Cyclical Price Fluctuations in the German Call-by-Call Telephone Market A case for Regulation?

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Preliminary version

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I. Evidence on cyclical price fluctuations

Since 1998, the German telephone market has been opened to competition. The incumbent Deutsche Telekom (DT) is no longer a monopolist but is faced with competition from some 30 other firms. Customers may switch to another provider or remain customer of DT but buy service on a call-by-call base. In the latter case, a customer has to pre-dial the number of the providers he selects and then she continues to dial the DT-number of the participant she wants to be connected with.

Thanks to the liberalisation, the price for telephone calls decreased considerably – for domestic long distance calls, at the end of 2002 the average price on working days was only 7 % of that in 1997 (Regulierungsbeörde für Telekommunikation und Post, 2003). Such a development is undoubtedly a great success, but it is not the topic of this paper. Instead of that we want to discuss a phenomenon we observed in the 2002 call-by-call market.

The suppliers in this market are free to change their prices as often as they want. Some of them underlie restrictions on the magnitude of prices but there are no restrictions on price changes. The usual sources of price information are either the internet or newspapers. Many newspapers publish the lowest prices each Monday. So, usually you have a price list close to you telephone which has to be updated from time to time. If you call the cheapest supplier from a “fresh” price list you often get no connection – demand is above its capacity. If you call the cheapest supplier from an older price list you often make the experience that the price announced (not all suppliers announce the price in advance) is higher than the price in the list.

With this anecdotal expience in mind we had, in 2003, a closer look at the data. In Figure 1, the price development of the three suppliers with the lowest average prices (6.85 to 7.16 cent for a three minute call) are shown. Apparently, there is a “systematic” up and down of prices during the whole year. We observe similar price movements also for the next cheapest suppliers – up to No 13 who is the first with a nearly constant price (12 cent on average, only one price change). There were additional suppliers (DT required 36.7 cent!), but they probably did not play a significant role in this market segment.[1] The systematic character of the fluctuations can also be seen from Table 1. Those suppliers who change prices more than once apparently followed an up-down (or better down-up) pattern. It seemed that they followed a policy where, first, they attracted customers by low prices and, afterwards, exploited those customers who were not completely up to date with their price information.

		A previous price increase	A previous price decrease
is followed by a	price increase	3	34
	price decrease	31	8

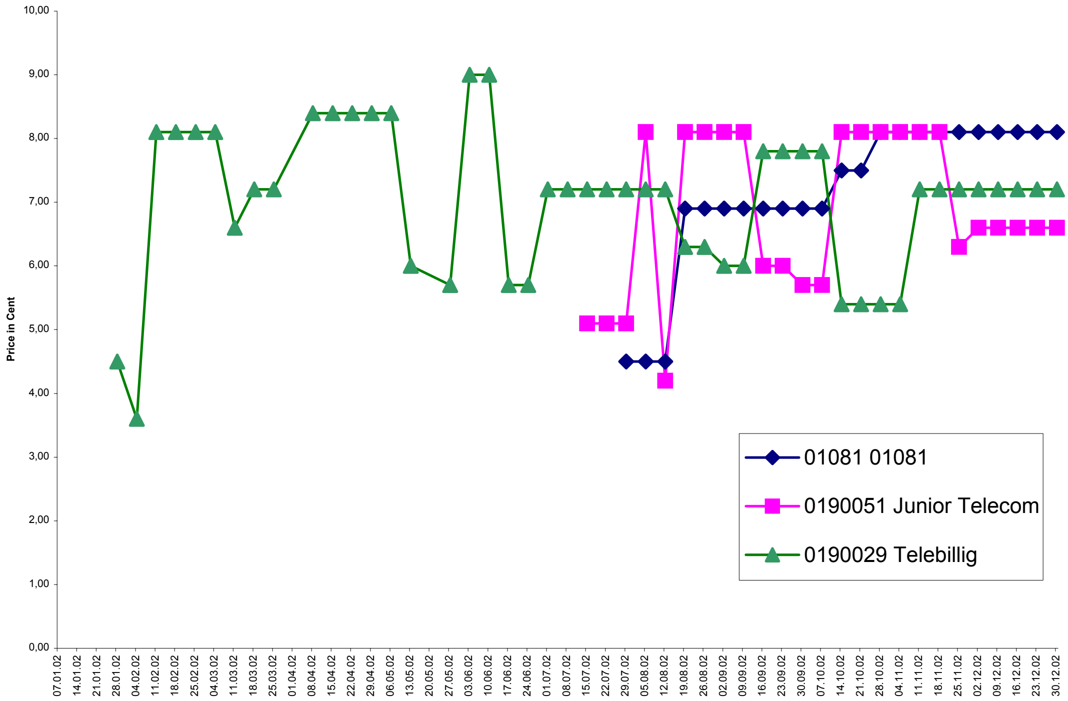
Table 1: The down and up of prices in 2002

The next question we posed was whether such a behavior could be equilibrial. For this purpose we investigated a two person game with two possible prices. A customers knows with probability α the current prices or she knows only last period's prices. In addition, we assumed one competitor to be capacity restricted. In a simulation study, we found that price fluctuations could be equilibrial depending on the parameter values. (Baier and Bolle, 2004).

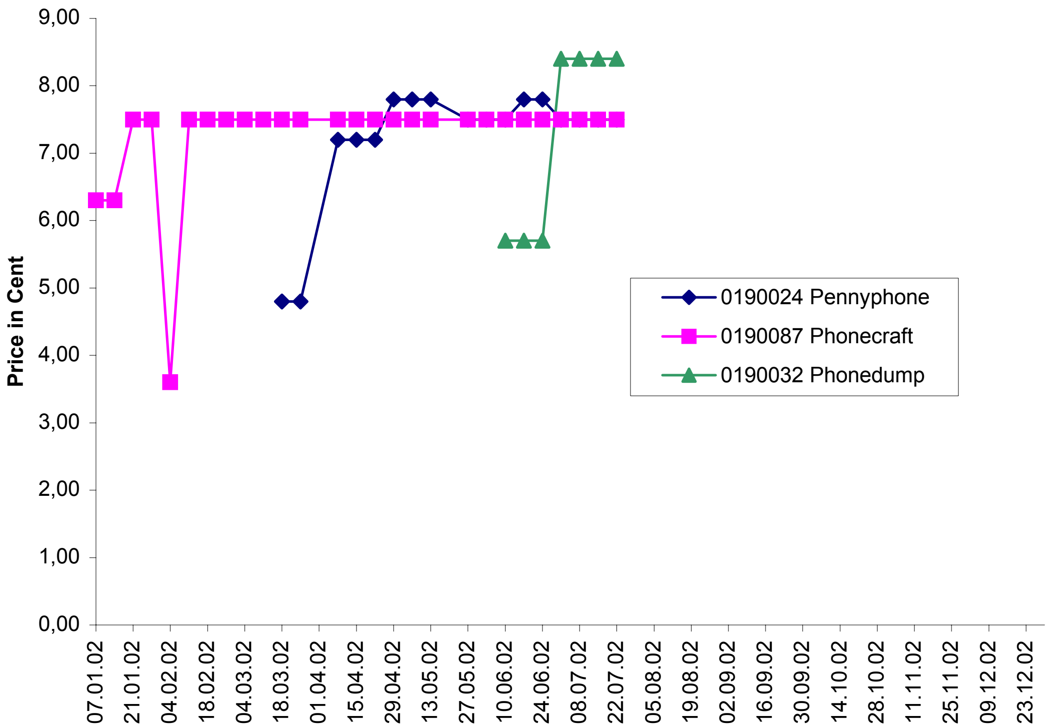
In the next section, we want to present a similar model, however with several changes. We want to assume the suppliers to maximise "average values" instead to maximise the sum of discounted values which simplifies the computations considerably. Under these conditions we can rely on exact values instead of simulations. We indicate, in a case without capacity restrictions, a region of prices and probabilities (for knowing the actual price) where equilibria with permanent price fluctuations exist.

[1] There are no numbers available on quantities sold.

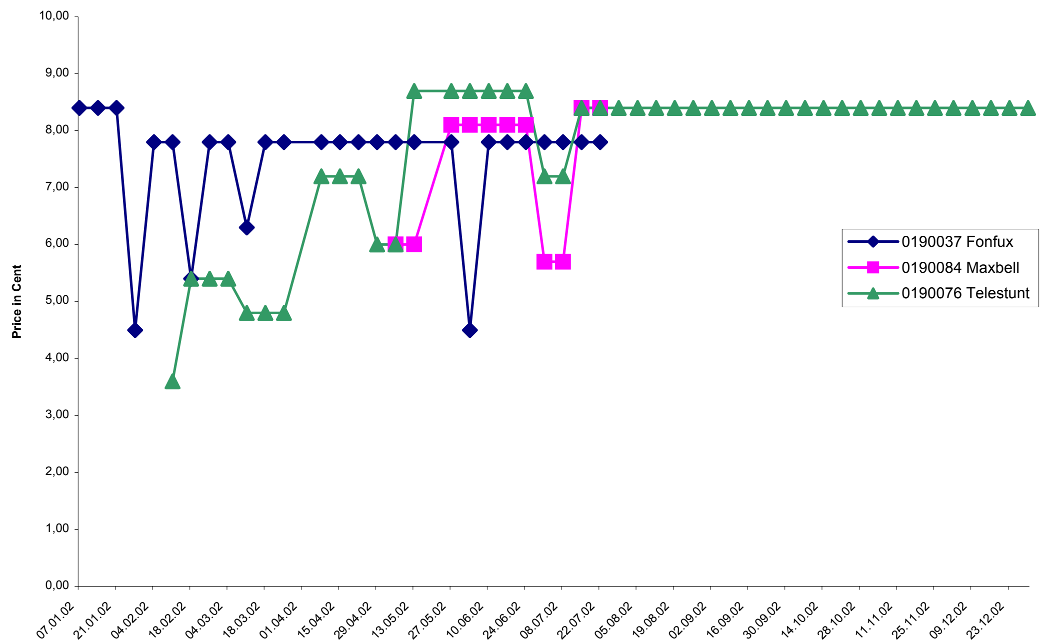
The three cheapest suppliers 2002



Number 4, 5, and 6 in the order of lowest averrage prices 2002



Number 7, 8, and 9 in the order of lowest averrage prices 2002



Number 10, 11, 12, 13, and 14 in the order of lowest averrage prices 2002

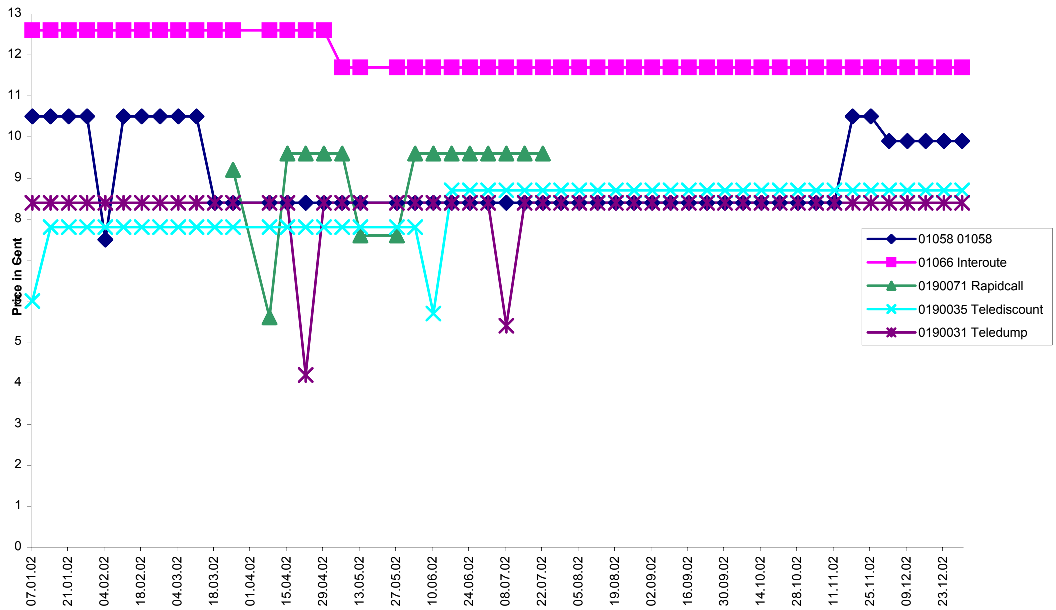


Figure 1: Price (three minute call) of cheapest suppliers in 2002.
Source: www.billiger-telefonieren.de (own graphical representation).

II. A duopoly model

Let us assume that every consumer carries out an individual but fixed number of telephone calls per period, independent of the price of the call. The prices of the suppliers determine which supplier she chooses but they do not influence overall demand.

There are two supplies with zero costs who choose their prices $p_i^t \in \{r,1\}$, i = 1, 2 with 0 < r < 1 in every period t anew. With probability α, a consumer is informed about the prices of period t, with probability 1 - α, she only knows the prices of period t –1 (she has an outdated list). The consumer decides on the basis of the information she has, i.e. either according to the prices of period t or according to the prices of period t – 1. If $p_i^t < p_j^t$ (or $p_i^{t-1} < p_j^{t-1}$ if only the prices of period t – 1 are known) then i gets the whole demand. If prices are equal she decides by chance. The whole market demand is normalised to 1.

Thus there are four different price combinations as indicated in Figure 2. The profits U(K_{t-1}, K_t), K_{t-1}, $K_t \in$ {A, B, C, D} are computed in Table 2. Please notice that, in any case, consumers pay period t's prices. Take the case (K_{t-1}, K_t) = (D, A). With probability α, K_t is known and Firm 1 gets r/2. With probability 1 - α, only K_{t-1} is known which again implies that both firms get half the market demand, i.e. firm 1's profit is again $p_t \cdot 1/2$ = r/2.

		Firm 1's prices	
		r	1
Firm 2's prices	r	A	B
	1	C	D

Figure 2: The possible price combinations.

K_t	p_t	K_{t-1} → Profit if t-1 is relevant / Profit if t is relevant ↓	A	B	C	D
			$p_{t/2}$	0	p_t	$p_{t/2}$
A	r	r/2	r/2	αr/2	r(1-α/2)	r/2
B	1	0	(1 - α)/2	0	1 - α	(1 - α)/2
C	r	r	(1 + α)r/2	αr	r	(1 + α)r/2
D	1	1/2	1/2	α/2	1 - α/2	1/2

Table 2: Profits $U(K_{t-1}, K_t)$ of firm 1 in period t. A consumer knows K_t with probability α and she knows K_{t-1} (but not K_t) with probability 1 - α.

Concerning the long-term goal of the firms we assume, for the sake of simplicity and contrary to Baier and Bolle (2004), that the firms do not discount but want to maximise their "average pay-off", i.e.

(1) $$V_i = \liminf_{n\to\infty} \frac{1}{n} \sum_{t=1}^{n} U(K_{t-1}, K_t)$$

with a certain initial K_0. In this goal function only those price combinations are relevant which occur infinitely often. So K_0 is only important because it may initialise a certain path $(K_t)_{t=0,1,...}$ but not in itself. For example, if the price policies of the competitors imply a permanent fluctuation between price combinations B and D then $V_i = \frac{1}{2}$ (U(B, D) + U(D, B)).

By interchanging the roles of firm 1 and firm 2 we get the profits of firm 2.

Subgames in this infinite game are described by the price structure of the last period. In the following, we want to concentrate on Markow strategies, i.e. we require identical strategies on identical subgames. Thus a Markow strategy s_i of firm i is a mapping

(2) $s_i = \{A, B, C, D\} \rightarrow \{r, 1\}$

So, we can describe s_i by

(3) $s_i = (x_A, x_B, x_c, x_D)$, $x_l \in \{r, 1]$.

Every pair of strategies results in a dynamic price structure as indicated by the examples in Figure 3.

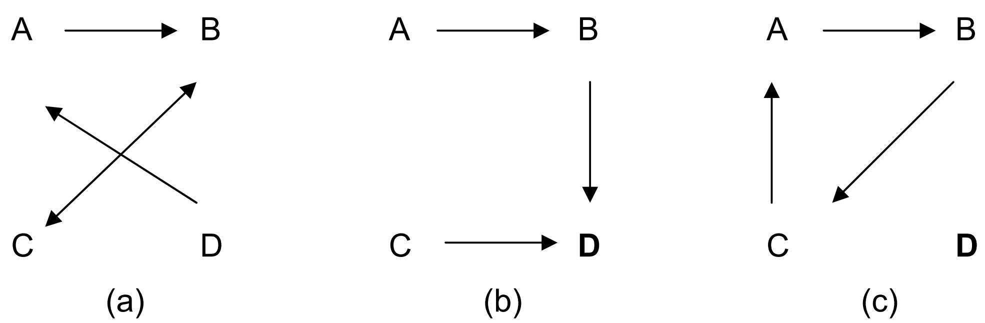


Figure 3: Price development under strategies (a): $s_1 = (1, r, 1, r)$ and $s_2 = (r, 1, r, r)$. (b): $s_1 = (1, r, r, 1)$ and $s_2 = (r, 1, r, 1)$. (c): $s_1 = (r, r, r, 1)$ and $s_2 = (r, 1, r, 1)$. A bold letter indicates a stationary state.

(a) is a case with permanent price fluctuations, evaluated $V_1 = \frac{1}{2}$ (U(B, C) + U(C, B)) by 1. (b) results in a permanent price structure D, evaluated U(D, D) by 1. (c) depends on the initial condition, the cycle is evaluated $\frac{1}{3}$ (U(A, B) + U(B, C) + U(C, A)).

While in Baier and Bolle (2004) we analysed the complete 16 x 16 game, here we only want to show that price fluctuations are equilibrial. For this purpose we (arbitrarily) take (a) from Figure 2 and ask whether this might be an equilibrium for certain (α, r) values, i.e. instead of analysing the whole 16 x 16 matrix we only regard the row and column belonging to $s_1^* = (1, r, 1, r)$ and $s_2^* = (r, 1, r, r)$. In Figure 4, we have indicated the price development for $s_2^* = (r, 1, r, r)$ and all possible s_1. Thus s_1^* is a best reply to s_2^* if $\frac{1}{2}$ (U(B, C) + U(C, B)) is not smaller than the values resulting from all the price dynamics in Figure 4. These are U (A, A) and $\frac{1}{2}$ (U(B, D) + U(D, B)) and $\frac{1}{3}$ (U(A, B) + U(B, C) + U(C, A)) and $\frac{1}{3}$ (U(A, B) + U(B, D) + U(D, A)). The respective inequalities are equivalent to

(4) $\alpha \le \frac{1}{2(1-r)}$

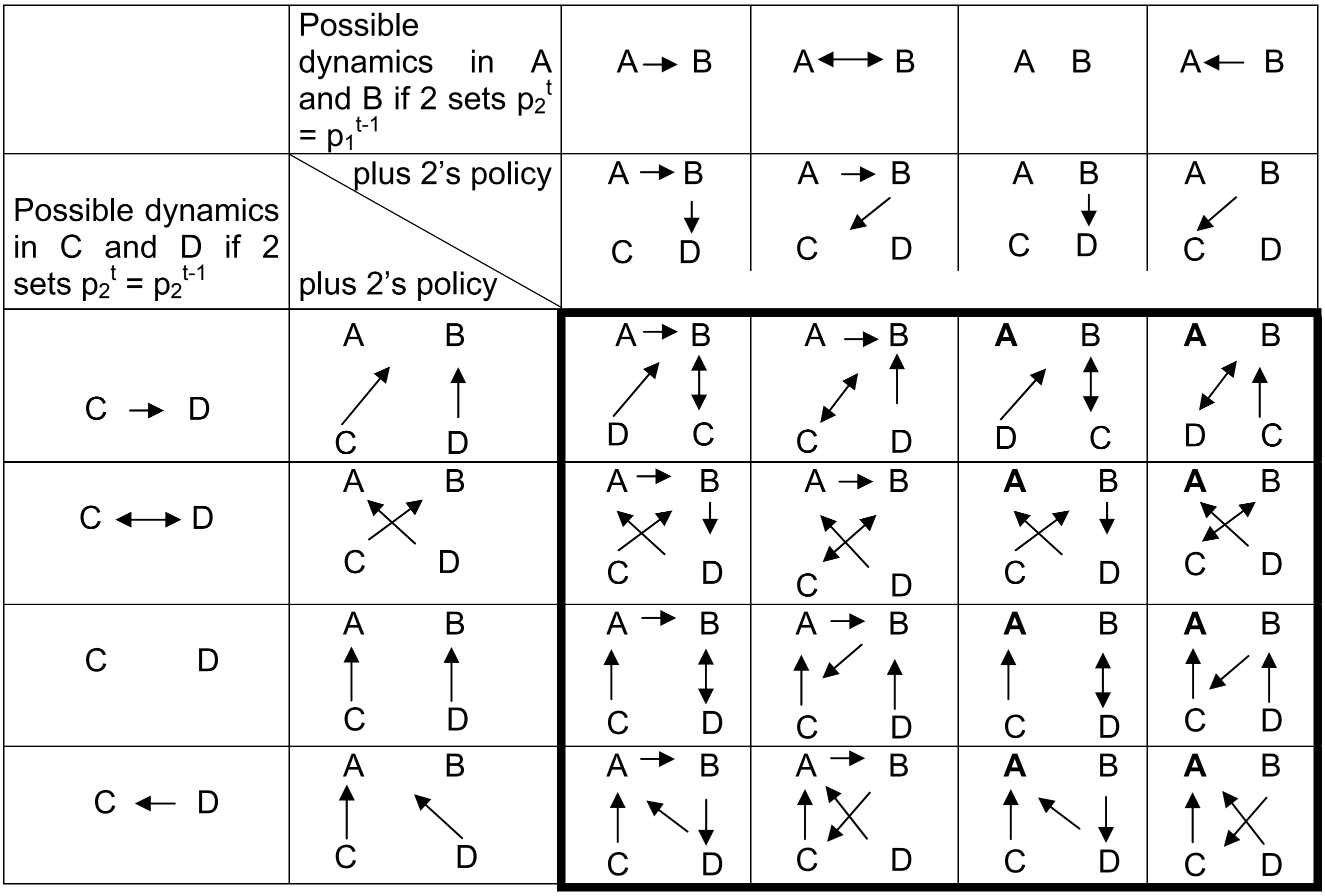


Figure 4: The price dynamics resulting from 2's policy $s_2^* = (r, 1, r, r)$ and all possible policies of 1. A → B in the first row results from $s_1(r, 1, ., .)$, C → D in the first column results from $s_2 = (., ., 1, 1)$, etc. The 16 possible price dynamics are superpositions of the second row and the second column.

Is s_2^* also a best reply to s_1^*? To answer this question, we ask whether $s_1' = s_2^*$ is a best reply to $s_2' = s_1^*$ and apply the above procedure. We arrive at the result that it is a best reply iff $\frac{1}{2}$ (U(B, C) + U(C, B)) is not smaller than $\frac{1}{2}$ (U(B, D) + U(D, B)) and $\frac{1}{2}$ (U(A, D) + U(D, A)) and $\frac{1}{2}$ (U(A, C) + U(C, A)) and $\frac{1}{4}$ (U(A, C) + U(C, B) + U(B, D) + U(D, A)) and $\frac{1}{4}$ (U(A, D) + U(D, B) + U(B, C) + U(C, A)). These restrictions are equivalent to

(5) $\alpha \leq \frac{1}{3}$

and

(6) $\alpha \leq 1 - r$

So, $s_1^* = (1, r, 1, r)$ and $s_2^* = (r, 1, r, r)$ are equilibrium strategies if (4), (5), and (6) apply (see Figure 5).

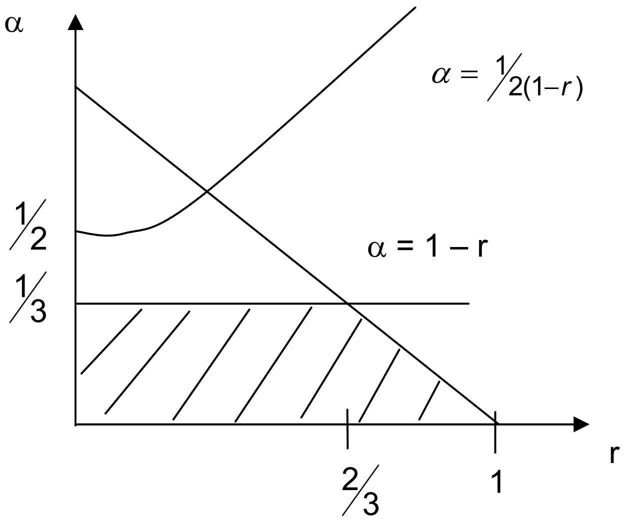


Figure 5: The parameter values (α, r) for which (s_1^*, s_2^*) is an equilibrium.

As the firms are in a symmetric situation, not only (s_1^*, s_2^*) but also (s_1', s_2') with $s_2' = s_2^*$ and $s_2' = s_1^*$ is an equilibrium. The two equilibria do not differ with respect to the price cycle which is in both cases B $\leftrightarrow$ C, but they differ in the path to the cycle. In (s_1^*, s_2^*) the path (if it does not start at B or C) is A $\rightarrow$ B $\leftrightarrow$ C or D $\rightarrow$ A $\rightarrow$ B $\leftrightarrow$ C, in (s_1', s_2') it is A $\rightarrow$ C $\leftrightarrow$ B or D $\rightarrow$ A $\rightarrow$ C $\leftrightarrow$ B. As the equilibrium values in (s_2^*, s_1^*) as well as in (s_2', s_2') are the same also every mixture of strategies is an equilibrium, i.e. there is also a symmetric equilibrium with a cycle B $\leftrightarrow$ C (the mixture only affects the path to B $\leftrightarrow$ C).

Usually, there are many equilibria for every parameter constellation. We do not want, however, to analyse the full set of equilibria because our simple duopoly model does not paint the detailed structure of the call-by-call market. The important thing to learn from our model is the fact that equilibria with price fluctuations occur if we deviate from complete price information.

In a model as simple as the duopoly model above we might ask why the consumers didn't anticipate the firms' behavior. But in a real market with several firms and "more stochastic" price fluctuations (see Figure 1) it is difficult to develop "rational expectations" in the sense of perfect forecasts. Thus it seems to be sensible not to provide our model consumers with rational expectations.

One can think of many other possibilities to "improve" the model, for example, introducing a continuum of prices or more suppliers or a more distributed price information. But we do not expect that the main result, namely the *possibility* of price cycles, would change.

III. Cyclical price fluctuations: A transition problem or a case for regulation?

The model in Section II showed the theoretical possibility, not the necessity of cyclical price fluctuations. So, the fact that we found such price policies in 2002 does not necessarily imply that they are perpetuated to 2004. Possibly the market situation (the parameters) are different or the consumers have learnt about the price policies of some suppliers and look now for constant price suppliers.

After comparing Figure 1 and Figure 6, it seems that the problem no longer exists. The cheapest supplier in 2004 (Interroute) seems to require completely constant prices. And also the other suppliers seem to show little (if at all) systematic down and up movements. All this is connected with prices which have more than halved during the last two years: The price of the cheapest supplier went down from 6.9 to 3.1 cents for a three-minute telephone call. The respective prices of DT were 36.9 cent in 2002 and 13.8 cent in 2004. These reduced prices are certainly also due to reduced costs of the supplier who buy, to a large extent, (regulated) services from DT. In addition, those who do not own cables for long distance connections profit from the oversupply in this market.

So, there are mainly two possible reasons for a change of policy: First, there may be a new parameter constellation in the market under which price fluctuations are no longer equilibrial. Second there may be a learning process by the consumers who learnt to avoid “exploitive” suppliers. In this case, the price fluctuations observed in 2002 might be a mere temporary problem, rising and fading away during the transition from a monopoly to a really competitive market. But how can we know? A third possibility are constant one week cycles in 2004. This remains to be investigated.

In our model as well as in reality some firms seem to exploit the incomplete information of many consumers. We cannot exclude that the relatively constant prices in 2004 will be followed by a period of high volatility again. The consumers can be misled by frequent price fluctuations they can only keep track of with prohibitive costs. So we think the regulatory authority should enforce measures against such policies. One measure is that all suppliers would be obliged to announce their price before they deliver their service. Many firms do this already but not all. Even if one decides not to try another supplier if the announced price is higher than last week’s price (which one knows), perhaps the next time one tries to avoid this supplier.

Another measure would be an obligatory period (say four weeks) following a price decrease during which a price can be lowered but not be increased. One must be careful, however, with the introduction of such irreversible price policies. In Bolle and Breitmoser (2004) it is shown in a general duopoly model that such restrictions largely facilitate tacit collusion.

So, it is not easy to give clear advise against exploitive cyclical price policies but, nonetheless, this problem should be given attention by the regulatory authority.

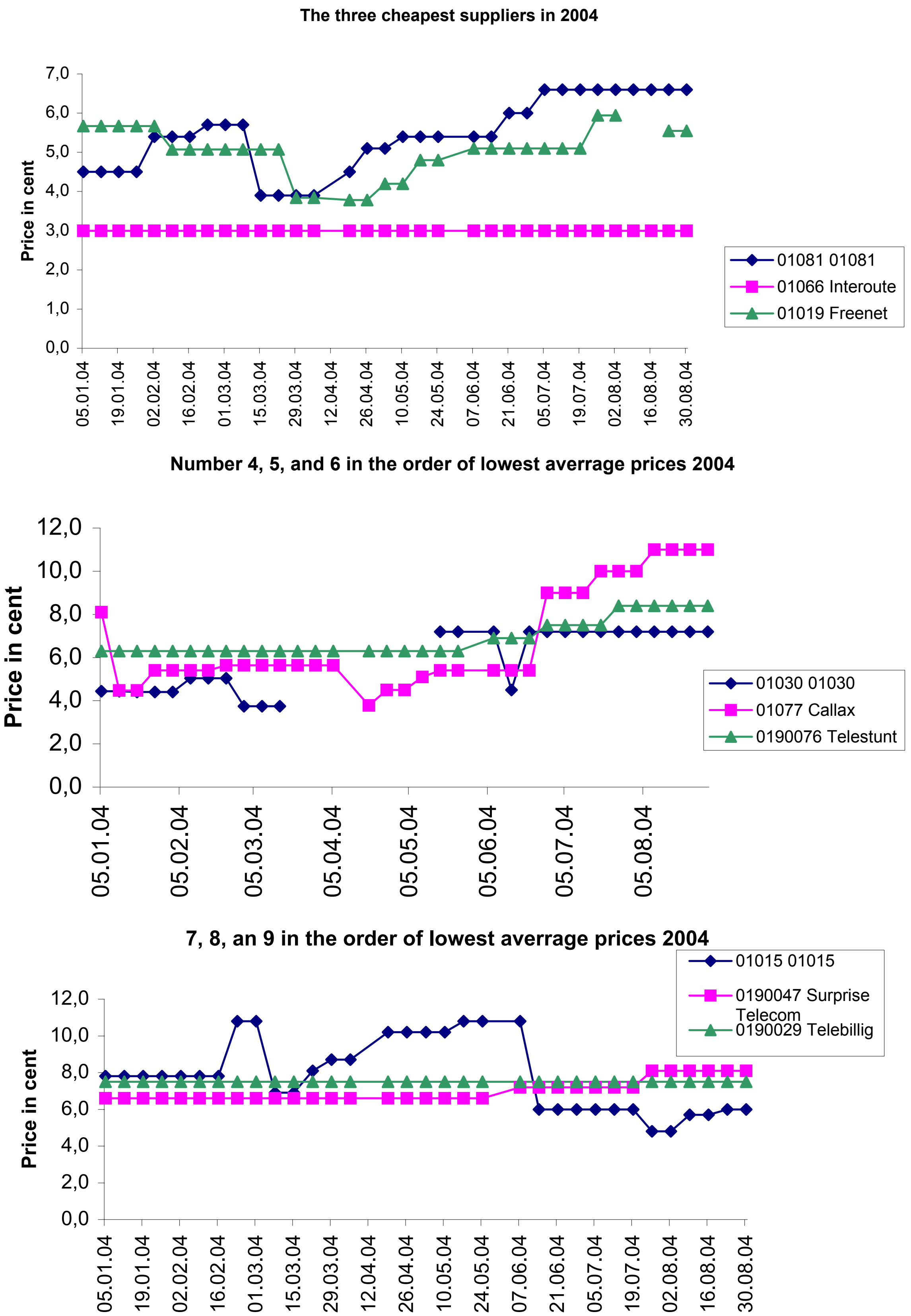


Figure 6: Prices (three minute-call) of the cheapest suppliers in 2004 Jan. - Aug.) Source: www.billiger-telefonieren.de (own graphical representation).

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