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Hedonic Prices in the German Market for Mobile Phones

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Abstract

This paper provides a hedonic price analysis of mobile telephones for the German market. We have assembled data on 302 different handsets from 25 manufacturers over the period from May 1998 to November 2003. While volume has a negative effect on the price of a mobile handset, the number of ringtones and the talk time battery life relative to the handset's weight positively affect mobile phone prices. Maybe somewhat surprisingly, radiation is statistically not significant. Also handsets have become cheaper over time, and handsets with additional features, such as MMS, MP3 or Bluetooth, command a higher price. In addition, we found positive brand name effects for *LG*, *Nokia*, *Motorola* and *Samsung*, but not for *Siemens* or *Sony*. According to our estimations these brand name premiums may range from 57 to 172 Euros.

1. Introduction

The demand for mobile phones has considerably increased over the past 20 years, in Germany as well as in other countries. The mobile penetration rate in Germany now exceeds 80 percent (see RegTP, 2004, p. 32/33), which suggests that the majority of Germans now possess a mobile telephone. A similar picture has emerged in other European countries.

At the same time, fierce competition has emerged among mobile handset manufacturers, whose market shares vary heavily from month to month. Nevertheless, little empirical analysis has been carried out on the pricing of mobile handsets. This paper aims to fill this gap and to provide an empirical analysis of mobile telephone prices. More specifically, we will conduct a hedonic price analysis, using data on 302 different mobile handsets from 25 manufacturers.

The data has been collected from the magazine *connect* (a special interest magazine for mobile telephony in Germany) over the period from May 1998 to November 2003. The magazine publishes data on mobile phones that are sold in Germany and also gives prices for these handsets in the German mobile phone market. Apart from prices we have collected information on characteristics, such as weight, radiation, volume, battery duration, the number of ringtones, MMS, MP3, Bluetooth, WAP and the date of introduction. In order to estimate hedonic prices for the various characteristics, we have used simple pooled OLS regressions.

The remainder of this paper is now organized as follows: Section 2 will describe the market for mobile telecommunications handsets in more detail. The empirical analysis is presented in section 3, which contains more information on both the data used and the methodology employed as well as the results of our hedonic price analysis. Section 4 summarizes our findings and concludes.

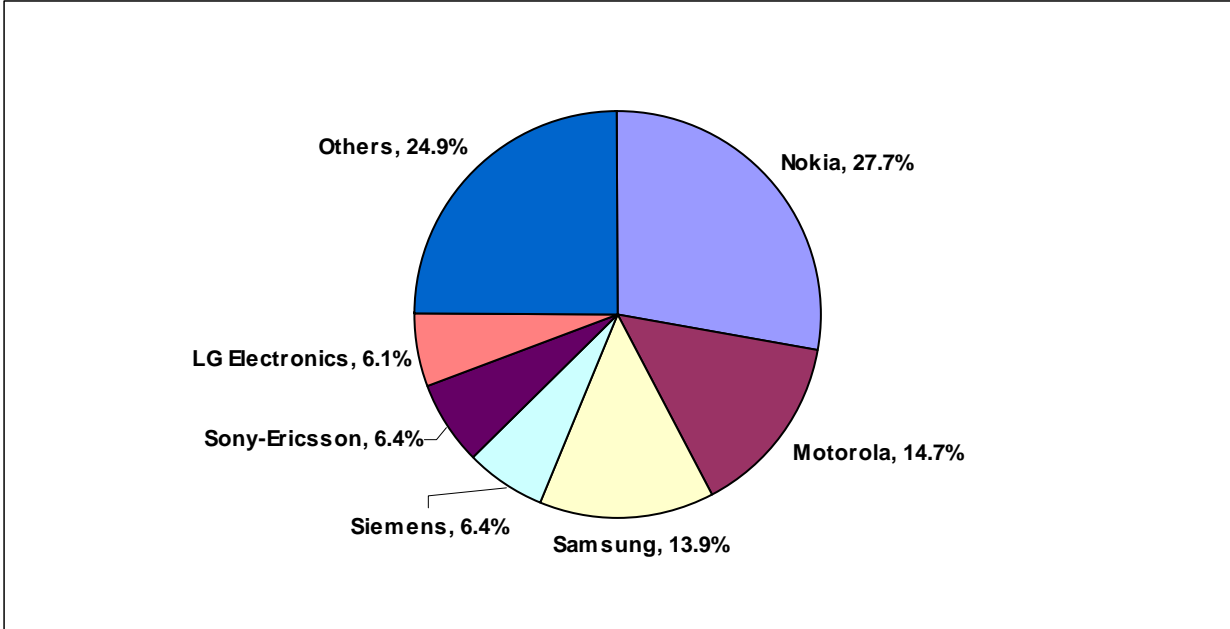
2. The Market for Mobile Telephone Handsets

Before we start to analyze the pricing of mobile handsets, let us briefly describe the most important market characteristics. The market for mobile telephone handsets is served by a large number of firms. While we will only examine handset prices for 25 firms in our sample, there are more active mobile telephone producers. The large number of firms suggests that barriers to entry are comparatively low and competition relatively intense.

Nevertheless, mobile telephone producers vary quite heavily in size and market share. The market leader is *Nokia* with a market share of 27.7 percent, followed by *Motorola*

(14.7%), *Samsung* (13.9%), *Siemens* (6.4%), *Sony-Ericsson* (6.4%) and *LG Electronics* (6.1%). The remaining firms still hold a market share of 24.9%. Figure 1 illustrates the market structure just described:

Figure 1



Source: Gartner Dataquest.

Market shares do not only differ heavily between firms, but also over time, i.e. market shares are not very stable. For example, *Nokia*'s market share has shrunk by 6.9% between 2003 and 2004, while *Samsung*'s market share has increased by 3.8% over the same year. This means that changes in market structure are quite substantial which in turn suggests that competition is quite intense.

Another important feature of the market for mobile telephone handsets is that many consumers do not buy handsets as stand alone products but rather as part of a bundle jointly with a package of mobile telephone services. This means that many consumers obtain their mobile telephone handset either as part of a mobile telephone contract or bundled with a package of prepaid mobile telephone minutes. In both cases, the handsets are usually heavily subsidized.

Handset subsidies are provided by mobile network operators and mobile service providers in order to acquire new customers or to keep old customers. From an economic point of view the phenomenon of mobile handset subsidies can be explained by the existence of switching costs. In markets with switching costs, consumers are at least to some degree

locked-in with a certain provider once they have made their purchase decision. When consumers face switching costs, they are less responsive to price differences once they have signed a contract, which implies that providers do not have to price as aggressively as in other markets (without switching costs) in order to retain their existing customer base.

However, as the theoretical literature shows, in markets with switching costs the competition for new customers tends to drive overall prices down to the point where firms can just cover their costs and obtain zero profits. This usually means that firms use discounts and actually subsidize consumers' initial purchases (such as mobile handsets) in order to compensate consumers' for their being locked-in later. The handset subsidy may thus be seen as an investment in the firm's customer base, which is necessary in order to "convince" consumers to sign a contract (see Farrell and Klemperer, 2001).

For our analysis it is important that, with competitive retail markets, consumers know that – while the mobile handset is initially subsidized – customers still pay for the handset indirectly via their mobile call charges, which usually exceed marginal costs. Moreover and even more importantly, there is little reason or evidence to presume that handset subsidies vary systematically between different handset producers. In fact, with competitive retail markets one should assume that mobile handsets do not differ systematically between brands, but that mobile telephone operators and service providers will offer the kind of mobile telephones that meet the taste and needs of a network's potential mobile customers. Furthermore, consumers can usually also decide not to obtain a subsidized handset jointly with a mobile services contract, but rather buy the mobile handset as a single product and then sign a different contract with lower charges for mobile telecommunications services.

Hence, while mobile telephone handsets are often part of a mobile phone contract or purchased jointly with prepaid cards, this essentially means that payments are indirectly made via charges for mobile services over the course of the contract's duration. However, the total price for mobile handsets should not be affected by this practice, as long as the market for mobile telephone services is competitive. Furthermore, there is little reason to suppose that handset subsidies differ between various brands in a competitive market.

3. Data and Methodology Employed

Hedonic Price Analysis

The idea that more complex products such as mobile phones can be “decomposed” into their various characteristics, which consumers value, has gained popularity with the development of Lancaster’s (1971) theory of consumption. According to Lancaster, a product consists of various characteristics that consumers value. As a consequence, one may also think of the product’s total price as being the sum of the various characteristics’ prices. The price for a certain characteristic is therefore regarded as a hedonic price so that a product’s total price may be decomposed in to a fixed price element and the product’s single characteristics’ prices.

In fact, hedonic price analyses have not only started with Lancaster (1971), but as early as 1928 when Waugh examined the pricing of asparagus (see Waugh, 1928). In more recent times, hedonic price analyses have been applied to many different products such as automobiles (see Court, 1939; Griliches, 1961; Berry, Levinsohn & Pakes, 1995, 2003), wine (see, e.g., Nerlove, 1995), housing (see, e.g., Maurer, Pitzer & Sebastian, 2004), modern technology products such as PCs (see Griliches, 1994; Pakes, 2003) or PDAs (see Chwelos, Berndt & Cockburn, 2003) and even somewhat exotic purchases such as islands (see Bonnetain, 2003).¹ Surprisingly enough, we are not aware of any hedonic price analysis of mobile telephone handsets. Therefore, this paper provides the first hedonic price analysis for mobile telephone handsets.

Data

To conduct such a hedonic price analysis for mobile phones, we have collected data on 302 different handsets from 25 manufacturers. The data was assembled from the magazine *connect* (a special interest magazine for mobile telephony) over the period from May 1998 to November 2003. Apart from the prices that the handsets command in the German market for mobile telephones we have also collected information on various characteristics such as the handset’s date of market introduction, its weight, radiation, volume, battery duration, number of ringtones, and additional features such as WAP, MMS, MP3, and Bluetooth.

¹ Other examples include paintings (see Chanel, Gérard-Varet & Ginsburgh, 1996), cigars (Stover, 1996), baby food (Maguire, Owens & Simon, 2004), and crude oil (Wang, 2003).

The variable PRICE consists of the handset's retail price in Germany at its date of introduction. We have taken the manufacturers recommended price for the mobile phone that consumers had to pay when they purchase the mobile phone as a single product without signing a contract or purchasing prepaid cards. That is, we have taken the unsubsidized handset price.

To take account of the decrease in handset prices over time, we have introduced a variable AGE, which is constructed by counting the number of months between December 2003 and the month when the handset was introduced. Hence, for a handset that has been introduced in December 2001 AGE would be set to 24, while for handsets that have been introduced in November 2003 (our most recent observation) AGE is set to 1.

The variable WEIGHT consists of the handsets weight in grams, RADI gives a handset's radiation, measured in SAR, which stands for "Specific Absorption Rate" and which is a measure of the amount of radio wave energy absorbed by the body when using a mobile phone. VOL gives the handsets' volume, measured in cubic millimeters (cmm), and DURA stands for the handset's talk time battery duration in minutes.

Table 1: Number of Handsets by Firms

Firm	Number of Models	Average Price (in €)
Alcatel	15	204.13
Audiovox	3	182.00
Benefon	3	281.66
Bosch	2	332.00
Ericsson	10	255.70
HP	1	1000.00
LG	6	355.00
Maxon	3	279.00
Mitsubishi	2	341.00
Motorola	37	352.64
NEC	5	335.40
Nokia	44	421.65
Panasonic	17	321.76
Philips	19	257.21
Sagem	18	236.00
Samsung	27	385.14
Sendo	8	187.75
Sewon	1	600.00
Sharp	2	599.00
Siemens	36	298.38
Sony	28	360.07
Telme	3	332.33
Toshiba	1	229.00
Trium	10	231.20
Windhorst	1	290.00
Total	302	346.72

We have also included the number of ringtones that come with the manufacturer's initial set-up of the handset (RING). Furthermore, there are a number of dummy variables that indicate whether a mobile phone provides for specific services such as WAP, MMS, MP3, and Bluetooth (BLUE). Finally, we have also constructed dummy variables for the 25 firms that we have in our sample.

Table 1 summarizes the number of mobile phones that we have in our sample by firms and gives the firms' average handset prices. While for a number of firms we have only one handset model in our sample, there are 44 *Nokia* models, 37 *Motorola* and 36 *Siemens* handsets. The firms' average handset prices vary from 182 to 1000 Euros, with an average of 346 Euros across all firms.

Table 2 gives some descriptive statistics for our variables. It should be noted that we cannot observe all characteristics for all mobile phones. For example, we have only 231 observations for the handsets' radiation (RADI) and only 208 for talk time battery duration (DURA).

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
PRICE	302	326.34	172.50	99	1200
AGE	302	20.30	23.97	3	85
WEIGHT	296	111.81	36.320	55	325
RADI	231	0.7581	0.3965	0	1.94
VOL	292	109320	48975.69	48384	599200
DURA	208	82.07	10.54	50.83	109
RING	257	26.39	10.98	0	66
BLUE	294	0.0816	0.2742	0	1
WAP	292	0.6609	0.4741	0	1
MP3	290	0.0482	0.2147	0	1
MMS	291	0.1374	0.3449	0	1

Estimation and Results

In order to estimate hedonic prices for the various characteristics, we have used simple pooled OLS regressions. We have tested for the functional form of the regression equation, using linear, semi-logarithmic, and logarithmic specifications. As Ramsey RESET tests indicate logarithmic specifications yield the best fit.

As can be seen from Table 3, we have estimated four different specifications (Models I to IV) in order to test the robustness of the results. Since all variables except the dummies are in logarithms the respective coefficients can directly be interpreted as elasticities.

For our regressions we have used talk time battery duration per gram (DURA/WEIGHT) as an explanatory variable. This is because battery duration tends to increase the battery's weight, and, thereby, also the mobile phone's total weight. Put differently, customers should prefer a longer battery duration, but not necessarily a heavier mobile phone.

Table 3: Hedonic Regressions

Variable/Model	I	II	III	IV
Constant	6.4211*** (3.56)	7.1164*** (4.81)	6.5567*** (5.14)	0.1670 (4.86)
ln_VOL	-0.1914 (-1.21)	-0.2350** (-2.00)	-0.1520 (-1.47)	-0.1937* (-1.90)
ln_AGE	0.2243** (4.65)	0.1647*** (3.90)	0.1796*** (4.77)	-
ln_RADII	-0.0349 (-0.44)	-0.0574 (-0.70)	-	-
ln_(DURA/WEIGHT)	0.4116** (2.19)	-	-	-
ln_RING	0.1704** (2.21)	0.1892** (2.45)	0.1664** (2.15)	-
WAP	0.0626 (0.86)	0.1547* (1.95)	0.1970*** (2.78)	0.1782** (2.53)
BLUE	0.6396*** (5.39)	0.3998*** (3.56)	0.3107*** (2.75)	0.3022*** (2.82)
MP3	0.6798*** (6.10)	0.3936*** (2.62)	0.3116** (2.20)	0.3432** (2.48)
MMS	0.3830*** (3.93)	0.2557** (2.53)	0.2713*** (2.89)	0.3006*** (3.48)
Firm Dummies	Yes	Yes	Yes	Yes
Nobs	174	203	254	283
adjusted R ²	0.57	0.50	0.44	0.43
Ramsey RESET Prob.	1.00 (0.39)	4.51 (0.00)	3.72 (0.01)	3.75 (0.01)

Notes: Heteroskedasticity robust t-statistics are given in parenthesis. ***, **, and * denotes 1, 5, and 10% level of confidence.

Table 3 summarizes the results of our regressions.² A handset's volume tends to have a negative impact on mobile phone prices, but it should be noted that VOL is not significant in any regression. Not surprisingly, AGE has a positive and statistically significant effect on a handset's initial price at its date of introduction. This mirrors the fact that mobile handset prices have decreased over time due to technical progress. This means that mobile phones with similar characteristics have been the more expensive the earlier they have been introduced to the market.

Maybe somewhat surprisingly, given some public policy debates, a mobile phone's radiation does not have a statistically significant effect on prices (even though the regressions yield the expected sign). This may suggest that consumers do not care too much about a mobile phone's radiation. However, the relatively small sample size of 174 in Model I and 203 in Model II may possibly also affect this finding.

As expected, talk time battery duration per gram (DURA/WEIGHT) positively affects prices, as does the number of ringtones (RING). The various different features (WAP, BLUE, MP3, and MMS) also tend to make mobile phones more expensive or valuable in consumers' eyes. Given the results of Model I, the ability to use MP3-files seems to generate the highest additional value for consumers. While WAP is not statistically significant in Model I, it is significant in the other three Models.

Following conventional practice for semi-logarithmic equations, the dummy variable coefficients can be interpreted as indicating the percentage difference in the prices of mobile phones that have a certain feature (such as MMS, MP3, or Bluetooth) to those that do not (see, e.g., Giles, 1982). Hence, mobile handsets with MP3 are on average 68% more expensive than others, while prices for mobile phones with MMS are on average 38% higher and prices for handsets with Bluetooth command a price premium of 64%.

In Table 4 we have calculated the hedonic prices for the various mobile phone characteristics as well as brand premiums (i.e., the hedonic price for the firm dummy), using the results from Model I.

Interpreting these results, reducing a handset's volume by one cubic centimeter adds a value of 59 Eurocent to the mobile phone. We also see that mobile phones have become cheaper over time. Between May 1998 and November 2003 prices for comparable mobile phones have decreased by an average of 7.76 Euros per month. An additional ringtone

² In addition, Table A1 in the Appendix summarizes the correlation between our variables.

increases a mobile phone's value by an average of 1.87 Euros. We also see that mobile handsets with additional features such as Bluetooth, MP3 and MMS command price premiums between 115.71 and 205.38 Euros compared to mobile phones that do not have these features.

Table 4: Hedonic Prices and Brand Premiums

Characteristic	Hedonic Price
Volume (in cmm)	-0.00059
Age (in months)	7.76
Battery Duration/Weight	147.65
Ringtones	1.87
Bluetooth	193.24
MP3	205.38
MMS	115.71
LG	171.76
Motorola	101.39
Nokia	57.80
Samsung	105.41

Finally, Table 4 also gives brand premiums for *LG*, *Motorola*, *Nokia*, and *Samsung*, compared to the average of all other mobile phones in our sample. These brand premiums vary between 57.80 and 171.76 Euros and indicate that consumers attach a positive value to these brands. In contrast, we did not find any statistically significant brand name premium for *Siemens*, *Sony* or *Ericsson*.

4. Summary and Conclusion

This paper has provided a hedonic price analysis for mobile handsets for the German mobile telephone market. For that purpose, we have assembled data on 302 different handsets from 25 manufacturers over the period from May 1998 to November 2003.

As expected, volume has a negative effect on the price of a mobile handset, while the number of ringtones and the talk time battery life relative to the handset's weight positively affect mobile phone prices. Maybe somewhat surprisingly, radiation is statistically not significant. Also handsets have become cheaper over time, as the positive coefficient for AGE indicates. Moreover, handsets with additional features, such as MMS, MP3 or Bluetooth, command a higher price. In addition, we also found positive brand name effects for *LG*, *Nokia*, *Motorola* and *Samsung*, but not for *Siemens*. According to our estimations these brand name premiums may range from 57 to 172 Euros.

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Appendix

Table A1: Correlation Matrix (obs=175)

PRICE	AGE	RADI	VOL	WAP	BLUE	RING	DURA	MP3	MMS
AGE	-0.1839	1							
RADI	-0.0616	0.0667	1						
VOL	0.0323	0.2712	-0.1486	1					
WAP	0.1794	-0.5212	0.0179	-0.1485	1				
BLUE	0.4021	-0.1845	-0.1952	0.2201	0.1263	1			
RING	0.2198	-0.3802	-0.1269	-0.1452	0.1235	0.1036	1		
DURA	0.0428	-0.0786	0.2636	0.0289	0.1924	-0.2004	0.1019	1	
MP3	0.2367	-0.0886	0.0008	0.4009	0.0910	0.0534	0.1723	0.0703	1
MMS	0.4360	-0.2682	-0.2675	0.1474	0.1734	0.3413	0.1698	-0.0861	0.0069

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