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Competitive Pressure: Competitive Dynamics as Reactions to Multiple Rivals

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Abstract

Research on competitive dynamics has focused primarily on interactions between pairs of firms (dyads). Drawing on the awareness-motivation-capability framework and strategic group theory we extend this perspective by proposing that firms' actions are influenced by perceived competitive pressure resulting from actions by several rivals. Specifically, we predict that firms' actions magnitude is influenced by the total number of rival actions accumulating in the market, and that this effect is moderated by firm type. We test our propositions with data on the German market for mobile telephony and find them supported: the magnitude of firm's actions is influenced by previous competitor actions and firms react more strongly to rivals of their own type (incumbents or challengers).

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Keywords: Rivalry, competitive dynamics, strategic groups

INTRODUCTION

Deutsche Telekom's price cuts were a reaction to the price decline in the German market for mobile telephony. – Handelsblatt 12/2005

In many industries firms constantly have to defend themselves against rival attacks on their competitive position (Smith *et al.*, 1991; Smith, Ferrier and Ndofor 2001). In turn, their actions may provoke retaliation from their rivals, further fuelling competition (Chen, Smith and Grimm, 1992; Yu and Cannella, 2007). The outcomes of competitive interactions determine competitive advantage and thus profitability (Chen and Hambrick, 1995; Ferrier, 2001), so that understanding their underlying mechanisms is central to competitive analysis and strategic management research in general (Chen, 1996; Ketchen, Snow and Hoover, 2004; Smith *et al.* 2001).

In the past two decades competitive dynamics research has analyzed competitive behavior between rival firms at the level of individual competitive actions (Ketchen *et al.*, 2004; Hutzschenreuter and Israel, 2009). A central question in this research is which factors induce firms to make competitive moves (Chen and Miller, 1994; Ferrier, Smith and Grimm, 1999; Ferrier *et al.*, 2002). Focusing on action-reaction dyads, i.e. matching pairs of actions and responses, scholars found evidence that firms are affected by their rivals' actions (Smith, Grimm and Gannon, 1992; Chen *et al.*, 1992; Chen and MacMillan, 1992; Chen, Su and Tsai, 2007).

The action-reaction dyad has been useful in providing a clear link between individual actions and responses, but it does imply two strong assumptions (Hsieh and Chen, 2010): First, managers are assumed to perceive actions by rival firms individually and not to evaluate them jointly. Second, each response is assumed to be targeted towards an individual rival action, not towards several rivals at once. These assumptions are useful to study competitive interactions

with few similar rivals, but in industries with many heterogeneous players this model of studying competition may be too narrow. Consequently, this study asks whether competitive actions by multiple rivals also *jointly* influence firm actions (Hsieh and Chen, 2010).

Specifically, we ask whether firms' competitive moves are influenced by the gradual buildup of actions by multiple rivals over time. Based on the awareness-motivation-capability (AMC) framework (Chen and Miller, 1994; Chen, 1996) we propose that as rival actions accumulate since a firms' last action managers perceive increasing 'competitive pressure', i.e. a perceived necessity to take competitive action, and that this influences their actions. Drawing on the literature on rivalry in strategic groups we also study the moderating effect of firms' type on their reactions to multiple rivals (Reger and Huff, 1993; Chen and Hambrick, 1995; Porac *et al.* 1995; Ferrier *et al.*, 1999; Chen *et al.*, 2007).

We address these questions by examining action magnitude as a central attribute of competitive moves (Smith *et al.*, 1992), using data on tariff setting in the German market for cellular telephony. By analyzing firms' reactions to multiple rivals this study complements Hsieh and Chen (2010) in introducing a new perspective of competitive interactions. It also contributes to theory by discussing how awareness, motivation and capability influence competitive pressure, thus extending the AMC framework to rivalry between a firm and groups of competitors (Chen and Miller, 1994; Chen, 1996). Finally, it provides a further link between competitive behavior and strategic group research by demonstrating that firms react differently to rival actions from within or outside their own strategic group (Cool and Dierickx, 1993; Porac *et al.*, 1995, Smith *et al.*, 1997; Leask and Parker, 2007).

The results from our empirical study provide strong support for our arguments. Firms' action magnitude is influenced by the buildup of rival actions: the more actions that have accumulated in the market since a firm's last competitive move, the greater that move's magnitude. We also find that the effect of rival actions on action magnitude is moderated by firm type: challengers react more strongly (even exclusively) to rival challengers' actions, and incumbents react to rival incumbents' actions. We conclude that competitive pressure and the link to rivalry in strategic groups provide a promising new perspective on competitive dynamics.

The paper is structured as follows: we first develop our theoretical framework derive hypotheses. We then present the data and research methods, and report our empirical results. We then draw conclusions and identify directions for future research.

THEORETICAL FRAMEWORK AND HYPOTHESES

Competitive Pressure

The basic building blocks of competitive interaction are 'externally directed, specific, and observable competitive move[s] initiated by a firm to enhance its relative competitive position' (Smith *et al.*, 2001:321; Porter, 1980). Consequently, competitive moves are at the heart of research on competitive dynamics. Scholars have studied how they are influenced by characteristics of the acting firm, e.g. size and past performance, as well as by industry characteristics, e.g. buffering from competition and industry-life-cycle (Chen and MacMillan, 1992; Ferrier *et al.*, 2002; Más-Ruiz *et al.*, 2005; Fjeldstad *et al.*, 2004). The main focus, however, is on the interaction between firms, i.e. how each firm's competitive moves are influenced by its rivals' behavior (Bettis and Weeks, 1987; Smith *et al.*, 2001).

Most studies on these interactions focus on action-reaction dyads (Smith *et al.*, 2001). These dyads consist of a matching pair: an action and a reaction in direct answer to it, for example a firm introducing a new product and a competitor responding with a price cut, and are typically identified through content analysis of third-party reports or newspapers (Chen *et al.*, 1992; Yu and Cannella, 2007). By providing a clear link between competitive actions and responses a large number of studies can establish a clear connection between firms' competitive moves and previous rival actions (Smith *et al.*, 2001; Hutzschenreuter and Israel, 2009).

However, inherent in the main advantage of the action-reaction dyad approach – the fact that it allows clear a identification of matching pairs of competitive moves – is also a potential drawback. As pointed out by Hsieh and Chen (2010), it implies two strong assumptions about competitive interactions. First, it assumes that firms perceive each rival action individually and are unaware of (or disregard) potential interdependencies. Second, it assumes that firms' reactions are exclusively responses to individual actions by specific rivals and never to multiple rivals' actions at once. In mature industries with a small number of highly visible rivals these assumptions may hold, but in dynamic markets with a large number of firms they seem excessively restrictive. There, it seems more plausible that only some of a firm's actions are direct responses to an attack by an individual competitor whereas others may be directed towards several rivals at once as the firm attempts to improve its relative competitive position.

In this paper we develop an alternative perspective of competitive interaction to complement the action-reaction dyad. In particular, we assume that, firms also perceive the sum of all rival actions in the market jointly: as each firm sees its rivals' actions accumulate since its last competitive move it perceives an increased threat of finding itself at a competitive disadvantage and is increasingly motivated to react. We call the perceived necessity to make a competitive

move through a joint evaluation of multiple rivals' actions 'competitive pressure', going back to Porter's description of competitive interaction (1980:17). We predict that competitive pressure influences firm behavior, i.e. that firms make competitive moves in response to 'the aggregate impact of multiple rivals' actions' (Hsieh and Chen, 2010:3), as well as to specific actions by individual rivals.

We use the term 'competitive pressure' to distinguish the concept from 'perceived competitive tension', defined by Chen *et al.* (2007:103) as, 'the extent to which a firm's managers and industry stakeholders consider a given rival to be the focal firm's primary competitor'. As discussed by Chen *et al.* (2007), competitive tension is a dyad-level construct, i.e. it describes the (possibly asymmetric) perceived relationship between a pair of rival firms. In contrast, competitive pressure describes a perceived relationship between a focal firm and its entire competitive environment, and thus complements the concept of competitive tension.

Ferrier and Lee (2002) compare the exchange of competitive actions between firms to fighters exchanging punches in a boxing match. To describe competitive pressure we propose a different sporting metaphor: in this context firms are like runners in a race where each individual competes against all the others, although now and again he or she may put in a burst of speed to overtake a specific individual.

Awareness-Motivation-Capability Framework

To investigate how firms perceive competitive pressure and how it affects their actions we draw on the awareness-motivation-capability (AMC) framework. The AMC framework has its origins in psychology and is used frequently in competitive dynamics research (e.g. Chen and MacMillan, 1992; Chen, 1996; Smith *et al.*, 2001). It suggests that firms will respond to rivals'

actions if three conditions are met: they must be aware of the moves, motivated to respond to them, and they must possess the necessary capabilities to do so.

Competitive pressure is affected by a firm's awareness of rival moves and by its motivation to respond to them. If a firm is unaware of rival actions it cannot perceive a necessity to respond to them, motivated though it may be (Chen and Miller, 1994). If a firm is aware of rival actions but not motivated to respond to them, e.g. because they are not perceived as threatening, then it will also not experience competitive pressure. However, if a firm is both aware of rival actions and motivated to respond to them, we propose that it will see a necessity to respond, or 'competitive pressure'.

Firm capabilities may influence competitive pressure in two ways. It is possible that firms perceive increased competitive pressure if they perceive a necessity to act but lack the capacity to do so. Conversely, it is also conceivable that firms perceive greater pressure if they see a need to make a competitive move and know that they are in principle able to do so, but have not done so yet. We do not hypothesize which of these two effects is stronger. Instead, we note that a firm can only relieve competitive pressure if it possesses the necessary capabilities to take action.

Thus, our argument is threefold: first, competitive pressure can arise from a firm's awareness of and motivation to respond to a buildup of actions by one or more rivals. Second, firms will seek to relieve competitive pressure by making competitive moves. Third, these moves may be directed towards several rivals at once. This argument is consistent with the finding by Hsieh and Chen (2010) that an increasing number of rival actions increases the likelihood that a firm will make a competitive move to protect its competitive position, and with Reger and Huff (1993) who show that managers' actions are influenced by perceived rivalry.

We focus on one central aspect of firms' competitive moves, their magnitude. Action magnitude is interesting for two reasons: first, it provides an indication of how large a competitive impact the firm is attempting to achieve. Second, it is a proxy for how much effort and risk an action implies for a firm: large actions require more resources to implement and are less easily reversible (Smith *et al.*, 1992; Chen and MacMillan, 1992). As noted, a firm observing a buildup of rival actions since its last action will perceive increasing competitive pressure. Eventually the pressure will become so great that the firm will attempt to relieve it through a competitive move. We propose that a firm perceiving more competitive pressure will both try to make its action count for more (i.e. have more impact on its relative competitive position), and be more willing to accept greater cost and risk. Our first hypothesis then is:

[H1] *The greater the number of rival actions since a firm's last competitive move, the greater the magnitude of its next move.*

The proposed effects and the related constructs of awareness, motivation, and capability are illustrated in Figure 1. The moderating influence of firm type is discussed in more detail below.

An alternative mechanism to the one we propose is also conceivable: instead of reacting to rival actions directly, firms may instead be observing only their bottom line and reacting to changes there which in turn may be caused by rival actions. In our empirical setting the two mechanisms are observationally indistinct, but the data suggest the alternative explanation is unlikely in our setting. We observe telecommunications firms introducing tariffs every 2 to 5 months, and a bottom line effect from rival actions in such a short time would imply an extremely high degree of price elasticity. However, Grzybowski and Pereira (2008) find that the German market for mobile telephony is inelastic (elasticity of -0.38 for calls). Therefore we are

confident that our results are not strongly influenced by the alternative mechanism. Nevertheless, disentangling the two effects in other markets may be an interesting direction for future research.

INSERT FIGURE 1 AROUND HERE

Moderating Effect of Firm Type

The competitive pressure firms perceive may not be equally influenced by all actions and rivals alike. Certain actions may be more visible and motivate more responses, for example those that particularly threaten a firm's key markets (Chen *et al.*, 1992). Another possibility – and our focus here – is that firms feel greater pressure from certain groups of rivals than from others. Indeed, there is substantial evidence that firms perceive a different degree of rivalry towards different competitors (Chen *et al.*, 2007; Kilduff *et al.*, 2010; Marcel *et al.*, 2011).

Porter (1979) proposed that rivalry may differ between groups of competitors with similar strategies. Although the strategic group concept has been debated (Hatten and Hatten, 1987; Barney and Hoskisson, 1990, Tang and Thomas, 1992) there is evidence that strategic groups do affect rivalry. For example, Cool and Dierickx (1993) find that in the early stages of the U.S. pharmaceutical industry, firm rivalry within the same strategic group was stronger than between firms in different groups. Strategic groups have also been found to directly influence firms' competitive actions (Smith *et al.*, 1997; Más-Ruiz *et al.*, 2005; Fernández and Usero, 2009).

One possible reason for these effects is that strategic similarity may shape the way managers perceive rivalry in their industry (Reger and Huff, 1993; Porac *et al.*, 1995; Peteraf and Shanley, 1997; Nath and Gruca, 1997). Drawing on cognitive psychology, Reger and Huff (1993) argue that managers consciously or unconsciously group competitors to make sense of complex

competitive situations, that these groups are distributed and adapted through managerial interaction and that this leads to a shared perception of ‘cognitive strategic groups’. Related, Porac *et al.* (1995) find that firms tend to consider companies that are strategically similar as close rivals and adjust their competitive behavior accordingly. In their study ‘large firms rivaled large firms and small firms rivaled small firms.’ (Porac *et al.*, 1995:224).

These arguments suggest that firms’ perceptions of rival actions are influenced by group membership. We therefore propose that the competitive pressure experienced by a firm may also differ depending on whether the actions it observes are made by rivals in its own strategic group or by others.¹ We draw on strategic group theory and the awareness-motivation-capability framework to investigate exactly how group membership influences competitive pressure.

In complex market situations managers must make sense of the competitive arena to make appropriate strategic decisions. Research using cognitive and social learning theories has provided significant evidence that managers do so by reducing their focus to a few rival firms: those that are in their own strategic group (Porac *et al.*, 1995; Reger and Huff, 1993; Peteraf and Shanley, 1997). Consequently, we propose that firms are more likely to be aware of actions by rivals in their own strategic group.

Strategic group membership may also affect firms’ motivation to respond to rival actions for several reasons. First, social learning theory suggests that a strong strategic group identity may lead to a myopic view of competition (Peteraf and Shanley, 1997), causing firms to disregard actions by rivals from other strategic groups. Second, strategic group membership may influence

¹ Note that in this study we do not distinguish between the concepts of ‘strategic’ and ‘competitive’ groups. This issue is discussed in Leask and Parker (2007).

firms' motivation to respond due to market similarity. For example, Chen (1996) argues that managers perceive competitive actions by rivals with similar markets as particularly threatening. Third, firms in the same strategic group are likely to have similar resource bases, giving them the capability to contest with rivals. Although it has been argued that this might decrease motivation (Young *et al.*, 2000), Chen *et al.* (2007) find that greater capability to contest leads to a greater perception of competitive tension between pairs of firms because stakeholders view them as direct competitors and because they are likely to compete for resources. This suggests that the same may hold for competitive pressure. In summary, we propose that due to social group perception, greater market commonality and greater capability to contest, managers are more motivated to respond to actions by rivals from their own strategic group.

Besides being motivated, firms in the same strategic group are likely to have the capability necessary to react to each other's actions as they will tend to have similar resources, similar interpretations of the competitive landscape and possibly even overlapping identity domains (Chen, 1996; Porac *et al.*, 1995; Chen *et al.*, 2007; Livengood and Reger, 2010).

A large number of dimensions have been proposed (and extensively discussed) to identify strategic groups (e.g. McGee and Thomas, 1986; Ketchen and Shook, 1996). One common distinction is between incumbents and challengers in an industry (e.g. Porter, 1979; Máz-Ruiz *et al.*, 2005; Fernández and Usero, 2009). Since cognitive strategic groups have been shown to correspond to groups based on archival measures like size (Nath and Gruca, 1997; Chen *et al.*, 2007), we propose that the argument above holds for rivalrous behavior between challengers and incumbents, and use this simple distinction in our empirical analysis.

Consequently, our second argument is that as managers observe rival actions accumulating in the market they experience greater competitive pressure from actions by rivals in their own strategic group (of their own type). Combined with our first proposition that greater competitive pressure leads to greater action magnitude, this leads to our second and third hypotheses:

[H2] *The magnitude of an incumbent's competitive moves is more strongly influenced by other incumbents' than by challengers' actions.*

[H3] *The magnitude of a challenger's competitive moves is more strongly influenced by other challengers' than by incumbents' actions.*

RESEARCH METHODS

Data

Our dataset covers the German market for mobile telephony during the period from June 2005 to February 2009. It contains monthly observations of all tariffs offered by all firms in the market. The data was collected by *teltarif*, a price-comparison website for telephone and broadband tariffs, and subjected to extensive cleaning.²

The market for mobile telephony is especially well suited for our research questions for two reasons. First, tariffs in this market constitute both the price and the product offered by the firms. In the period under consideration there were no longer significant differences in coverage or call quality between the mobile network providers in the German market. Creating tariffs was therefore firms' only means of differentiation except advertising (German Federal Network Authority, 2009:74). Miravete (2009) supports this point: he finds evidence in the US mobile

² The most important data cleaning steps are described in the Appendix.

telephony market that nonlinear tariffs like the ones considered here are indeed strategic complements (i.e. a means for differentiation).

Second, the industry structure in Germany during the period in question allows us to clearly identify incumbents and challengers. The incumbents in the market are the four large mobile network operators (MNOs) that entered the market the 90's and together hold approximately 85% market share (T-Mobile, Vodafone, E-Plus and O2). The challengers are 34 small mobile virtual network operators (MVNOs) that enter the market from 2005 on and operate partially locally and partially at a national level. Besides the difference in entry timing and market share the incumbents and challengers also differ with regard to resources. MNOs are vertically integrated, owning and operating their own infrastructure. In contrast, MVNOs buy airtime from MNOs and use it to construct new tariffs that are sold under their own brand.

A third group of companies in the market, seventeen tariff resellers, were excluded from the analysis. They operate mainly as an independent distribution platform for MNO tariffs and a large proportion of their offering comprises MNO tariffs sold under a joint brand. Including them in the analysis would artificially inflate the number of tariffs in the market. It could also produce a spurious effect: tariff resellers routinely offer bundles of new tariffs shortly after activity by MNOs, but this is merely a result of including the new MNO tariffs in their portfolios.

Although tariffs are obviously targeted at very different customers segments, e.g. occasional callers and heavy usage business customers, the dataset initially lacked a classification of market segments. We therefore allocate each tariff to one of four unique market segments (subsequently referred to simply as 'markets') using standardized usage baskets (German Federal Statistical Agency, 2006). The markets reflect four different customer types: rare, low, average and heavy

users. The allocation of tariffs to markets is performed with a standardized algorithm, checked by hand, and subjected to extensive robustness tests. The allocation procedure is described in detail in the Appendix.

Variables

We do not directly observe competitive pressure – this would require data on perception, e.g. from interviews with managers (Porac *et al.*, 1995). In Figure 1 this is indicated by the dashed boxes. Instead, we observe three elements in the model via archival data: rival actions, firm type and the resulting competitive moves. This approach is supported by Chen *et al.* (2007) who find perceptual measures of competitive tension to be closely related to ‘objective’ archival measures.

Our basic unit of observation is each firm’s activity in each market and month. A firm is considered to have made a competitive move if at least one new tariff is introduced in a given month and market.

Action Magnitude. The dependent variable, action magnitude, is measured as the number of tariffs introduced by a firm in a given month and market. This simple measure allows us to capture the two central characteristics of action magnitude: the effort of implementation and the targeted impact for competitors. A firm’s first introduction of tariffs when it enters the market is not counted, as it cannot be considered a ‘reaction’.

Challenger Actions. The first of our two main independent variables is the number of actions by rival firms that are classified as challengers. It is measured as the number of tariffs introduced by all challengers (except the focal firm) in the market in question since the focal firm’s last tariff introduction in that market. Due to our focus on the buildup of competitive pressure this measure is designed as a ‘stock’ measure as opposed to the ‘flow’ measures – e.g. a moving

average of rival activity – that are commonly found in the competitive dynamics literature (e.g. Young *et al.*, 1996; Hsieh and Chen, 2010).

Incumbent Actions. Our second main independent variable is the number of actions by incumbent rival firms. It is measured as the number of tariffs introduced by all incumbents (except the focal firm) in the market in question since the focal firm’s last tariff introduction in that market (again a stock measure). We drop incumbent actions on the same network as the focal firm to address two industry-specific concerns about the data discussed in more detail below.

Incumbent. This is a dummy variable for the firms’ type, coded 1 for incumbents.

Fixed Effects. To account for the panel data structure and unobserved, time-invariant differences we include fixed-effects dummies for markets and firms. To account for seasonal effects we also include fixed-effects dummies for the months of the year.

Econometric Analysis

Our dependent variable is limited to positive integers. Therefore OLS is an inappropriate model as it assumes the dependent variable to be continuous and unbounded. The standard regression model for positive, discrete-valued data is a Poisson model (Greve, 2003; Keil *et al.*, 2008; Li, 2008). However, in a standard Poisson distribution we would expect the mean and the variance to be equal, whereas in our data the variance of action magnitude is almost four times the mean ($\hat{\mu} = 0.389$ and $\hat{\sigma}^2 = 1.478$) indicating severe overdispersion. The main cause of the overdispersion is a large number of zero counts and we therefore use a zero-inflated Poisson model (Lambert, 1992; Winkelmann, 2003). Vuong tests between the two models indicate that the zero-inflated model is a substantial improvement over the standard model. The sample size is easily large enough to warrant use of this type of model, and graphical analysis showed residuals

to be approximately normally distributed, indicating that it provided an appropriate fit. Robustness tests using negative binomial, standard Poisson and OLS models are reported below.

The zero-inflated Poisson model is a nested model including a logit ('inflation') model to account for zeros in excess of what would be predicted by a normal Poisson, and conditional on that a Poisson model. We use the same independent and fixed-effects variables for both the logit and Poisson models as the factors influencing the decision to take *any* action are likely to be the same influencing the decision on an action's *magnitude*.

The zero-inflated Poisson model also addresses a potential endogeneity problem in the data due to selection bias. As firms choose whether to act in each period it is possible that the process is subject to a self-selection mechanism with some firms choosing to execute small actions often while others act less often but then with greater magnitude. Acting as a filter for excess zero-observations (no action) the inflation model fulfills a similar function to the logit or probit models used in standard nested selection models (Shaver, 1998).

Two model specifications are used. The first aims at testing Hypothesis 1. Here we divide the dataset into two subsets: one includes only incumbents' reactions as the dependent variable and the other contains only the challengers' actions. We estimate a zero-inflated Poisson model for each subsample:

$$G = \beta_0 + \beta_1 CA_{ijt-\tau} + \beta_2 IA_{ijt-\tau} + \gamma Z + \epsilon_{ijt}$$

On the left hand side $G = \log(\omega/(1 - \omega))$ for the inflation model, where ω is the probability of observing an excess zero. For the Poisson model $G = \log(\lambda)$, where λ is the parameter (and mean) of the Poisson distribution. On the right hand side, $IA_{ijt-\tau}$ and $CA_{ijt-\tau}$ are the number of

actions in market j by all incumbents and challengers (respectively) except firm i between the current month t and month τ , when firm i last introduced a tariff in market j . Z indicates fixed effects dummies, the β and γ are the regression coefficients, and ϵ denotes the error term.

The second specification tests Hypotheses 2 and 3. It is run on the entire sample and uses interaction terms to investigate the additional influence on incumbents' and challengers' actions of actions by firms in their own group. These models are specified as:

$$G = \beta_0 + \beta_1 CA_{ijt-\tau} + \beta_2 IA_{ijt-\tau} + \beta_3 Inc_i + \beta_4 Inc_i \times CA_{ijt-\tau} + \beta_5 Inc_i \times IA_{ijt-\tau} + \gamma Z + \epsilon_{ijt}$$

Here, the interpretation of the first variables is identical to the first model, Inc_i is the dummy variable indicating firm i 's type, and the interaction terms are specified by multiplying Inc_i with the main independent variables. The interaction terms allow us to capture the additional influence of actions by rival incumbents and challengers on a firm's action magnitude depending on which group the firm belongs to itself. Specifically, Hypothesis 2 predicts that the marginal effect of the term $Inc_i \times IA_{ijt-\tau}$ on action magnitude will be positive, indicating that the effect of rival incumbents' actions is stronger if the focal firm is an incumbent. Hypothesis 3 predicts that the marginal effect of $Inc_i \times CA_{ijt-\tau}$ on action magnitude will be negative.

Controls for Wholesale Pricing and Corporate Policy

We address two industry-specific issues related to the connection between challengers' action magnitude and previous actions by incumbents. They concern the potential influence on our results of wholesale prices and subsidiaries.

The concern about wholesale prices is related to the challengers' dependency on the incumbents' infrastructure. The incumbents in this market are vertically integrated: they both sell

cellular telephone services and operate their own physical networks (i.e. transmission masts, fixed-line backbones and switches). In contrast, challengers do not own or operate infrastructure. Instead, they buy airtime wholesale from the incumbents and rebundle them into new tariffs. The concern is that a change in wholesale prices by an incumbent would imply a change in input prices for all the challengers operating on its network. This could make it necessary for the challengers to introduce new tariffs, and an incumbent might anticipate this change by introducing new tariffs of its own. In the data, this would appear to be an exchange of competitive actions (incumbent lowers prices, challengers react by lowering prices as well) rather than supply-side input price adjustment.

The second concern is that some of the challengers and incumbents belong to the same corporation, e.g. Base (challenger) and E-Plus (incumbent). Although the challengers are generally legally independent subsidiaries that service low-usage markets under a separate brand it is conceivable that they might be acting in concert with the relevant incumbent, thereby biasing our results. Note that challengers and incumbents belonging to the same corporation always operate on the same network.

We address these concerns by dropping previous actions by incumbents on the same network as the focal firm for the calculation of the independent variables. We thus use only tariff introductions by incumbents on a different network, ensuring that neither changes in wholesale prices nor corporation-wide policies influence our results. Note that if the focal firm is an incumbent the problems do not arise, as incumbents always operate on their own networks.

RESULTS

Main Results

Tables 1 and 2 report descriptive statistics and correlations for the dependent and main independent variables. We observe a total of 819 tariffs offered by 38 companies in four market segments for 45 months. Overall, this results in 2,105 firm-month-market observations (note that not all firms were active in all markets in all months). The correlations between the independent variables are mild, indicating that multicollinearity is not a major concern. Further multicollinearity tests are reported below.

INSERT TABLES 1 AND 2 AROUND HERE

Table 3 reports the regression results and marginal effects for the split sample regressions, using only incumbents' reactions in Model (1) and only challengers' reactions in Model (2). The two nested models of the zero-inflated Poisson model are shown in the upper and lower parts of the table. The lower part of the table reports the logit ('inflation') model estimating the likelihood of excess zeros and the upper part of the table shows the results of a standard Poisson model. χ^2 -tests indicate that all models had explanatory power ($p = 0.000$). The coefficient estimates for the fixed- and time-effects dummies are not reported.³

Both the logit and Poisson models are generalized linear models. Therefore the regression coefficients cannot be interpreted as marginal effects the same way they would be in linear models (Norton *et al.*, 2004; Hoetker, 2007). We address this issue by calculating the average

³ Results are available from the authors. The season dummies are excluded in Model (2) as the maximum-likelihood estimation algorithm did not converge if they were included.

marginal effects for each independent variable for the Poisson model (the model of interest).⁴ We report the marginal effects for Models (1) and (2) in columns ME(1) and ME(2), respectively.

INSERT TABLE 3 AROUND HERE

Hypothesis 1 [H1] predicts that action magnitude is positively related to the number of previous competitor actions. This is partially supported for challengers and incumbents by the marginal effects in Table 3: in the sample with challengers' action magnitude, ME(1), the marginal effect of rival challengers' actions is positive and highly significant ($\widehat{ME} = 0.005, p < 0.001$). In ME(2) the same holds for the marginal effect of incumbent actions in the sample with incumbents' action magnitude ($\widehat{ME} = 0.031, p = 0.000$). Thus H1 is supported, but only for actions by firms of the same type.

According to our second hypothesis [H2] incumbent action magnitudes are more strongly influenced by incumbents' actions than by challengers' actions, and Hypothesis 3 [H3] argues that challengers are more strongly influenced by challengers' actions than incumbents' actions. The marginal effects in the split sample models provide support for both hypotheses: the marginal effect of a greater number of actions by rivals of the same type as the focal firm is associated with significantly higher action magnitude. The marginal effect on action magnitude of firms from the other group is not significant.

Although the marginal effects in the split sample models are promising, they do not constitute a formal test for H2 and H3. One method to test the hypotheses would be to compare the magnitude of the marginal effects the two models, however Hoetker (2007) warns against

⁴ Note this not the same as the marginal effect at the average values of the covariates (Hoetker, 2007).

comparing coefficients across nonlinear models, especially when sample sizes are different (as is the case in our dataset). Therefore, in Table 4 we report regressions on the full sample – incumbent *and* challenger actions – using interaction terms and the incumbent dummy. As before the upper (lower) panel reports the result of the Poisson (inflation) model, and the marginal effects for Models (3) and (4) are reported in columns ME(3) and ME(4), respectively.

INSERT TABLE 4 AROUND HERE

Model (3) in Table 4 provides partial support for H1: Whereas the marginal effect of challengers' actions is not significant in ME(3) ($\widehat{ME} = 0.002, p < 0.39$), the marginal effect of incumbents' actions is significant and positive ($\widehat{ME} = 0.005, p < 0.023$), as predicted by H1.

Model (4) provides strong support for H2 and H3: In ME(4) the marginal effect of the interaction terms is negative and significant for challengers and positive and significant for incumbents ($\widehat{ME} = -0.011, p < 0.016$ and $\widehat{ME} = 0.021, p = 0.000$, respectively). These results suggest that incumbents' action magnitude is more heavily influenced by other incumbents' actions than by challengers' actions and vice versa, supporting H2 and H3.

As more rival actions cause firms to make greater moves in response, one might expect the number of tariffs in the market to spiral upwards. However, the marginal effects in our models are all well below one, suggesting that the effect of additional moves on action magnitude is rapidly dampened. This is consistent with the overall pattern in the data, as the average number of tariffs introduced per firm and month remains approximately constant from 2006 (0.9440) through 2009 (1.141).

Robustness Tests

We report a number of robustness test including tests for multicollinearity, inclusion of incumbent tariffs on the same network, and alternative model specifications.

Multicollinearity. Although the correlations between the independent variables reported in Table 2 are mild, the firm fixed-effects are highly correlated with the dummy variable Inc_i by construction: each firm is either an incumbent or a challenger. This induces high multicollinearity and may account for the fact that the incumbent dummy is not significant in ME4 (note the high coefficient standard error, a typical effect of high multicollinearity). Dropping the ‘incumbent’ dummy in Model (4) does not change the results, but does significantly reduce multicollinearity, resulting in variance inflation factors below 3.16. The results are also robust to randomly dropping 5% of the observations. Together, these tests indicate that multicollinearity is not a major concern (Belsley *et al.*, 1980).

Incumbent tariffs on same network. The second robustness test checks that excluding incumbent tariffs introduced on the same network does not unduly influence our results. Including the incumbent tariffs introduced on the same network in the models does not substantially change our results. In Models (1) to (3) the results are identical in sign and significance, in Model (4) the only difference is that the coefficient for $Inc_i \times IA_{ijt-\tau}$ is no longer significantly different from zero ($p < 0.197$). The fact that the difference in challengers’ and incumbents’ reactions to incumbents’ competitive moves is no longer significant in this specification would appear to imply that challengers react more strongly to incumbents’ moves if incumbent tariffs on the same network are included. Following the argument above, this suggests that excluding them may have been an important step to avoid biased results.

Alternative model specifications. To ensure our results in Model (4) are not due to specifics of the zero-inflated Poisson model we check our results against several alternative model specifications, including a negative binomial model, a standard Poisson, and an OLS model.

First, the results of both the split samples regressions and the full-sample regressions remain unchanged in sign, magnitude and significance if we use a negative binomial regression model instead of the zero-inflated Poisson model.

Second, the results are largely robust using a standard Poisson model: The marginal effects have the same sign although they are no longer significant for $Inc_i \times IA_{ijt-\tau}$ and $CA_{ijt-\tau}$ ($p < 0.190$ and $p < 0.185$ respectively). For this test we had to drop zero-observations, i.e. ignore months where firms were inactive, to avoid misspecification through overdispersion. We also had to drop the incumbent dummy to avoid severe multicollinearity. We are reassured that our results hold in sign with alternative specifications, but take confidence regarding our model choice from the decrease in significance when using alternative specifications.

Third, although the dependent variable is obviously not normally distributed we check our results against an OLS regression. Again dropping zero-observations and the incumbent dummy the coefficients are similar in sign and magnitude to our main results, although due to relatively large standard errors only the coefficient for $Inc_i \times CA_{ijt-\tau}$ is significantly different from zero ($p < 0.039$). The fact that the OLS coefficients are not significant provides further evidence that our regression specification is the more appropriate choice.

Fourth, we control for the potential influence on our results of the strong increase of the number of incumbents in the market. We do so by running a regression of the challengers' actions $CA_{ijt-\tau}$ on the number of challengers in the market and using the residuals instead of

$CA_{ijt-\tau}$ in Model (4). The results remain unchanged, except that the marginal effect of the interaction term $Inc_i \times CA_{ijt-\tau}$ is no longer significant. Finally, the results remain largely unchanged for including year dummies in the regression and for using robust standard errors.

DISCUSSION

Competitive dynamics research has studied the exchange of competitive actions and responses between rival firms by focusing on action-reaction dyads (Smith *et al.*, 2001; Hutzschenreuter and Israel, 2009). This has allowed researchers to study how firms react to specific actions by individual rivals (e.g. Chen and Miller 1994), but not on how firms react to their competitors as a group. Our study provides an important early step to close this gap by examining how firms react to multiple rival actions. Based on the awareness-motivation-capability framework we develop the concept of competitive pressure to describe the mechanism by which firms perceive and respond to actions by one or several rivals.

First, we propose that firms observing more rival actions make larger competitive moves due to increased competitive pressure. In our dataset this is supported: we find evidence that firms' action magnitude is positively influenced by previous rival actions, albeit only if the rivals are of their own type. In a second step we examine the moderating influence of strategic group on competitive pressure. We argue that managers experience greater competitive pressure when they observe actions by competitors that are similar to themselves (Chen, 1996; Young *et al.*, 2000; Chen *et al.*, 2007), and that this manifests itself in greater action magnitude. The data also supports this prediction: Challengers' action magnitude is influenced more strongly by the number of challengers' actions than by the number of incumbents' actions, and vice versa.

Our study contributes to competitive dynamics research by investigating the previously neglected question of how firms respond to actions by multiple competitors (the only exception is Hsieh and Chen, 2010). The concept of competitive pressure allows us to relax the strong assumptions implicit in the action-reaction dyad. It also lets us generalize the promising concept of competitive tension between two firms to the relationship between a firm and multiple rivals (Chen *et al.*, 2007). It is broadly supported by the data and thus provides additional support for a perspective of competitive dynamics founded in managerial perception (Marcel *et al.*, 2011).

Our research is related to a recent study by Hsieh and Chen (2010) that investigates the relationship between a firm and multiple rivals. We extend and complement their study in two ways. First, we propose and discuss the mechanism of competitive pressure to explain why firms take competitive action in response to multiple rivals' actions. Second, we offer a different perspective on rival actions: whereas Hsieh and Chen follow the classical literature in using a 'flow' measure of rival activity we focus on the buildup of competitive pressure by using a 'stock' measure of competitive actions.

Managerial Implications

Our results have several implications for managers deciding on strategic moves in competitive environments. First, they suggest that it may be worthwhile to monitor rival firms even if they have been inactive for some time. If an inactive rival firm observes a large number actions accumulating in the market, its competitive pressure is likely to grow, leading to a large action. Knowing what has happened in the market since a rival's last competitive move can alert managers to a potential major move in the future.

Second, firms have been shown to benefit from small, late or missing reactions to their competitive moves (Chen and MacMillan, 1992; Smith *et al.*, 2001). Our findings suggest that to minimize the magnitude of rivals' reactions a firm should downplay its own *and all other rivals'* competitive moves to minimize the risk that currently inactive competitors become aware of them and find them sufficiently threatening to take action.

Finally, when planning actions managers should screen rivals that are strategically similar to their own firm with particular care, as it is they who are most likely to respond.

Limitations and Future Directions

Our study has several limitations. First, we do not directly observe competitive pressure using archival data. Future research would benefit from directly measuring managers' perception of actions by multiple rivals in the market, similar to recent studies on perception of pairs of rivals (Chen *et al.*, 2007; Marcel *et al.*, 2011; Kilduff *et al.*, 2010). This might also allow researchers to investigate the relative importance for competitive pressure of individual rivals' actions as compared to the sum of multiple rivals' actions.

Second, we used a simple dichotomous distinction between incumbents and challengers to identify strategic groups. Future research may benefit from using more fine-grained measures to identify strategic group membership (Hatten and Hatten, 1987). We also considered only one type of action, tariff setting, and only action magnitude as one important attribute of competitive moves. Tariff setting is doubtless the most important competitive action in the market for mobile telephony, but future research including other strategic variables (e.g. advertising) may allow a more complete view of competitive action in this industry. Finally, we do not explicitly link firm behavior to performance.

As discussed earlier we used a ‘stock’ measure of rival actions in contrast to the common ‘flow’ measures of rival activity. Comparing the relative effects of stock and flow measures of rival activity on competitive pressure and firm behavior may pose an interesting avenue for future research.

In summary, our study is an early attempt to extend our understanding of competitive behavior by relaxing the assumptions underlying the action-reaction dyad. We hope that future work will extend these results to advance our understanding of rivalry between multiple firms.

REFERENCES

- Barney JB, Hoskisson RE. 1990. Strategic Groups: Untested Assertions and Research Proposals. *Managerial and Decision Economics* **11**: 187–98.
- Belsley DA, Kuh E, Welsch RE. 1980. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. John Wiley & Sons: New York.
- Bettis RA, Weeks D. 1987. Financial Returns and Strategic Interaction: The Case of Instant Photography. *Strategic Management Journal* **8**: 549–63.
- Chen MJ. 1996. Competitor Analysis and Interfirm Rivalry: Towards A Theoretical Integration. *Academy of Management Review* **21**(1): 100–34.
- Chen MJ, Hambrick DC. 1995. Speed, Stealth, and Selective Attack: How Small Firms Differ from Large Firms in Competitive Behavior. *Academy of Management Journal* **38**(2): 453–82.
- Chen MJ, MacMillan I. 1992. Nonresponse and Delayed Response to Competitive Moves: The Roles of Competitor Dependence and Action Irreversibility. *Academy of Management Journal* **35**(3): 539–70.

- Chen MJ, Miller D. 1994. Competitive Attack, Retaliation and Performance: An Expectancy-Valence Framework. *Strategic Management Journal* **15**: 85–102.
- Chen MJ, Smith KG, Grimm CM. 1992. Action Characteristics as Predictors of Competitive Responses. *Management Science* **38**(3): 439–55.
- Chen MJ, Su K, Tsai W. 2007. Competitive Tension: The Awareness-Motivation-Capability Perspective. *Academy of Management Journal* **50**(1): 101–18.
- Cool KO, Dierickx I. 1993. Rivalry, Strategic Groups and Firm Profitability. *Strategic Management Journal* **14**: 47–59.
- Fernández Z, Usero B. 2009. Competitive Behavior in the European Mobile Telecommunications Industry: Pioneers vs. Followers. *Telecommunications Policy* **33**: 339–47.
- Ferrier WJ. 2001. Navigating the Competitive Landscape: The Drivers and Consequences of Competitive Aggressiveness. *Academy of Management Journal* **44**(4): 858–77.
- Ferrier WJ, Lee H. 2002. Strategic Aggressiveness, Variation, And Surprise: How The Sequential Pattern Of Competitive Rivalry Influences Stock Market Returns. *Journal of Managerial Issues* **14**(2): 162–80.
- Ferrier WJ, Mac Fhionnlaoich C, Smith KG, Grimm CM. 2002. The Impact of Performance Distress on Aggressive Competitive Behavior: A Reconciliation of Conflicting Views. *Managerial and Decision Economics* **23**: 301–16.
- Ferrier WJ, Smith KG, Grimm CM. 1999. The Role of Competitive Action in Market Share Erosion and Industry Dynamics: A Study of Industry Leaders and Challengers. *Academy of Management Journal* **42**(4): 372–88.

- Fjeldstad OD, Becerra M, Narayanan S. 2004. Strategic Action in Network Industries: An Empirical Analysis of the European Mobile Phone Industry. *Scandinavian Journal of Management* **20**: 173–96.
- German Federal Network Agency. 2009. Jahresbericht 2009: Annual Report of the German Federal Network Agency [16 March 2011].
- German Federal Statistical Agency. 2006. Recalculating the Consumer Price Index for Telecommunications Services on Base 2000: Methodological Description. <http://www.destatis.de/> [16 March 2011].
- Greve HR. 2003. A Behavioral Theory of R&D Expenditures and Innovations: Evidence from Shipbuilding. *The Academy of Management Journal* **46**(6): 685–702.
- Grzybowski L, Pereira P. 2008. The Complementarity Between Calls and Messages in Mobile Telephony. *Information Economics and Policy* **20**(3): 279–87.
- Hatten K, Hatten ML. 1987. Strategic Groups, Asymmetrical Mobility Barriers and Contestability. *Strategic Management Journal* **8**: 329–42.
- Hoetker G. 2007. The use of logit and probit models in strategic management research: Critical issues. *Strategic Management Journal* **28**(4): 331–43.
- Hsieh K, Chen M. 2010. Responding to Rivals' Actions: Beyond Dyadic Conceptualization of Interfirm Rivalry. *Working Paper presented at the Academy of Management Annual Conference 2010*.
- Hutzschenreuter T, Israel S. 2009. A Review of Empirical Research on Dynamic Competitive Strategy. *International Journal of Management Reviews* **11**(4): 421–61.

- Keil T, Maula M, Schildt H, Zahra SA. 2008. The Effect of Governance Modes and Relatedness of External Business Development Activities on Innovative Performance. *Strategic Management Journal* **29**(8): 895–907.
- Ketchen DJ, JR., Shook CL. 1996. The Application of Cluster Analysis in Strategic Management Research: An Analysis and Critique. *Strategic Management Journal* **17**: 441–58.
- Ketchen DJ, JR., Snow CC, Hoover VL. 2004. Research on Competitive Dynamics: Recent Accomplishments and Future Challenges. *Journal of Management* **30**(6): 779–804.
- Kilduff GJ, Elfenbein HA, Staw BM. 2010. The Psychology of Rivalry: A Relationally Dependent Analysis of Competition. *Academy of Management Journal* **53**(5): 943–69.
- Lambert D. 1992. Zero-Inflated Poisson Regression, with an Application to Defects in Manufacturing. *Technometrics* **34**(1): 1–14.
- Leask G, Parker D. 2007. Strategic Groups, Competitive Groups and Performance Within the U.K. Pharmaceutical Industry: Improving Our Understanding of the Competitive Process. *Strategic Management Journal* **28**: 723–45.
- Li J. 2008 Asymmetric Interactions between Foreign and Domestic Banks: Effects on Market Entry. *Strategic Management Journal* **29**(8): 873–93.
- Livengood RS, Reger RK. 2010. That's Our Turf! Identity Domains and Competitive Dynamics. *Academy of Management Review* **35**(1): 48–66.
- Marcel JJ, Barr PS, Duhaime IM. 2011. The Influence of Executive Cognition on Competitive Dynamics. *Strategic Management Journal* **32**(2): 115–38.
- Más-Ruiz FJ, Nicolau-Gonzálbez JL, Ruiz-Moreno F. 2005. Asymmetric Rivalry Between Strategic Groups: Response, Speed of Response and Ex-Ante vs. Ex-Post Competitive Interaction in the Spanish Banking Market. *Strategic Management Journal* **26**: 713–45.

- McGee J, Thomas H. 1986. Strategic Groups: Theory, Research and Taxonomy. *Strategic Management Journal* **7**: 141–60.
- Miravete EJ. 2009. Competing with Menus of Tariff Options. *Journal of the European Economic Association* **7**(1): 188–205.
- Nath D, Gruca TS. 1997. Convergence Across Alternative Methods for Forming Strategic Groups. *Strategic Management Journal* **18**(9): 745–60.
- Norton EC, Wang H, Ai C. 2004. Computing Interaction Effects and Standard Errors in Logit and Probit Models. *The Stata Journal* **4**(2): 154–67.
- Peteraf M, Shanley M. 1997. Getting to Know You: A Theory of Strategic Group Identity. *Strategic Management Journal* **18**: 165–86.
- Porac JF, Thomas H. 1994. Cognitive Categorization and Subjective Rivalry Among Retailers in a Small City. *Journal of Applied Psychology* **79**(1): 54–66.
- Porac JF, Thomas H, Baden-Fuller C. 1989. Competitive Groups as Cognitive Communities: The Case of Scottish Knitwear Manufacturers. *Journal of Management Studies* **26**(4): 397–416.
- Porac JF, Thomas H, Wilson F, Paton D, Kanfer A. 1995. Rivalry and the Industry Model of Scottish Knitwear Producers. *Administrative Science Quarterly* **40**(2): 203–27.
- Porter ME. 1979. The Structure within Industries and Companies' Performance. *Review of Economics and Statistics* **61**(2): 214–27.
- Porter ME. 1980. *Competitive Strategy*. The Free Press: New York.
- Reger RK, Huff AS. 1993. Strategic Groups: A Cognitive Perspective. *Strategic Management Journal* **14**(2): 103–23.
- Shaver JM. 1998. Accounting for Endogeneity When Assessing Strategy Performance: Does Entry Mode Choice Affect FDI Survival? *Management Science* **44**(4): 571–85.

- Smith KG, Ferrier WJ, Ndofor H. 2001. Competitive Dynamics Research: Critique and Future Directions. In *The Blackwell Handbook of Strategic Management*, Hitt MA, Freeman RE, Harrison JS (eds). Blackwell Publishing: Oxford; 314–361.
- Smith KG, Grimm CM, Gannon MJ. 1992. *Dynamics of Competitive Strategy*. SAGE Publications: Newbury Park, CA.
- Smith KG, Grimm CM, Gannon MJ, Chen M. 1991. Organizational Information Processing, Competitive Responses, and Performance in the U.S. Domestic Airline Industry. *The Academy of Management Journal* **34**(1): 60–85.
- Smith KG, Grimm CM, Wally S, Young G. 1997. Strategic Groups and Rivalrous Firm Behavior: Towards a Reconciliation. *Strategic Management Journal* **18**(2): 149–57.
- Tang M, Thomas H. 1992. The Concept of Strategic Groups: Theoretical Construct or Analytical Convenience. *Managerial and Decision Economics* **13**: 323.329.
- Winkelmann R. 2003. *Econometric Analysis of Count Data*. 4th ed. Springer: Berlin et al.
- Young G, Smith KG, Grimm CM. 1996. "Austrian" and Industrial Organization Perspectives on Firm-Level Competitive Activity and Performance. *Organization Science* **7**(3): 243–54.
- Young G, Smith KG, Simon D. 2000. Multimarket Contact and Resource Dissimilarity: A Competitive Dynamics Perspective. *Journal of Management* **26**(6): 1217–36.
- Yu T, Cannella AA. 2007. Rivalry Between Multinational Enterprises: An Event History Approach. *Academy of Management Journal* **50**(3): 663–84.

APPENDIX A – MAIN TABLES AND FIGURES

Figure 1: Proposed Relationships

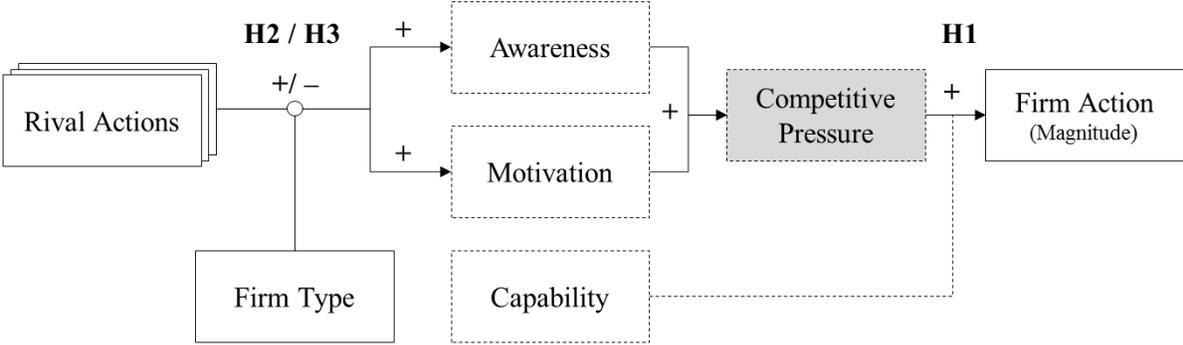


Table 1: Descriptive Statistics

Variable	Mean	SD	Min	Max
(1) Action Magnitude	0.39	1.48	0	18
(2) Challengers' Actions (CA)	13.42	14.93	0	112
(3) Incumbents' Actions (IA)	13.75	21.33	0	187
(4) Incumbent (dummy)	0.34	-	0	1
(5) Incumbent x CA	2.48	7.19	0	67
(6) Incumbent x IA	2.93	7.25	0	67
N =		2105		

Table 2: Correlation Table

Variable	(1)	(2)	(3)	(4)	(5)
(1) Action Magnitude	1				
(2) Challengers' Actions (CA)	-0.063*	1			
(3) Incumbents' Actions (IA)	-0.007	0.559*	1		
(4) Incumbent (dummy)	0.227*	-0.298*	-0.176*	1	
(5) Incumbent x CA	0.122*	0.229*	-0.010	0.479*	1
(6) Incumbent x IA	0.259*	-0.062*	0.135*	0.560*	0.486*
N =		2105			

Asterisks mark correlations that are significantly different from zero at the 5% level

Table 3: Split Sample Regression Models

Action Magnitude				
	Challengers (1)	Incumbents (2)	Marginal Effects Challengers (ME1)	Marginal Effects Incumbents (ME2)
Conditional Poisson Model				
Challengers' Actions (CA)	-0.017* (0.009)	-0.004 (0.007)	0.005*** (0.002)	0.0090 (0.01)
Incumbents' Actions (IA)	-0.015** (0.007)	-0.005 (0.005)	-0.0010 (0.001)	0.031*** (0.007)
Constant	-0.246 (0.625)	1.337*** (0.325)		
Inflation Model				
Challengers' Actions (CA)	-0.211*** (0.046)	-0.022 (0.019)		
Incumbents' Actions (IA)	-0.03 (0.024)	-0.061*** (0.012)		
Constant	20.604 (761.638)	1.932*** (0.558)		
Fixed Effects				
Firms	yes	yes		
Markets	yes	yes		
Seasons (months)	yes	no		
Observations	1,385	720		
Chi-squared statistic	134	184		
Model test (Chi-squared)	0.00	0.00		
Vuong z	6	7		

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Full Sample Regression Models

Action Magnitude	Regression Coefficients		Marginal Effects	
	(3)	(4)	(ME3)	(ME4)
Conditional Poisson Model				
Challengers' Actions (CA)	-0.011** (0.005)	0.029** (0.012)	0.0020 (0.003)	0.007* (0.004)
Incumbents' Actions (IA)	-0.013*** (0.003)	-0.022** (0.009)	0.005** (0.002)	-0.008*** (0.003)
Incumbent	3.811** (1.495)	2.234 (1.999)	0.8340 (0.876)	0.7230 (0.49)
Incumbent x CA		-0.044*** (0.013)		-0.011** (0.005)
Incumbent x IA		0.015 (0.01)		0.021*** (0.004)
Constant	-2.643* (1.506)	-1.268 (2.009)		
Inflation Model				
Challengers' Actions (CA)	-0.027** (0.012)	0.016 (0.022)		
Incumbents' Actions (IA)	-0.042*** (0.01)	0 (0.015)		
Incumbent	2.583 (5.04)	0.531 (1.948)		
Incumbent x CA		-0.024 (0.025)		
Incumbent x IA		-0.064*** (0.018)		
Constant	-0.724 (5.045)	1.299 (1.973)		
Fixed Effects				
Firms	yes	yes		
Markets	yes	yes		
Seasons (months)	yes	yes		
Observations	2,105	2,105		
Chi-squared statistic	540	519		
Model test (Chi-squared)	0	0		
Vuong z	8.613	7.957		

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

APPENDIX B – SUPPLEMENTARY MATERIAL

Allocation of Tariffs to Markets

Initially, the dataset lacked a segmentation of the tariff market although tariffs were obviously targeted at very different customers segments, e.g. occasional callers and heavy usage business customers. Treating all tariffs as competing equally for the same customers could skew our results, so we allocated each tariff to a unique market segment (subsequently referred to simply as ‘market’). This is achieved using three standard usage baskets defined by the German Federal Statistical Agency (2006) for ‘rare’, ‘low’ and ‘average’ cellular phone users. No basket was available for business users, so we defined a ‘heavy’ user basket as an inflated version of the average user basket. The baskets are provided in Table B1.

Each tariff was allocated to a unique basket (‘market’) with the following procedure:

1. *Calculate the monthly cost of each tariff for each of the four user baskets using the tariff components and the usage pattern for the baskets.*
2. *Using all tariffs, identify the lower 10%-ile in terms of cost for each user basket by month.*
3. *Calculate the relative distance of each tariff’s cost to the lower cost percentile for each user basket in the month it was introduced.*
4. *Allocate each tariff to the basket where the relative distance is smallest.*

In calculating the monthly cost we make two simplifying assumptions. First, we take assume calls are distributed evenly over the day. In the period covered by our dataset a decreasing number of tariffs differentiate between different times of day ; where different rates were offered

we used the average cost. Second, if off-net prices varied for different providers we used the average off-net price. This affected only a minor percentage of the tariffs in the sample.

The results of the tariff allocation for average monthly user bills are provided in Table B2. A potential weakness of the market allocation procedure is that the user baskets were only available for 2000. In the time between then and the end of our dataset there may have been changes in usage patterns arising endogenously from increasing diffusion and falling prices.

The allocation was robust towards a wide range of inflation factors for the heavy user basket and towards using fiscal quarters rather than months to define the lower cost quartile. Results were also robust towards using lower percentiles between 5% and 15%. The 10%-ile level was chosen because it yielded the most plausible allocation based on a qualitative investigation of tariff names. The lists allocating the tariffs to the markets are available on request from the authors.

Table B1: Tariff Allocation

Results of Tariff Allocation to Markets

Observations and average monthly user bill in EUR

Market	Obs.	Mean*	SD*	Min*	Max*
Rare	162	8.89	4.66	2.00	24.54
Low	163	36.61	8.26	15.45	56.00
Average	173	56.80	15.42	26.00	102.73
Heavy	321	126.05	45.43	9.00	308.25

* Units = EUR / month

Table B2: Usage baskets

Usage in minutes

(monthly values calculated on basis of German Federal Network Authority's baskets of 2000)

Assumption: Call duration constant over different types

	Unit	Rare users	Low-level users	Average users	Heavy users*
Total duration of calls	min	20	60	200	600
o/w to own network	min	7	27	69	207
o/w to other network	min	4	9	40	120
o/w to fixed-line	min	9	24	91	273
SMS	#	20	60	60	180

* Note: No basket was available for heavy users, therefore two assumptions were made:

- Call distribution is assumed to be identical to average users.
- Total call duration is assumed to be 600 min (30min x 20 working days)

Data Cleansing

The data gathered by *Teltarif* was subjected to extensive cleansing at the provider and tariff levels.

Providers. Non-mobile operators, e.g. a data-service company offering tariffs as an add-on for companies implementing software solutions were excluded from the dataset. Furthermore, 22 providers which each introduced only a single tariff in one month and market were dropped for the calculation of the dependent variable, as these tariff introductions cannot seriously be considered reactions. Three providers who had only a few tariffs and for whom no information could be found on the internet were also dropped from the dataset. Finally, seventeen tariff resellers were dropped, as discussed in detail in the paper.

Tariffs. The following tariffs were dropped to avoid distortions in price calculations and the calculated number of new tariffs: Bundles including a mobile tariff and DSL (broadband) access, bundles including a mobile tariff and a fixed-line tariff, add-on options for tariffs (such as ‘Extra 100 free SMS’), and pure data tariffs for mobile devices (without calling functionality),

Note that tariffs are also influenced by firms’ strategy of attracting new customers by subsidizing mobile handsets, and subsequently recovering their investment over the duration of the tariff contract. While we cannot control for this effect due to a lack of data on handset subsidies, we argue that a new tariff constructed to subsidize a particular handset does constitute a competitive move.