone service: fixed line (TP) and mobile (MP). Main telephone line (MTL) service counts all fixed line connections for households, business, government, public telephone, and so on, while mobile telephone subscription (MTS) counts all subscriptions of portable telephones using mobile systems.

The TP rate for a country is the number of main telephone lines per 100 inhabitants, or

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

The MP rate for a country is the number of mobile telephone subscribers per 100 inhabitants, or

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

The cross-over point is defined to be the point in time when $MP / TP > 1$ occurs, that is, the year when mobile subscriptions for a country exceed fixed line service.

Figures 1 and 2 show TP and MP for each country of the European Union in 1998 and 2001, respectively (International Telecommunication Union, 2001a, 2002). The countries are arranged in descending order of MP.

In Figure 1 only one country, Finland, had passed the cross-over level in 1998. But after just three years (Figure 2), all 15 countries in the EU passed the cross-over level. Further, the order of these countries changed, with Finland was fifth in MP in 2001 and Luxemburg first. At the same time TP in these 15 countries had a modest increase or even a slight decreased over the same period.

Figure 1. Penetration rates in the EU in 1998

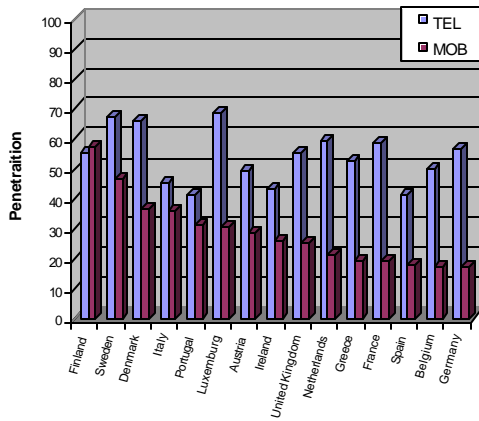
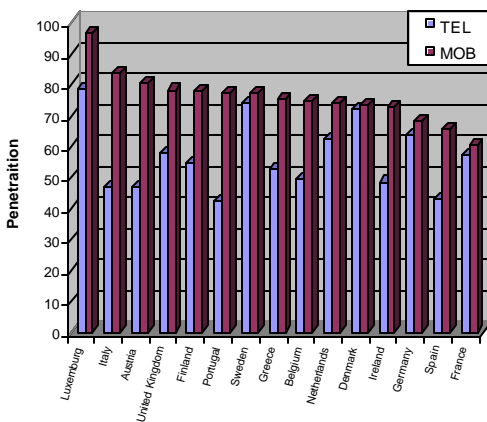


Figure 2. Penetration rates in EU in 2001



In light of these dramatic changes in MP, there is a question about the effect of cross-over on fixed line household coverage rates. Unfortunately, government statistical organizations in many countries of the EU do not collect data on fixed line coverage rates on a regular basis. There are no archives or other sources that have data across consecutive years.

3. Telephone household coverage in the EU

The European Commission did collect data on telecommunications in 15 countries in 1999 through a survey conducted by EOS Gallup Europe. Periodic “Omnibus Surveys” in 15 countries collected data on telecommunications through 44,340 face-to-face interviews.

Figure 3 shows the fixed line household coverage rates for EU countries in 1999, arranged in descending order of the percentage of mobile only households (shown later in Figure 5). Portugal had the lowest coverage level and Finland the second lowest. Austria, Belgium, Spain, and Ireland had less than 90 percent coverage. Other countries, including Denmark, Italy, and France, had more than 90 percent coverage. Figure 3 does not verify whether

there have been changes in the fixed line household coverage over the last several years.

Figure 3. Fixed telephone household coverage

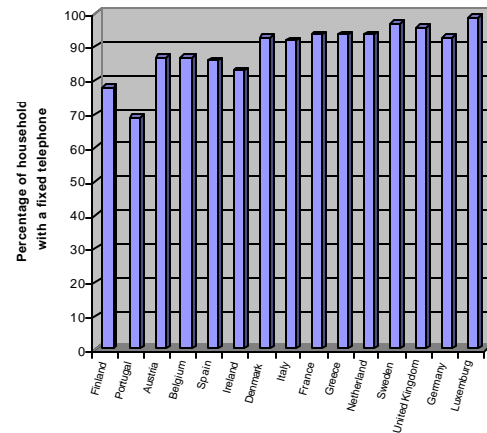
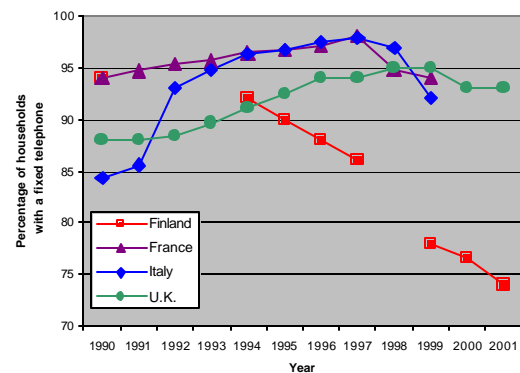


Figure 4 presents the change in coverage in four EU countries for which data are available for several years. There are missing percentages for some years where data do not exist for three of the four countries. (Data are taken from the International Telecommunication Union (2001b, 2001c), European Commission (1999), Kuusela and Vikki (1999), Ministry of Transport and Communications Finland (2000), Statistics Finland (2001), and Office of Telecommunications UK (2001a, 2001b, 2001c).) Finland shows decreasing coverage, almost linearly, from 94 percent in 1990 to 74 percent in 2001. The coverage in France and Italy decreased since 1998, while coverage in the UK has decreased since 2000.

Figure 4. Fixed telephone household coverage in 4 selected countries between 1990 and 2001



The non-coverage in Figure 3 in 1999 is a more complex phenomenon than the graphical display suggests. In the past, the non-coverage was due to non-telephone households that did not have fixed line telephones. But more recently mobile telephones are contributing to non-coverage as well.

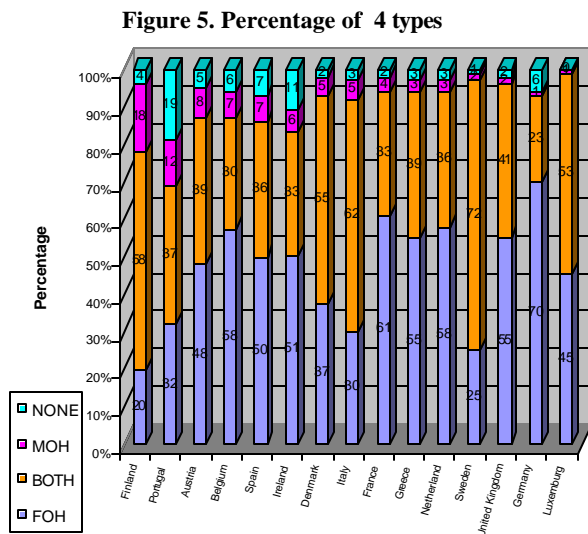
4. Mobile only households and coverage in the EU

Figure 5 shows four types of telephone coverage for the 15 EU countries: NONE for households without either fixed line or mobile service, MOH for households with mobile only service, BOTH for households with fixed line and mobile telephone service, and FOH for households with only fixed line telephones. If we exclude NONE and MOH from each bar in Figure 5, we obtain the non-coverage rate in Figure 3 for each country. The countries in Figure 5 are arranged by descending order of the percentage of MOH.

The percentage NONE in EU countries are quite diverse. Portugal has the highest level, at 19 percent, and Ireland the second highest at 11 percent. Luxemburg had the lowest level, almost zero percent.

There are mobile only households in all 15 countries before 2000, although the percentages are quite variable. For example, one household in six in Finland was mobile only, in Portugal one in eight, in Austria, Belgium, Spain and Ireland, one in 13 to 17.

The lower percentages of FOH do not always correspond to higher percentage MOH. For example, Sweden has an FOH percentage of 25, the lowest level in the EU, but Sweden also has a very low 2 percent MOH. In contrast, Germany has the highest level for FOH (70 percent), but the lowest level of for MOH (one percent).



The European Commission (1999) also provides socio-demographic characteristics for the four types of households (that is, NONE, MOH, BOTH, and FOH). Table 1 presents the EU consolidated percentages by urbanization, household size, and income level. Urbanization is divided into three categories, metropolitan (principal urban area including the capital), urban (secondary urban areas), and rural (smallest localities). The household size is

classified from one person per household to four or more persons per household. Income levels are grouped into four categories, high (highest income categories for each country), mid-high (upper half of the middle categories), mid-low (lower half of the middle categories), and low (lowest income categories for each country).

NONE households tend to be in rural areas, to more often have only one person, and to have lower income. MOH households had the same percentage for the urbanization, but a higher percentage of one-person households and lower incomes.

Table 1. EU consolidated percentages by socio-demographic characteristics

	NONE	MOH	BOTH	FOH
Urbanization (99.6) ^a				
Metropolitan	3	4	41	52
Urban	5	4	41	50
Rural	5	4	34	57
Household Size (99.9)				
One	10	6	15	69
Two	4	3	29	63
Three	3	4	48	45
Four and more	3	4	53	41
Income (77.4)				
High	1	2	62	35
Mid-high	1	3	46	50
Mid-low	5	5	32	58
Low	12	6	18	63

a : item response rate

The European Commission (1999) report describes the trends of MOH by different income categories in 15 countries. Denmark, France, Ireland, Italy, Austria and Finland have a stronger tendency for MOH to be in the lower income level than other countries.

5. Affects of mobile only households on telephone surveys

The Office of Telecommunications UK (2001a, 2001b, 2001c) provides subsequent quarterly percentages of NONE and MOH by age, housing tenure, income, and other household characteristics. These findings are summarized in Table 2 for 2001. It is evident that MOH tend to be younger, more often living in rented housing, and have lower income levels. These trends coincide with those in Finland (see Table 1 of Kuusela and Vikki (1999)).

These trends in Europe have created increasing concern about the coverage properties of existing telephone sampling methods. Those methods typically select telephone households from lists that generate telephone numbers for households with fixed line service. Commercial telephone survey and market research firms in countries with the highest rates of MOH may be changing the methods used to select telephone household samples.

Table 2. UK percentages by selected household characteristics

Age	NONE			MOH		
	May	Aug.	Nov.	May	Aug.	Nov.
15 - 24	1	1	0	11	11	19
25 - 34	1	1	0	9	10	6
35 - 44	0	0	1	6	6	4
45 - 54	0	1	1	5	4	5
55 - 64	1	2	0	1	1	3
65 - 74	0	1	0	0	0	1
75+	2	2	0	0	1	0
Housing tenure						
Owned outright	0	1	0	1	0	1
Mortgage	0	0	0	3	3	3
Rented(private)	2	2	0	10	19	20
Rented(local authority)	1	4	2	14	14	15
Rented(housing association)	3	3	3	12	14	15
Income(pound)						
Under 9,500	1	3	1	9	10	14
9,500 - 17,500	1	1	1	8	7	9
17,500 - 30,000	0	0	0	2	6	4
30,000 - 50,000	0	0	0	3	3	2
Over 50,000	0	0	0	1	2	0

We sent email messages to 61 commercial survey research companies specialized in telephone field work in Finland, Austria, and Belgium to ask whether they are contacting mobile telephone numbers for telephone surveys. The list of companies is based on the directory of European Society for Opinion and Marketing Research (ESOMAR). Table 3 shows results of attempts to contact these companies. Table 4 summarizes several answers received.

Table 3. Response rates and mobile sample use rates for contacted companies

Country	Contact	Response	Using Mobile Samples
Finland	19	4(21%) ^a	4(100%) ^b
Austria	15	6(40%)	3(50%)
Belgium	27	6(22%)	2(33%)

a: percent of companies answering email query
 b: percent of companies using mobile households in telephone samples, among responding companies

Table 4. Selected answers contacted companies

Country	Answer
Finland	"We use a sample in our telephone omnibus where people are being sought either through their fixed telephone line or from their mobile phone."
	"We started contacts to mobile this year (2001). We have decided to conduct 10% of the interviews in households with a mobile number only."
Austria	"We contact when conducting telephone surveys about 12% of respondents via mobile. Thus they are represented in the sample."
	"Mobile phone respondents are offered to do the interview on an ordinary telephone line on another time within the field time."
Belgium	"We contact a mix of mobile and fixed phone numbers for telephone surveys."
	"We call fixed phones, and mobile only if there is a list of mobile telephone numbers provided by the companies of the sector. So there is a problem of non-coverage."

There is a range of responses to the increasing MOH rates across these countries. Some companies in these countries have already started to call mobile telephone numbers in 2000 or 2001. They combine fixed telephone samples with mobile telephone samples of fixed percentages to get over the non-coverage problem.

6. Mobile telephone penetration and coverage in North America

The effect of increased mobile telephone service in North America, particularly on fixed telephone household coverage, are not as well understood as the effects in Europe. Anecdotal and limited reports to date project the percentage of MOH to be very small, but increasing, in the US and Canada. In this section, we analyze ancillary data on mobile telephone service the US and Canada to show that there have been some changes in fixed and mobile telephone household distributions.

Figure 6. Mobile penetration of North America

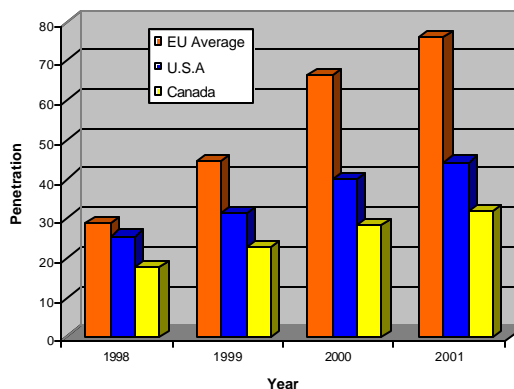
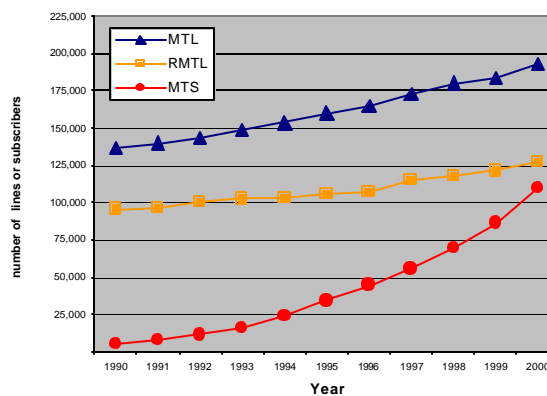


Figure 7. Fixed telephone lines and mobile subscribers in the United States



Note. Unit of number : 10 x 3

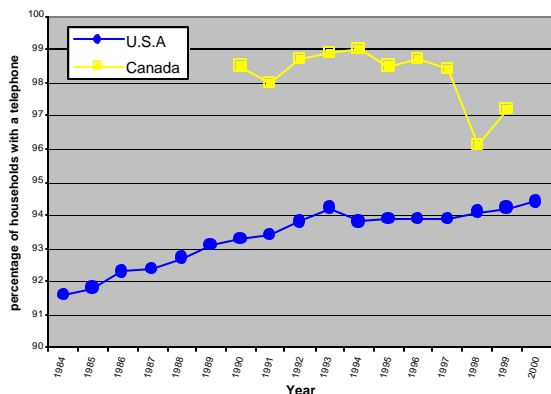
Mobile penetration in the US is compared to the European Union's average in Figure 6 (International

Telecommunication Union (2001a, 2002)). Mobile penetration of the US and Canada are much lower than the EU average. But the United States and Canada have seen a steady increase in mobile penetration. Still, the difference between the EU and the North America in mobile penetration rates has been increasing.

At the same time, mobile telephone subscription in the US has been increasing exponentially over the last decade. Figure 7, based on International Telecommunication Union (2001b, 2001c) and Federal Communications Commission (2001a) data, presents trends in MTL, MTS, and residential main telephone lines (RMTL) in the United States from 1990 to 2000. MTS increased exponentially and almost reached to the number of RMTL by 2000.

The US and Canada have more complete information than the EU on telephone household coverage. Unfortunately, the US and Canadian data on MOH is not nearly as complete. Figure 8 shows fixed telephone household coverage for the US since 1984 and Canada since 1990 (International Telecommunication Union (2001b, 2001c); Federal Communications Commission (2001b)). The two countries have different trends, with Canada having higher coverage but decreasing coverage in the last few years, but the United States having an almost steady level of coverage since 1994, after increases in the 1984-1993 period.

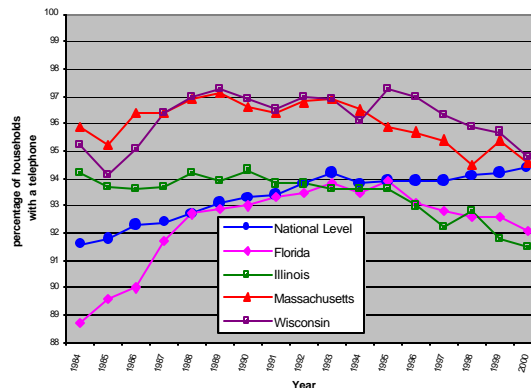
Figure 8. Fixed telephone household coverage of North America



However, the steady household coverage rate in the US is not duplicated in each of the states. In some states, there was a decline in fixed telephone household coverage over the same period. Figure 9 compares the national level with the state level for fixed telephone household coverage in four selected states, Florida, Illinois, Massachusetts, and Wisconsin (Federal Communications Commission (2001b)). These four states show that fixed telephone household coverage rates have been apparently

decreasing since 1995. For example, the coverage of Illinois in 1984 was 94.2, and in 1995, 93.6, but in 2000, it was only 91.5.

Figure 9. Fixed telephone household coverage of 4 selected states in the United States



At the same time, other states such as Arkansas, Connecticut, Georgia, Maryland, Oregon, and Washington have had decreasing coverage during recent years, but the decrease in these states is not as dramatic as in the other four states.

7. Mobile telephone penetration and coverage in some Asian countries

In Asia, South Korea and Hong Kong represent an accelerated shift in mobile service experienced across the Pacific rim countries. The cross-over for these two countries occurred earlier than other countries such as Taiwan, Singapore, and Japan. For example, mobile penetration in South Korea and Hong Kong reached the cross-over point in 1999.

Fixed telephone household coverage in South Korea has decreased from 95.2 percent in 1997 to 93.4 percent in 2000 (Korea National Statistical Office (2000)). The coverage in most major metropolitan areas in South Korea was below 93 percent.

Hong Kong does not currently have survey data on fixed line telephone household coverage. But the office of the Telecommunications Authority (2001) reports that after long period of increase, the number of RMTL in 2001 had dropped to the level last seen in 1998.

8. Conclusions

The effect of mobile telephone service on the fixed line coverage rate has become evident in most countries in the world since the end of the twentieth century. It is speculated that one of main reasons that mobile penetration in the US and Canada is lower

that in the EU countries is because of the differences in the cost of service, distribution of pre-paid mobile and differences in mobile networks. The EU has only one mobile system, GSM, whereas the US and Canada have multiple systems, such as CDMA, TDMA, AMPS, and GSM. The diversity of systems has not made it as cost-effective for companies to offer truly comparable plans.

The next several years will be an important period of transition between fixed line and mobile services. If there is a significance increase in mobile penetration in the US, the fixed line telephone household coverage on a national level could begin to decline.

6. References

- Collins, M.(1987). "The problems of non-coverage and unlisted numbers in telephone surveys in Britain," *Journal of the Royal Statistical Society, Series A*, 150, 241-253.
- European Commission (1999). *Telecommunications survey - residential - report*. Unpublished manuscript available at <http://europa.eu.int/ISPO/infosocitecompolicy/en/EOSTudy/Resid/forward.htm>.
- Federal Communications Commission (2001a). *Trends in Telephone Service*. Unpublished manuscript available at http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/trend801.pdf.
- Federal Communications Commission (2001b). Telephone subscribership in the United States [http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/subs0301.pdf].
- International Telecommunications Union (2001a). *ICT - Free Statistics Home Page*, <http://www.itu.int/ITU-D/ict/statistics/index.html>.
- International Telecommunications Union (2001b). *Yearbook of statistics - telecommunication services 1990-1999*.
- International Telecommunications Union (2001c). *Yearbook of statistics - telecommunication services 1991-2000*.
- International Telecommunications Union (2002). *ICT - Free Statistics Home Page*, <http://www.itu.int/ITU-D/ict/statistics/index.html>.
- Korea National Statistical Office (2001). *Report on the social statistics survey*.
- Kuusela, V. and Vikki, K. (1999). "Change of telephone coverage due to mobile phones," paper presented at *International Conference on Survey Nonresponse*, Portland OR.
- Ministry of Transport and Communications Finland (2000). *Case mobile Finland*.
- Mitofsky, W. (1970). "Sampling of telephone Households," Unpublished CBS memorandum.
- Nathan, G. (2001). "Telesurvey methodologies for household surveys - a review and some thoughts for the future," *Survey Methodology*, 27, 7-31.
- Office of Telecommunications United Kingdom (2001a). "Consumers' use of fixed telecoms services, summary of Oftel residential survey, Q5 May," Unpublished report, available at <http://www.oftel.gov.uk/publications/research/2001/q5fixr0701.htm>.
- Office of Telecommunications United Kingdom (2001b). "Consumers' use of fixed telecoms services, summary of Oftel residential survey, Q6 August," Unpublished report, available at <http://www.oftel.gov.uk/publications/research/2001/q6fixr1101.htm>.
- Office of Telecommunications United Kingdom (2001c). "Consumers' use of fixed telecoms services, Oftel residential survey, Q7 November," Unpublished report, available at http://www.oftel.gov.uk/publications/research/2002/q7_fixed_res.htm.
- Office of the Telecommunications Authority Hong Kong(2002). "OFTA statistics-wireline service," Unpublished report, available at <http://www.ofta.gov.hk/datastat/wireline.html>.
- Statistics Finland(2001). "Consumer survey, August," Unpublished report.
- Steeh, C. and Cannon, B. (2000). "Threat or opportunity: cellular telephone use by households," paper presented at *the Annual Meeting of the American Association for Public Opinion Research*, Portland, OR.
- Trewin, M. and Lee, G. (1988). "International comparisons of telephone coverage," *Telephone Survey Methodology*, Groves, R.M., et al., eds. New York: John Wiley and Sons, pp. 9-24.
- Waksberg, J. (1978). "Sampling methods for random digit dialing," *Journal of the American Statistical Association*, 73. 40-46.