INVESTMENT RESEARCH

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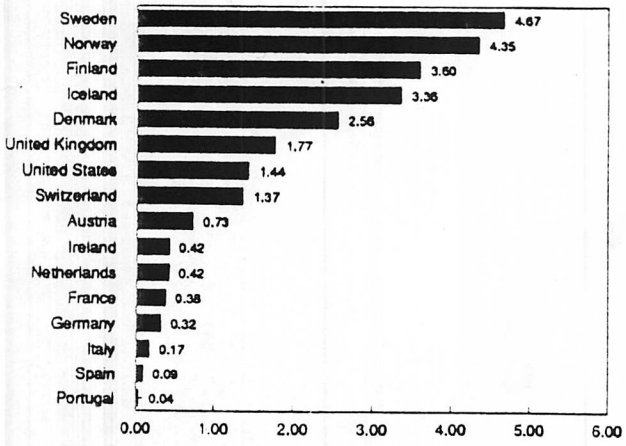
Scandinavia Sets The Pace For Cellular

Since its introduction, the cellular market has astounded critics and fans alike with its phenomenal growth. In fact, the former head of Motorola's Cellular Development Division said in 1985 that cellular would "go down in telecommunications history as one of the costliest engineering and marketing disasters ever [1]." Scandinavia has since become the model marketplace illustrating the growth potential of the cellular industry with overall penetration (weighted by the number of subscribers) topping 4%. However, the degree to which similar performance can be expected here in the US, or for that matter, in other markets, has not been thoroughly examined. The question then becomes why should we, or perhaps more appropriately, why should we not, expect the same levels of penetration in our own markets. We see very little reason not to expect the US markets to actualize the same level of penetration once these markets reach the current age of the Scandinavia markets, especially given that the demographic profile is remarkably similar to those seen in these countries.

Cellular Penetration (% as of 6/90)



Background

Cellular technology was introduced into commercial use in Sweden and Norway in 1981, with Finland coming on in early 1982. An additional system was introduced by the PTTs in these countries in 1986 using the NMT-900 standard (its previous system utilized the NMT-450 standard). Both of the aforementioned standards utilize analog coding schemes, however, the NMT-900 standard, is essentially "second generation cellular" and allows for greater spectrum efficiency. In Sweden, when the strategy for the wide-scale deployment of radio communications began to come into place back in the Mid-1960's, Televerket, Sweden's telephone company, first began planning its "seamless" network.

Cellular service was introduced in the US in 1983 in Chicago, Illinois.

Demographic Profile

The strong demographic profile of this region has proved to be in large part, a driver of the outstanding gains in cellular penetration. Income levels are among the highest of the European countries, with GDP per person exceeding that of the average US citizen. As seen in Figure 1, telephone penetration averages 66.2% for the Scandinavian countries versus 33.6% for the other European countries, and when looked at in relation to GDP per capita it becomes quite clear that the correlation between penetration among the European countries, telephone penetration, and GDP per capita, is amazingly high (this was borne out also by a regression analysis using these aforementioned variables - see Appendix A). We have also found in our previous cellular work that those countries in which a large percentage of the labor force is employed in the service sector can generally expect an expansion of their addressable markets. The types of industries present in Scandinavia have served to create a highly industrialized society in which, on average, 63.4% of the labor force is employed in the areas of communication, financial

services, or other service industries, as compared to the 69.9% employed in similar fields in the United States (see Table 1) and only 57.6% for the other European countries. Scandinavia, as a whole, also maintains very low levels of unemployment, at 2.9% as compared to the European average of 7.4%. The full employment policy implemented in Sweden in the 1930's has resulted in unemployment of only 1.5%, with the enabling factor being the large numbers employed in the public service sector, also adding favorably to the number of people employed in the service sector. Age distribution has also been found to be a critical variable in determining the addressable market, with many surveys indicating that the most responsive age group is 35-44. In Scandinavia, this group represents 20.2% of the population (See Table 1). This compares to 13.4% for the other European countries and 14.1% for the United States. Automobile ownership also tends to be a bit higher in the Scandinavia countries than the other European countries with average penetration of 36.4% (vs 33.6%).

Table 1
Comparable Demographic Statistics

Country	GDP (A) (E)	Telephones (B) (E)	Autos (C) (E)	Service (D) (E)	Unemployment (G)	% Between 35-44 (F)	Penetr.
Australia	12,612	54.0%	67.6%	53.7%	6.0%	18.8%	0.73%
Austria	16,671	46.0%	30.6%	69.8%	4.8%	13.0%	
Canada	16,019	42.1%	42.1%	65.8%	7.5%	18.8%	2.56%
Denmark	10,839	29.3%	29.3%	58.4%	9.6%	15.1%	3.60%
Finland	23,204	32.9%	32.9%	62.1%	3.4%	16.2%	0.38%
France	17,171	36.9%	36.9%	54.3%	9.7%	14.5%	0.32%
Germany	19,677	44.1%	44.1%	43.4%	8.4%	12.9%	
Greece	4,719	12.7%	12.7%	53.0%	7.7%	12.4%	3.36%
Iceland	21,109	52.5%	43.1%	55.5%	1.3%	NAV	0.42%
Ireland	9,228	23.5%	20.6%	56.8%	17.7%	12.2%	0.17%
Italy	14,996	44.8%	35.5%	57.9%	11.9%	13.5%	
Japan	19,465	53.5%	22.1%	69.6%	2.3%	16.3%	0.42%
Netherlands	15,408	42.5%	34.1%	60.6%	8.6%	18.7%	
New Zealand	10,620	41.0%	45.5%	66.3%	7.4%	13.2%	4.35%
Norway	22,125	62.2%	38.2%	42.3%	3.9%	20.1%	0.04%
Portugal	4,342	16.6%	13.5%	51.8%	5.9%	12.4%	0.09%
Spain	9,543	28.1%	25.2%	65.6%	16.5%	15.3%	4.67%
Sweden	22,508	89.0%	42.0%	55.8%	1.5%	24.2%	1.37%
Switzerland	28,128	33.4%	40.2%	67.8%	0.5%	NAV	1.77%
United Kingdom	14,449	52.1%	31.2%	69.9%	6.4%	13.6%	1.44%
United States	18,338	65.0%	47.3%		5.2%	14.1%	
Avg Eur Excl Scand	15,029	40.0%	33.6%	35.1%	9.6%	13.6%	0.60%
Avg Scandinavia Only	22,623	66.2%	36.4%	63.6%	2.6%	20.9%	4.30%
Med Eur Excl Scand	14,996	36.9%	31.2%	55.1%	8.4%	13.5%	0.42%
Med Scandinavia Only	22,508	62.2%	37.7%	65.6%	3.4%	20.1%	4.35%

Weighted Average by Population

(A) GDP per Capita using current PPPs (1987)
(B) Telephones per Thousand (1985)
(C) Passenger Cars Per Thousand (1985)
(D) % of total civilian employment employed in service industry
(E) OECD Economic Survey (April 1989)
(F) Yearbook of Labor Statistics International Labor Office (1988)
(G) CIA World Fact Book (1990)

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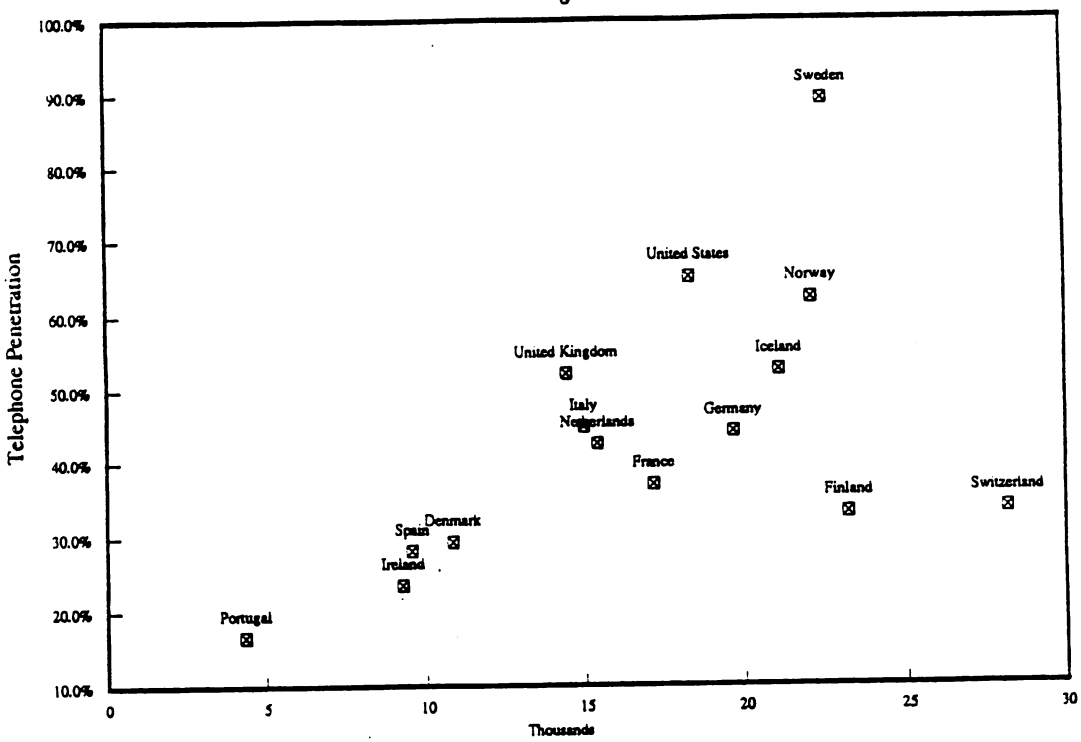
Figure 1

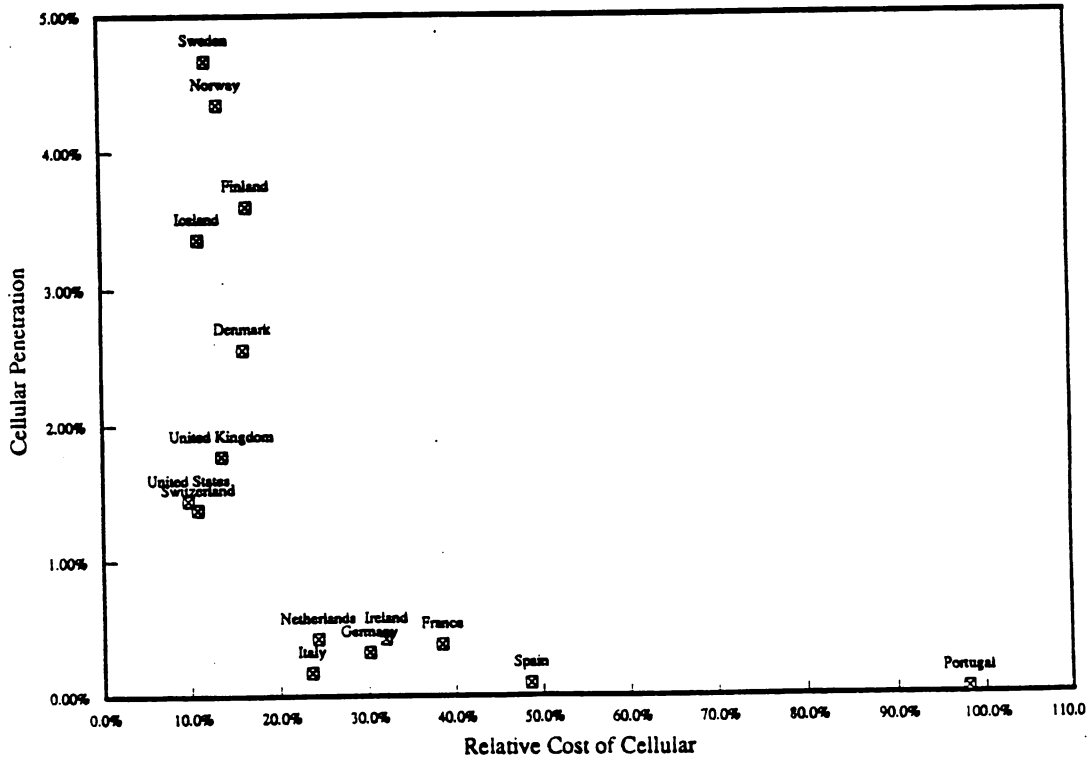


GDP Using Purchasing Power Parity at YE89

Pricing

The pricing environment has also been quite attractive for this region especially when we compare the cost of owning a cellular phone as a % of total GDP to other EEC countries. As can be seen in Table 2, the annual cost of cellular for the Scandinavia countries(this includes the cost of the hardware in addition to the monthly and price per minute charges), represents only 14.2% of GDP per capita, considerably lower than that their European neighbors for whom this expenditure represents 23.9%. Figure 2 illustrates this strong correlation between the relative cost of cellular and penetration, with the countries with the lowest relative cost capturing the greatest percentage of population. The exceptions to this are the United Kingdom, United States, and Switzerland, whose systems are only six, five, and three years old, respectively.

Figure 2



Relative Cost as % of GDP Per Person

Table 2
The Annual Cost of Cellular

	Rel Cost (1) (A)	Lowest Avail HW Cost (1) ($)	System (2)	Subs (2)	Start-Up (2)	Monthly (1)	Yearly (1)	Connection Charge (1)	Monthly Rental (1)	Air-Time Peak (1) ($)	Air-Time Off-Peak (1) ($)
Austria	22.2%	2,120	(B)	53,106	11/84	132	3,704	0	38	0.47	0.29
			TACS900	1,306	2/90						
Belgium	24.6%	2,140	(A)	33,400	4/87	127	3,750	86	43	0.42	0.21
Cyprus	34.9%	1,500				91	2,646	54	27	0.32	0.32
Denmark	16.2%	1,470	(A)	54,276	1/82	100	2,778	108	12	0.44	0.22
			(B)	73,609	12/86						
Finland	16.7%	1,770	(A)	115,318	3/82	197	4,164	30	23	0.87	0.34
			(B)	52,083	12/86	125	3,300	30	15	0.55	0.27
France	38.4%	2,190	Radiocom	181,231	11/85	361	6,568	44	105	1.28	0.64
			(A)	18,000	8/89	322	6,096	42	78	1.22	0.61
Iceland	11.2%	1,330				68	2,322	176	8	0.30	0.30
Ireland	32.0%	1,110	TACS900	13,500	12/85	147	2,953	79	39	0.54	0.35
Italy	23.5%	1,590	RTMS	75,100	9/85	149	3,539	161	40	0.54	0.20
Luxembourg	27.5%	2,150	(A)	443	6/85	229	4,898	0	143	0.43	0.43
Netherlands	24.3%	1,720	(A)	28,300	1/85	162	3,717	53	48	0.57	0.33
			(B)	29,000	1/86	159	3,681	53	45	0.57	0.33
Norway	13.6%	1,240	(A)	136,481	11/81	141	4,701	77	23	0.59	0.59
			(B)	41,477	12/86						
Portugal	NM	2,700	C450	3,246	1/89	124	4,256	68	44	0.40	0.20
Spain	48.5%	2,780	(A)	32,940	6/82	141	4,676	204	51	0.45	0.13
Sweden	12.2%	1,140	(A)	226,196	10/81	134	2,797	49	22	0.56	0.37
			(B)	125,716	12/86	123	2,665	49	11	0.56	0.37
			Comvik	17,900	8/81	132	2,702	41	22	0.55	0.29
Switzerland	10.9%	2,010	(B)	80,051	9/87	88	3,066	0	44	0.22	0.09
UK	13.6%	1,610	TACS900	500,000	1/85	155	1,965	85	43	0.56	0.17
			TACS900	440,000	1/85	155	1,965	85	43	0.56	0.15
W Germany	30.1%	2,530	NAV	176,649	9/85	278	5,905	39	72	1.03	0.41
US	9.8%	700	NM	3,509,000	6/83	104	1,102	NAV	NAV	NAV	NAV
Avg Eur Excl Scand	27.6%	2,076				187	3,893	71	52	0.67	0.30
Avg Scandinavia Only	13.9%	1,349				139	3,196	45	19	0.60	0.36
Med Eur Excl Scand	24.4%	1,720				144	3,610	54	43	0.46	0.26
Med Scandinavia Only	13.6%	1,240				133	3,049	46	19	0.58	0.34

Sources:
(1) X25 Partnership Mobile Communications
(2) Mobile Communications

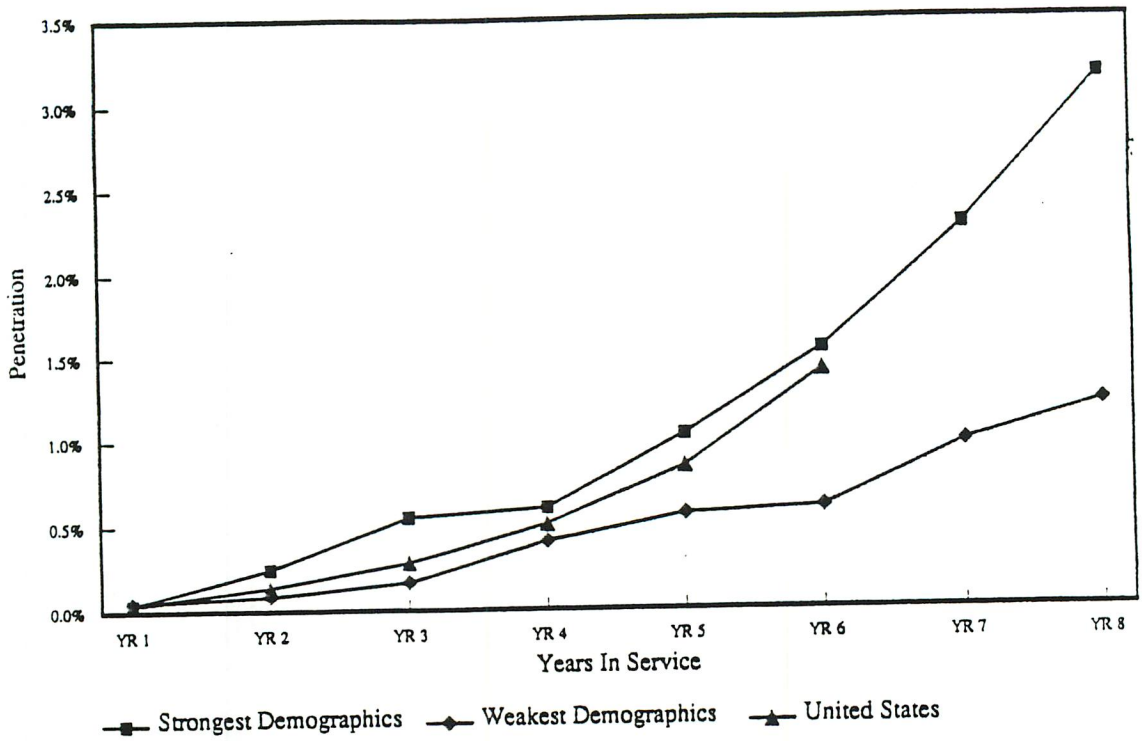
Average Weighted According To Population

Key:
(A) Annual Cost as % of GDP Per Capita
(B) Uses NMT-450 Standard
(C) Uses NMT-900 Standard

Age of Market

Given the demographic characteristics of this region, it becomes clear why these markets have achieved the penetration levels that we see today. However, in many cases, these same demographic factors show the United States to be a favorable environment for the acceptance of cellular telephony. Why then do we not see the same levels domestically ? It becomes obvious when we look at penetration according the age of the given market. Quite simply, we must consider that cellular was introduced 3 years earlier in the Scandinavia markets than here in the US. In Figure 3, we have separated out the best and worst cellular markets (as determined by the level of GDP per person and telephone penetration with the best markets being Finland, Norway, Sweden, and Switzerland and the worst markets, demographically, being Denmark and Spain) and have charted the levels of penetration according to the years in service as they compare to US. Penetration in the United States is clearly on the same path for growth as those countries which we consider to be, demographically, the best markets. The pace of growth also appears to accelerate somewhere between the fourth and fifth years of operation. In most countries, this appears to coincide with the introduction of some form of "second generation cellular", such as the NMT-900 standard introduced in 1986 in the Scandinavia countries. This transition was, incidentally, driven primarily by capacity constraints in many of its metropolitan areas, a problem plaguing some areas here in the US.

Figure 3



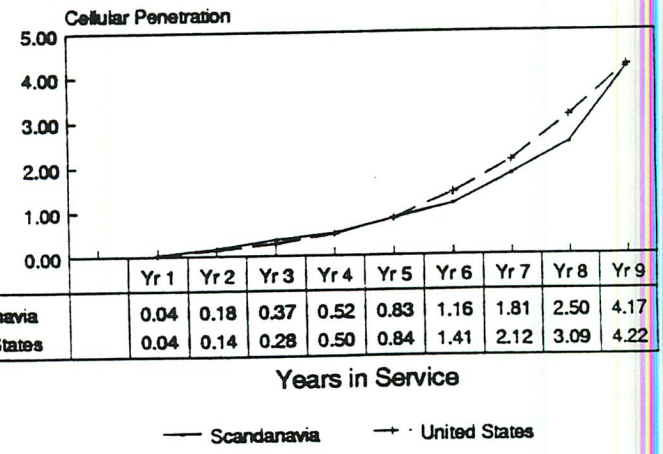
Unable to regression on YR 9 because only 2 samples exist.
Penetration based on regression done for each yr in service.

Table 3
Penetration By Age of Market

	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8	YR 9
Austria	0.0100%	0.0620%	0.1093%	0.1619%	0.2247%	0.3045%			
Belgium	0.0578%	0.1942%	0.3141%						
Denmark	0.1399%	0.3153%	0.5990%	0.9001%	1.1249%	1.5274%	1.9767%	2.4193%	
Finland	0.0549%	0.1785%	0.3667%	0.4717%	1.0085%	1.4489%	2.1058%	3.1667%	
France	0.0002%	0.0171%	0.0705%	0.1759%	0.3196%				
Norway	0.0407%	0.2688%	0.5687%	0.9430%	1.5207%	2.0883%	2.8695%	3.6241%	4.1138%
Spain	0.0002%	0.0006%	0.0013%	0.0020%	0.0044%	0.0109%	0.0298%	0.0764%	
Sweden	0.0121%	0.1801%	0.2998%	0.5389%	0.7775%	1.3142%	1.7900%	2.6221%	4.1683%
Switzerland	0.0837%	0.4686%	1.1063%						
United Kingdom	0.0781%	0.2167%	0.4622%	0.9019%	1.5307%				
United States	0.0388%	0.1421%	0.2823%	0.5045%	0.8397%	1.4102%			
West Germany	0.0066%	0.1081%	0.2936%	0.6021%	0.9959%				
Average	0.0436%	0.1793%	0.3728%	0.5202%	0.8347%	1.1578%	1.7543%	2.3817%	4.1411%

Source: Mobile Communications

A number of demographic factors in this region have proven to create an environment especially conducive to the growth of this industry. Can we expect the US to realize the levels of penetration seen in these Nordic markets ? Certainly. We've shown that not only does the US have a demographic profile remarkably similar to that of the Scandinavian countries but, more importantly, we have seen that penetration in US markets has already surpassed the other countries when compared on an age of market basis (see Table 3), and as such we believe that penetration in the United States should reach the same levels as the Scandinavia countries, or 4.0-4.2% (from its current 1.7%), sometime in the 1992-93 timeframe.



	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Scandanavia	0.04	0.18	0.37	0.52	0.83	1.16	1.81	2.50	4.17
United States	0.04	0.14	0.28	0.50	0.84	1.41	2.12	3.09	4.22

Scandanavian penetration avg wtd by total number of subs;
Penetration for US beyond Yr 6 are Morgan Stanley Estimates.

[1] George Calhoun, Digital Mobile Radio, 1988.

Appendix A

Regression Formula:

Penetration = (GDP Per Person * 0.821537) + (Tel Penetration * 0.039725) + Constant (-1.44022)

Regression Output:

Constant	-1.44022	
Std. Err of Y Est	1.299352	
R Squared	0.462936	
No. of Observations	15	
Degrees of Freedom	12	
X Coefficient(s)	0.821537	0.039725
Std. Err of Coef.	0.649136	0.022249

In order to normalize coefficients, GDP per person is stated in thousands and penetration figures are in whole numbers.