A Fallacy of Dominant Price Vectors in Network Industries

Jana Heimel and Friedel Bolle

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Abstract

In German mobile phone contracts, calls in the provider's home net are usually less expensive than external calls (to the network of a competitor). Thus customers have to compare vectors of prices, and such a comparison can be the source of a fallacy in the presence of network externalities. Even if a provider with a lower market share requires lower prices for calls in the home as well as to other networks, his average price may be higher than that of a larger provider. Not being aware of this fact is called "a fallacy of dominant price vectors." Based on a questionnaire study this fallacy turns out to be a real phenomenon.

Europa-Universität Viadrina
Lehrstuhl für Volkswirtschaftslehre,
insb. Wirtschaftstheorie
Große Scharrnstraße 59
15230 Frankfurt (O)
e-mail: bolle@euv-ffo.de

1. Introduction

In theories of bounded rationality such as Simon (1957) and Selten and Gigerenzer (2002), it is assumed that people follow a simplified course of reasoning which, in some situations results in systematic errors. In this paper we want to describe such a systematic error when network economics apply; that is, when customers of a network profit from an increasing number of customers on their home network.

Network economics induce significant competition advantages for larger networks, in particular if price discrimination between services in the home (on-) network and in other (off-) networks is allowed. Laffont *et al.* (1998b) show that, with price discrimination, there are often only equilibria where one network corners the market. With respect to market entry, they remark "… even if the incumbent is constrained to offer a reciprocal access charge, he can block small scale entry by an appropriate choice of on-net and off-net prices." (Laffont *et al*, 1998b, p. 54). It seems difficult for smaller competitors to survive and even more difficult for entrants to be successful. Both necessarily have to undercut prices by non-marginal amounts just to match the advantaged incumbent. Possibly, in the case of rational consumers, competition for much smaller firms and entrants would be hopeless: they would never cover their initial losses which are necessary to grow to a competitive market share. But are consumers completely rational?

Using the example of mobile telephone services, this paper argues that a large percentage of customers may be subject to a fallacy which makes it easier for small firms to compete with the advantaged large ones. The next section reviews the fallacy in the context of the German mobile phone market. Section 3 discusses our survey and results, while section 4 briefly concludes.

2. Dominant price vectors in the German mobile phone market

In Germany, there are four owners of mobile phone networks with market shares[1] (2004) of 38.5 % (T-mobile), 37.8 % (Vodafone), 13.3 % (E-Plus), and 10.4 % (O_2). Part of their services is marketed by some 15 service suppliers who, however, hold only 26 % of the market (Reg TP, 2005). The prices of services (telephone calls to the customer's own or another network during the daytime (7am to 6 pm), at night, on

the weekend, for an SMS, monthly charges, and so on) can be represented in a price vector $(p_1, \ldots, p_n)$.

Empirically, many of these prices do not vary among suppliers. For example, an SMS costs 19 cents, independent of the sender's and the receiver's network. For the sake of simplicity, in the following we concentrate on a pricing scheme $p = (p_h, p_e)$, where p_h is the price for one-minute calls in the intra- (home) network, and p_e is the price for external calls. Apart from fixed price components of large consumer contracts, these are the only price components that differ essentially among the providers. In Germany, we often find $p_e > p_i$, reflecting the termination fees to be paid by the home network to the external network of 14.3 to 17.9 cents/min in 2004 (USTR, 2005) which are apparently above termination costs.[2] Let us say that p^2 *dominates* p^1 or $p^2 < p^1$ if $p^1 \neq p^2$ and $p_h^2 \leq p_h^1$, $p_e^2 \leq p_e^1$. At first glance, it seems clear that – all other prices being equal – we should always prefer a dominant price vector. But this impression is wrong in the case of a network industry.

Let s^i be the share of total calling time a certain customer calls other customers in network i. Let us assume that s^i is independent of the customer's home network: s^i reflects the network choice of his friends and family. Then the average price P^i that is paid by the customer if he joins network i under the scheme p^i is

$$(1) \qquad P^i = s^i p_h^i + (1 - s^i) p_e^i.$$

Therefore, joining a network with $s^1 = 0.4$ and $p^1 = (5, 10)$ implies an average price of $P^1 = 8$ while joining network with $s^2 = 0.1$ and $p^2 = (4, 9)$ implies an average price of $P^2 = 8.5$. Instead of having a price advantage of 1, the service of the second (apparently cheaper) provider is in fact 0.5 more expensive.

Under a "balanced calling pattern" (Laffont, 1998a), the average s^i equals the market share of network i. For analytical work an even stronger assumption is regularly used, namely that every customer shows such a balanced calling pattern. Let us, for the moment, proceed with such an assumption.

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[1] See Reg TP (2005)
[2] All prices referred to in this paper are in Euros.

Provider	Tariff	Home on/off-peak	External on/off-peak	Market Share	Average Price on/off-peak
T-Mobile	Telly Smile	29/19	79/43	38.5 %	59.8/33.8
Vodafone	Vodafone Fun	29/19	69/49	37.8 %	53.9/37.7
E Plus	Private Tariff Plus	29/19	59/39	13.3 %	55.0/36.3
0_2	Starter	39/19	59/29	10.4 %	57.0/30.0

Table 1: Selected on-peak (7am to 6pm) and off-peak tariffs (March 20, 2005) with prices in cents/min. Prices are weighted averages according to (1) with s^i = market share.

In Table 1, we compare selected tariffs for customers with small demands, which is defined by tariffs with low fixed price elements and high per-minute prices.[3] Note that there are a lot more tariff schemes of the network owners and of the other service providers than are shown in Table 1, but these other tariffs tend to differ in more than just the home and external prices. For comparing the tariffs, it is important that these prices are evaluated correctly. We see that Vodafone offers a less costly peak tariff compared with the dominant price vectors of E-Plus and O_2. For off-peak tariffs we find that T-Mobile's tariff is more attractive than that of E-Plus. So, for someone who is calling predominantly on-peak (or predominantly off-peak) there is a situation where dominant price vectors exist while the average according to (1) points in the opposite direction. Falsely assuming that dominant price vectors always indicate less expensive service instead of relying on P^i from (1) is called a "Fallacy of Dominant Price Vectors".

The Fallacy of Dominant Price Vectors can arise even when calling patterns are not in fact balanced. The assumption of balanced calling patterns only helps to simplify the demonstration of the fallacy. To illustrate this point, note that a customer of, say, Vodafone will probably have more than 37.8 % calling partners in his home network – possibly the number is as high as 80 %. Then his average prices are even more in favour of staying in the Vodafone network. If he is lured away to E-plus because he

[3] Fixed price = 10 Euros in all cases. "Normal" demand customers pay 25 – 30 Euros, while "high" demand customers pay 40 – 50 Euros (with average variable prices smaller than in Table 1). The tariffs in Table 1 are the least expensive ones if the customer's calling time is less than about 70 mins/month.

bases his decision on Dominant Price Vectors, then this is even stronger evidence of the Fallacy.

Following the logic of dominant price vectors would be rational if one could coordinate a change in one supplier with a change in most of one's calling partners. This solution, however, is difficult in practise for two reasons. First, contracts have a length of two years in Germany and they will typically expire at different times. Second, one's friends have their own circle of calling partners who also have to be convinced to switch to another supplier. So, only if there is a predominately closed group of callers (say a family), is such a strategy likely to justify focusing on dominant price vectors.

An indication that many consumers may suffer from the Fallacy of Dominant Price Vectors comes from the fact that even many automatic price comparisons services (called *Tarifrechner* or tariff calculators) similarly suffer from such a fallacy. These tariff calculators are provided as a free service by non-profit consumer organisations and also by all kind of firms who want to attract visitors to their home pages. They compute average prices of contracts under certain assumptions about consumption patterns. The tariff calculator offered by *Stiftung Warentest* (the leading German consumer advising agency) assumes (in the case of customers with "high" demand) 50% of the calls to other mobile phones to be in the home network and 50% to be external – independent of the network size. For customers with low demand they assume 100% of the calls to be external, which is even more advantageous for E-plus and O_2 (see Table 1).

3. An Internet Questionnaire

In order to find further evidence for or against the Fallacy of Dominant Price Vectors, we elicited responses to a questionnaire which was made available on the Internet. Mobile phone customers were asked to answer a number of questions with respect to their personal characteristics, networks, consumption patterns, etc.[4] Of the respondents, 55% were male, 48% students, 79% between 20 and 30 years old; their networks were T-Mobile 21%, Vodafone 32%, E-Plus 16%, O_2 32%. According to their own estimation, they used their mobile phones 48% during peak time (7 am to 6

[4] The complete results can be found under http://www.econ.euv-frankfurt-o.de/DAJanaHeimel.pdf

pm). A disproportionate 60% regarded themselves as “low” demand customers (< 70 mins/month), 25% “normal” demand customers and 15 % “high” demand customers (>150 mins/month). Their average monthly bill was 36.47 Euros. Apparently, our respondents are not representative of German mobile phone users. We have, however, no indication that they might be particularly prone to the Fallacy of Dominant Price Vectors.

The questionnaire was advertised in Internet discussion groups and via an email to students of the Viadrina University in Frankfurt (Oder), Germany. We received 326 complete responses from which we excluded 23 who were customers of service providers. We only wanted direct customers of the four networks since we believe that these clearly decided for a certain network and thus are better suited for our central question. Of course, customers of service providers (who resell services of the four net owners) know which of the four networks is their home network, but they may still regard themselves as customers of the service provider itself.

Table 2 summarizes the results of how respondents evaluated the importance of contract elements and attributes of a mobile phone operator. Here the first indication that the Fallacy of Dominant Price Vectors may occur becomes obvious. The market share turned out to be least important for our subjects and the importance of sharing one’s network with family and friends was 7th or 8th among 12 attributes. Instead, on-net and off-net price were found to be more important attributes.

The central question was whether the respondents preferred a price vector p^1 = (price within home network, external connection price) = (39 cent per minute, 79 cent per minute) of a supplier with a market share $s^1 = 0.4$ to a price vector p^2 = (39, x) of a supplier 2 with a market share $s^2 = 0.1$. The parameter x was reduced stepwise by 5 cents from 79 cent down to 34 cents. The results are presented in Figure 1.

We do not want to discuss in depth the exact reasons behind the 14.5% of respondents who chose supplier 2 when x = 79 and the 15.5% who chose supplier 1 when x = 34. This might reflect a general preference for the smaller or larger supplier. Instead, our focus is on the 85.5% of the subjects who chose Supplier 1 for x = 79 and the 84.5% (not exactly the same ones) who chose Supplier 2 for x = 34. So, the majority seemed to be aware that size (market share) of the competitors counts – but they underestimated (just as Table 1 proposes) the influence of size on the surplus

from different contracts. Under (1) and under the assumption that the given market shares reflect the calling frequencies in the home network, customers should be indifferent between Supplier 1 and Supplier 2 when x=66. However the majority tended to switch to Supplier 2 as soon as it offered a dominant price vector.

Importance of	**T-Mobile**	**Vodafone**	**E-Plus**	**O_2**
handset	3.00	2.97	3.19	3.26
net availability	4.43	4.36	4.06	4.05
market share	**2.11**	**2.02**	**1.71**	**1.68**
mobile phone operator of family and friends	**3.17**	**3.51**	**3.04**	**3.16**
special offers	2.29	2.63	2.71	2.89
image	2.51	2.66	2.27	2.34
rental fee /basic charge	3.98	4.11	4.33	4.16
on-net-price	3.81	4.28	3.81	3.75
off-net-price	3.78	3.90	3.94	3.97
price to fixed line	3.65	3.76	4.13	3.88
price for SMS	3.40	3.56	3.50	3.29

Table 2: Importance of contract elements and attributes of a mobile phone operator evaluated (from 1 "very unimportant" to 5 "very important") by mobile phone customers (sorted by membership of the supplier). The order of attributes is that in the questionnaire.

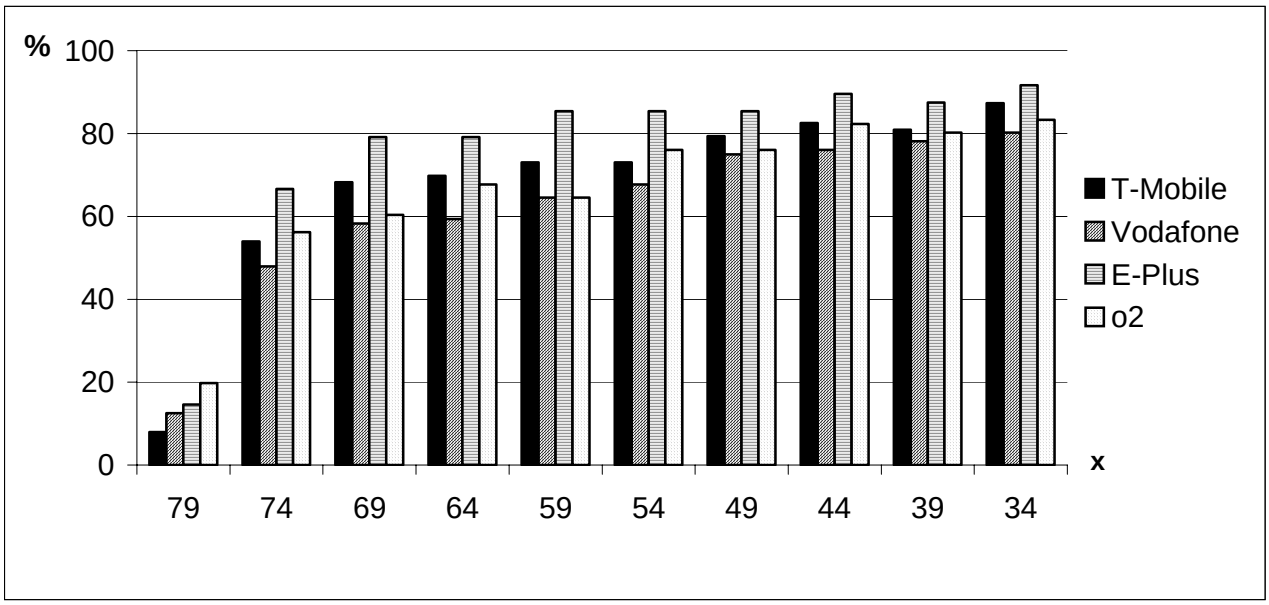

Figure 1: Percentage of participants who selected supplier 2's tariff of 39/x cents instead of 39/79 cents from supplier 1.

As the respondents have no other information than market shares (and prices) it is difficult to assume that they did not use market shares as substitutes for the calling frequencies. It seems that most of them took into account these calling frequencies only as a second criterion (a lexicographical ordering) and that instead they were guided by the dominance relation.

The fallacy can be observed for customers of all networks alike. If only customers of the small networks E-plus and 0_2 had been involved, we could have argued that they identified themselves as the small network customers and substituted the market share of 10% by the larger share of their personal calling partners in their own network. But this argument does not apply for the customers of large networks. If anything, they should identify themselves as the customers of the large network and thus assume the calls into their home network to have a share above 40%. That is, under such an assumption the customers of T-Mobile and Vodafone should switch at even lower rates than x = 66 to the smaller networks. Figure 1 indicates that, in fact, the customers of the large networks seem to switch a bit later, but also for these respondents we find that about 50% would switch for x < 79 (the largest x for which the price vector of the smaller network is dominant).

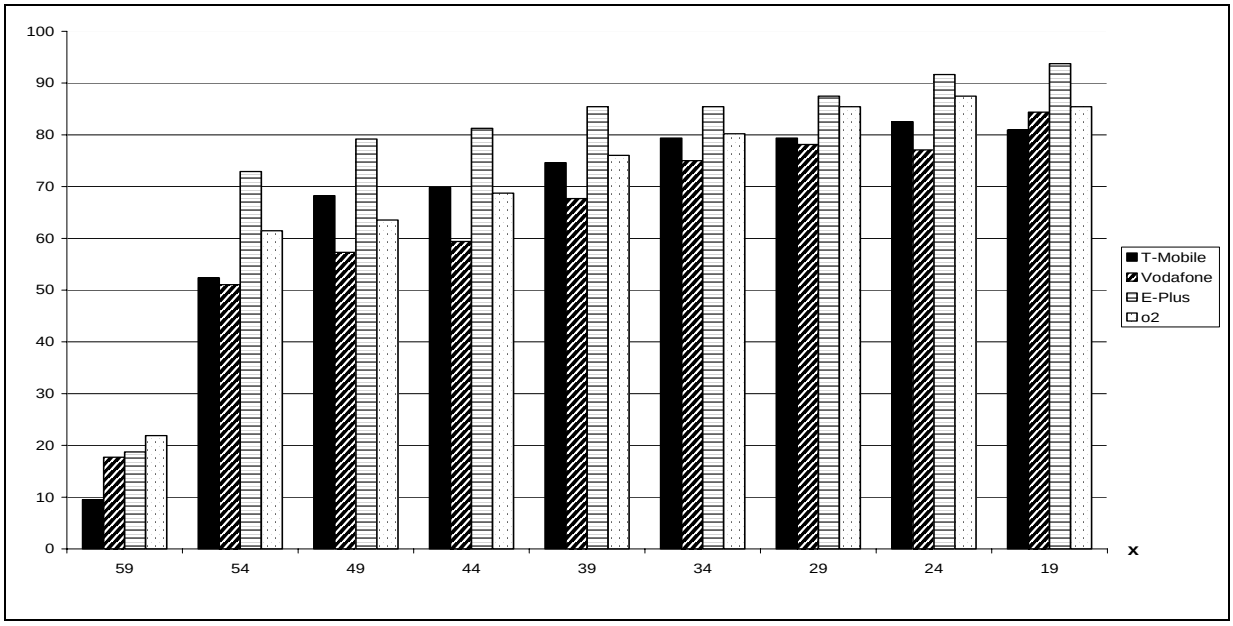

Figure 2: Percentage of decisions for 19/x cents from supplier 2 instead of 19/59 cents from supplier 1.

The subjects were also asked to decide in a second case with different prices (cents) namely between p^1 = (19, 59), s^1 = 0.4 and p^2 = (19, x), s^2 = 0.1 with x reduced stepwise by 5 cents from 59 cent down to 19 cents. A consumer, who takes market shares as a substitute for his individual calling frequencies should have changed to network 2 when being charged x = 44 cents for an external call. However, 65% of the respondents chose the smaller network already for x = 49, and more than 50% chose the smaller network immediately when the price vector (19.x) became dominant (see figure 2); that is, for x = 54.

4. Conclusion

Mobile phone contracts include a number of prices for different services and contain fixed price as well as take-or-pay price elements. This complexity makes the comparison of these contracts rather difficult and dependent on personal demand structures. Here we concentrate on the evaluation of only one aspect of mobile phone contracts, namely the price of calls in the home network and the price of external calls. We show that a fallacy of dominant prices exists: as the average price depends on the distribution of internal and external calls, the dominance relation $p^2 < p^1$ does not imply that the average price under p^2 is smaller than under p^1.

The fallacy we have identified may play an important role in explaining the existence (or at least for the effective threat) of market entry and for the survival of small networks amidst competition with larger incumbents. As Kim *et al.* (2003) show, the providers with larger networks are advantaged. We show they may be advantaged, but not as they should be in the face of rational consumers, the standard assumption in the literature.

Our findings suggest policymakers concerned that price discrimination in network industries may be used to limit competition may have less reason to worry than previously thought. On the other hand, we have not considered how networks may optimally adjust their pricing to take into account consumers' irrational behavior. This remains an interesting issue for future research.

References

Gigerenzer, G. and Selten, R. (Eds.) (2002): Bounded Rationality: The Adaptive Toolbox, Cambridge, MA; London: MIT Press.

Heimel, Jana (2005) Netzwerkeffekte im Mobilfunk – eine empirische Studie am Beispiel des deutschen Mobilfunkmarktes. Diplomarbeit. http://www.econ.euv-frankfurt-o.de/DAJanaHeimel.pdf

Kim, Hee-Su and Kwon, Namhoon (2003): "The Advantage of Network Size in Acquiring New Subscribers: A Conditional Logit Analysis of the Korean Mobile Telephony Market," *Information Economics and Policy*, 15: 17-33.

Laffont, Jean-Jacquef, Rey, Patrick and Tirole, Jean (1998a): "Network Competition: I. Overview and Nondiscriminatory Pricing," *RAND Journal of Economics*, 29: 1-37.

Laffont, Jean-Jacquef, Rey, Patrick and Tirole, Jean (1998b): "Network Competition: II. Price Discrimination," *RAND Journal of Economics*, 29: 38-56.

RegTP (2005): Jahresbericht 2004 – Bonn [HTML] http://www.regtp.de/reg_tele/start/fs_05.html

Simon, (1957): "Models of Man," New York – London, Wiley.

Stiftung Warentest (2005): Handytarife Hitliste Wenigtelefonierer. Normaltelefonierer. Vieltelefonierer. 14.03.2005 [HTML] http://www.stiftung-warentest.de/online/computer_telefon/infodok/1131835/1131835.html.

USTR, United States Trade Representative (2005): Results of the 2005 Section 1377 Review of Telecommunications Trade Agreements, 15.04.2005 [HTML] http://www.ustr.gov/assets/Trade_Sectors/Services/Telecom/Section_1377/asset_upload_file959_7529.pdf.