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**Do Magazines' "Companion Websites" Cannibalize  
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# Do Magazines' "Companion Websites" Cannibalize the Demand for the Print Version?<sup>¶</sup>

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## Abstract

We analyze the relationship between website visits, magazine demand and the demand for advertising pages using Granger non-causality tests on the basis of an extensive and externally audited quarterly data set for the German magazine market spanning the period I/1998 to II/2004. We use traditional panel data estimators and an estimator suitable for heterogeneity across magazines. We find very robust evidence for positive effects from website visits to circulation. There is no evidence of causality running in the opposite direction. Our findings are contrary to the widespread belief that the Internet will cannibalize print media markets.

**JEL-classification:** C32, C33, L11

**Keywords:** Granger causality, heterogeneous panel data models, Mean Group Estimation, website visits, magazine circulation

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*“The internet: last resort or nail in the coffin?”* Frank Patalong in Germany’s leading news magazine “Der Spiegel”, April 6, 2005.

*“Newspapers are cannibalizing themselves.”* Frederick W. Searby of J.P. Morgan in “The New York Times”, March 14, 2005.<sup>1</sup>

*“Seize the day! Either you are going to cannibalize yourself or somebody else is going to cannibalize you.”* Mark Mooradian, Vice President of the media consultancy Jupiter Media Metrix (1997).<sup>2</sup>

## 1 Introduction

The Internet is often termed “the great equalizer” of product prices.<sup>3</sup> The Internet might, however, very well have more direct effects on real markets by complementing or substituting real products. This study analyzes the relationship between a particular real market, magazines, and a corresponding virtual market, namely the online companion version of those magazines.

We econometrically test for causal relationships between website visits and magazine circulation using data on 41 German consumer magazines. We also analyze causalities between website visits and the demand for advertising pages in the print version. Thus, our study hence provides an analysis of “channel competition” or “channel conflict”, as it is termed in the marketing literature.<sup>4</sup>

The results of existing econometric studies on the relationship between magazine and newspaper websites and the demand for the corresponding print edition are widely divergent. These studies are reviewed in Section 3.1. With one exception, existing studies analyze the effects of sheer website presence and do not consider, how often a website is actually accessed. These studies also disregard a potential reverse causality. The exception is Pauwels and Dans (2001), who study the effects of circulation on website visits — but disregard reverse causality — for a sample of twelve Spanish newspapers. Their study is, however, based on daily observations, which

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<sup>1</sup>Cited by Seelye (2005).

<sup>2</sup>Cited by Hickey (1997, p. 38).

<sup>3</sup>For example by Brynjolfsson and Smith (2001).

<sup>4</sup>See Alba et al. (1997), Brynjolfsson and Smith (2000) as well as Coughlan et al. (2001) for discussions of channel competition between the Internet and real markets.

already end in August 1999,<sup>5</sup> and is in part based on variations across newspapers which might well be influenced by unobserved characteristics of the newspapers. In addition, Pauwels and Dans (2001) restrict their estimated parameters to be equal across newspapers. Finally, the existing studies we are aware of, are based on data collected up to 2001, a period in which Internet adoption rates were considerably lower than they are today.

Therefore, the main contributions of this paper are that we (i) use accurately measured and externally audited website visits data as an empirical proxy variable for website effects, (ii) use quarterly data spanning the recent period I/1998 to II/2004, (iii) provide evidence, both for the quantitative effects of website visits on circulation and advertising demand, as well as for causalities running in the opposite direction, and (iv) compare the results obtained by imposing different degrees of homogeneity in parameters across magazines instead of restricting them to be equal across magazines. The latter contribution includes a fully flexible estimator, which is feasible due to the fairly long time series dimension of our data.

Magazine websites are potentially perfect substitutes to their corresponding print editions. This is even more so in the market we analyze, where the contents of magazines' "companion websites", to a large extent, coincide with the content of the print version, even though none of the magazines make the printed magazines fully available online.<sup>6</sup>

Industry observers as well as publishers indeed tend to be pessimistic about the prospects of print media publishing, as the survey evidence summarized in Section 3.2 shows. There are, however, also stories of complementarity to tell, like the convenient and cost-effective way of subscribing on the Internet, the reach of a different audience over the Internet, whom might be turned into purchasers of the print version, and additional service, which can be offered over the Internet like searchable archives, permanently updated news,<sup>7</sup> chat-rooms, bulletin boards, instant messaging and links to external content. The websites we study in this paper all provide such website features. The complementary services are likely to raise switching costs for the combined product offering (Porter 2001). Moreover, a companion website

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<sup>5</sup>The total lengths of their times series differ for each newspaper. The longest time series relates to the period May 1997 to August 1999, the shortest time series relates to the period November 1998 to August 1999.

<sup>6</sup>We follow a distinction by Barsh et al. (2001, pp. 84-85) and use the term "companion website" for websites that have a large content overlap with the print version. By contrast, "destination websites" are top sites in their own categories and provide a complete and compelling experience and come with unique content and applications.

<sup>7</sup>The magazines we consider appear at most once a week.

serves as a vehicle for advertising the print edition. The cross-advertising goes both ways, since the print editions also advertise the online companion and many articles in the print versions provide URLs, leading to further information, which can be called up on the Internet.<sup>8</sup> Section 2 further discusses the competing forces which might be at work here.

It is important to note that website access is free of charge for the magazines we study, and that website users are not requested to register before entering the websites.<sup>9</sup> This is consistent with the evidence from the US, where companion websites also do not charge access fees to generate visits in order to sell online advertising (Barsh et al. 2001; Deleersnyder et al. 2002). There has, however, been a tendency towards charging, but results have so far not been encouraging (Hickey 1997; Robins 2001; Seelye 2005).

We would also like to point out that Internet penetration rates are fairly comparable between the US and Germany, so that the external validity of our results is not reduced due to differences in readers' ability to access magazines' companion websites. The share of German households with Internet access was 56.2 per cent in February 2005, the comparable figure for the US is 68.8 per cent.<sup>10</sup>

The 41 magazines we analyze are particularly relevant in terms of total circulation, both at a national (as discussed in Subsection 4.1) and an international level. According to data gathered by FIPP (2004), 17 of our 41 magazines rank in the worldwide Top 50 in various magazine categories. Four of our magazines belong to the Top 50 "General interest magazines" (with ranks between 6 and 41) and three appear in the Top 50 "Special Interest Magazines" list.<sup>11</sup>

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<sup>8</sup>Mitchell (2001) presents information on this kind of cross-channel promotion for the US. He cites survey evidence that 95 per cent of the offline editions promote the web editions (which is very similar to our data) while only 45 per cent of the web editions promote the print edition (which is very different from our data).

<sup>9</sup>There is one exception, however. "Der Spiegel" ([www.spiegel.de](http://www.spiegel.de)), Germany's leading weekly news magazine, charges an access fee for few selected articles, mostly lengthy feature articles or groups of related articles from past issues.

<sup>10</sup>This compares to an average EU Internet penetration of 44.8 per cent; France's penetration rate is 41.5 per cent and the UK's is 59.0 per cent. Source: <http://www.Internetworldstats.com/stats4.htm#eu>, accessed Feb. 28, 2005.

<sup>11</sup>Eight of our magazines appear in the FIPP (2004) Top 50 "Finance/Business/News" magazines worldwide (with ranks between 4 and 45), three appear in the Top 50 "TV Guides" (ranks 4–36), and one appears in the Top 50 "Men's Magazines" (rank 15) and Top 50 "Women's Magazines" (rank 27) respectively.

The main findings of the paper are that there exists quite robust evidence for the presence of Granger causality running from website visits to circulation. In other words: a higher number of website visits causes higher magazine circulation. These effects are statistically highly significant but economically small. We do not find any evidence for causalities running in the other direction. There is some evidence of advertising pages being Granger-caused by website visits, e.g. higher website visits causes higher advertising demand. This evidence, however, is less robust to model extensions.

Before starting the analysis we would, however, like to direct attention to two potential caveats of this study. First, we may be facing an “early adopter’s” problem in the sense that those magazines which launched a website early are the ones which had the most optimistic expectations regarding the benefits from launching a companion website. Early adopters are more likely to be included in our analysis since we require a minimum of 20 consecutive observations for most of our estimations. Our results remain, however, very robust to a reduction to a minimum of 10 consecutive observations, so that we do not worry much about selection effects.<sup>12</sup> Second, we restrict our attention to the relationship between a magazine’s own circulation and own website traffic, and are not concerned with cross-effects of other magazines’ websites on own circulation and advertising. Even though studying cross-effects is potentially interesting, it would either require an even longer time-series dimension of the data for the estimation of such effects to be feasible, or that we restrict our attention to a specific subgroup of magazines, rather than taking the industry-wide perspective which is the main aim of this study.<sup>13</sup>

## 2 Competing forces

This section discusses the competing forces at work that may drive the causality between circulation and website visits. The potential relationship between website visits and advertising demand is briefly discussed at the end of this section.

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<sup>12</sup>With regard to possible selection effects it is worth mentioning that none of the companion websites of German magazines were ever shut down.

<sup>13</sup>The only study that takes into account the website presence of competing magazines we are aware of is Kaiser (2003) who finds evidence for “awareness spillovers”, a positive relationship between magazine circulation the number of competing magazines with a companion website.

## 2.1 Potential negative effects of website visits on circulation

It is generally believed that the Internet is cannibalistic and that it will eventually replace the conventional ways of doing business as critically discussed by Porter (2001). Newspapers and magazines are indeed, at least in principle, ideal goods that can be distributed online. Their online distribution is associated with a low outlay and a frequent purchase. Print media, in particular magazines, come with a value proposition of intangible or informational nature and a high degree of differentiation. Shapiro and Varian (1999) point out that cannibalization might indeed be more imminent when information products are delivered online. Some industry observers like Hickey (1997) even draw horror scenarios of how Microsoft will “crush newspapers”.

## 2.2 Potential positive effects of website visits on circulation

There are three main ways in which companion websites could actually have a positive effect on magazine demand (and vice versa): (i) “awareness”, (ii) online subscription and (iii) additional service.

(i) *Awareness*: Companion websites allow consumers to get an idea about a magazine free of charge and hence may generate consumer awareness. If the online and offline readership differ with respect to readership characteristics, then a magazine’s companion website extends market reach (Nicholson 2001). Joukhadar (2004) for example points out that online companions may attract a more technology savvy readership than the print version. Many magazines also offer a preview or at least a table of contents of the current or forthcoming print version, so that prospective consumers can learn about the printed magazine.<sup>14</sup> These learning effects are at the core of an analysis of record sales and music downloads by Oberholzer–Gee and Strumpf (2004), whose empirical evidence suggests that music downloads act as appetizers for a later record purchase. An Internet presence might thus be seen as “a necessary step in the effort of a magazine to broaden and deepen its audience”, as argued by Barsh et al. (2001, p. 91).

(ii) *Online subscription*: All companion websites in our sample offer an online subscription possibility and, for this reason, a particularly cheap and cost-effective way of subscribing. Observers of the US publishing industry, such as Capell (2004) and Barsh et al. (2001), believe that online subscription is an important feature of a

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<sup>14</sup>Today, in April 2005, all magazines publish table of contents.

companion website. Capell (2004) reports that, in 2003, nine per cent of total subscriptions came from companion websites, up by three percentage points compared to 2002. Further growth in online subscriptions was expected for 2004. The importance of online subscription is also underscored by Bernd Ziesemer, editor-in-chief of “Handelsblatt”, a German daily specialized on economics and business matters, who argues that “most websites are run at a loss. In certain areas, for example in online subscription, website provision actually pays off.”<sup>15</sup>

(iii) *Additional service*: Existing studies, like Barsh et al. (1999) and Silk et al. (1999), point out that a key factor determining the relationship between “real” and “virtual” versions of a print medium is the relative positioning argument of the two outlet channels. This relative positioning argument is also emphasized in econometric work by Deleersnyder et al. (2002), Pauwels and Dans (2001) and Simon (2004). If the companion websites are just “shovelware”, where contents of the print medium are moved to the website, substitution will be more likely. If the companion website offers additional service, it might well be a complement (Barsh et al. 1999).<sup>16</sup>

A fourth potential positive effect may arise from the editors’ use of the companion website as a laboratory for trying out topics which, if successful, are later featured in the print edition as well. In this respect we do not even possess anecdotal evidence.

### 2.3 No effects of website visits on circulation

It might of course also be the case that there is no observable relationship between companion website visits and magazine demand. One obvious reason is that the positive and negative effects just balance out one another. Another reason might be that, since website access is for free, the companion website attracts low-valuation consumers, who would not have bought the print version anyway, as discussed by Oberholzer and Strumpf (2004) in a record industry context. This is closely related to the issue of reaching a different set of consumers online rather than offline as discussed above. More importantly, in particular in the case of magazines where consumption presumably is for information rather than hedonic, the online reading behavior might be completely different than offline reading habits so that there

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<sup>15</sup>Statement from a round table discussion hosted by the German Federal Ministry of Education and Research in Berlin on November 9, 2001.

<sup>16</sup>Note that we do not observe the companion websites’ characteristics. There is no data archive in Germany that allows us to track websites back to their launching date. Even if we could, a definition of a companion website’s relative positioning is largely arbitrary and thus subject to measurement error.



might be no relation at all between online and offline consumption.<sup>17</sup>

## 2.4 Advertising and companion websites

The effect of websites on the demand for advertising pages in the print versions is likely to be closely related to the effect of websites on circulation.<sup>18</sup> If companion websites induce circulation to rise, this will translate into an increase in advertising demand (and vice versa), since advertisers value circulation, i.e. contacts per reader to be more precise.

All online companions of the magazines we study offer detailed information on circulation and readership characteristics of the print edition. Hence, the companion websites are vehicles of advertising the print version. The opening of an additional outlet for advertising also enables publishers to offer the possibility of cross-advertising in both advertising outlet channels, thereby making advertising in either medium more attractive.

A more pessimistic view is taken by Silk et al. (2001) who assert a long-term inter-media rivalry in advertising since the Internet has advantages over printed media in the ability to address certain audiences, audience control and contractual flexibility. Their assessment is empirically supported by a small-scale econometric study on subjective ratings of 28 US magazines.

## 2.5 Summary

The review of the competing forces which may (or may not) dictate the relationship between companion websites and circulation as well as between companion websites and advertising demand shows that there is no clear evidence about the direction — and even less so about the magnitude — of the effects. We, therefore, believe that it is necessary to conduct a thorough econometric analysis as a next step. The alternative to such an econometric study is to conduct surveys among Internet users and publishers. We do not find, for reasons that we shall describe in Section 3.2, the evidence provided by surveys to be convincing so far.

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<sup>17</sup>Things might be different for newspapers that tend to be consumed primarily for information, and less much for hedonic reasons.

<sup>18</sup>We do not have information on online advertising space so that we cannot link online advertising space to offline advertising space.

## 3 Existing studies

### 3.1 Existing econometric evidence

There are two groups of existing econometric studies. The first group, which includes Deleersnyder et al. (2002) and Pauwels and Dans (2001), uses time series econometric methods. The second group of studies uses structural microeconomic models to evaluate the effects of websites on print media demand, such as Filistrucchi (2004), Gentzkow (2003), Kaiser (2003) and Simon (2004).

Deleersnyder et al. (2002) test for structural breaks in monthly circulation time series of 67 daily newspapers from Great Britain, observed between January 1990 and June 2001. On average, 42 monthly observations are available after the date at which the companion website was introduced. The same tests are run on monthly advertising time series of 13 Dutch newspapers for the period January 1990 to October 2000, with an average of 41 post-introduction observations. The identifying assumption of the paper is that significant positive (negative) structural breaks in the time series of a newspaper's circulation or advertising pages after a website launch indicate positive (negative) effects of Internet presence on circulation and advertising demand respectively. The authors find that few newspapers experience a drop in circulation and advertising demand due to the existence of a companion website. The effects are, however, disperse and economically fairly small.

Similarly, Pauwels and Dans (2001) analyze twelve Spanish newspapers using tests for unit roots and cointegration. They use daily data on website visits, page views and circulation. Their main finding is that circulation increases digital visits, but they omit to analyze reverse causality. In addition, Pauwels and Dans use data on audience characteristics to show that a close match in characteristics between online and offline readers increases the size of the online audience.

While the existing time-series econometric studies apply similar methods but come to dissimilar conclusions, there are substantial differences between the existing microeconomic studies, both with respect to methodology and results. Gentzkow (2003) uses consumer survey and media consumption data for 16,171 adults from Washington D.C. His data spans the period March 2000 to February 2003 and was collected by a market research firm. He derives a structural model for the demand for differentiated products which, unlike standard models for differentiated product demand, allows products to be substitutes. His main finding is that print and online editions of the same newspaper are weak substitutes.

In an analysis for German women’s magazines Kaiser (2003) estimates structural static and dynamic models for the demand for differentiated models. He uses quarterly panel data for the period I/1996 to IV/2001. The study shows that website provision does not have a significant effect on magazine demand. This conclusion is robust to alternative specifications of the potential website effects, including “passive learning” and “active learning” through readers’ Internet adoption.

Apart from not discussing consumer learning, Filistrucchi (2004) uses exactly the same model as Kaiser. He uses monthly data on the four leading Italian daily newspapers observed between 1976 and 2001. In fact, Filistrucchi finds statistically highly significant and economically sizeable negative effects of website presence on newspaper circulation. He asserts that many Italian daily newspapers started to charge access fees from early 2001 onwards.

Simon (2004) applies a simple linear demand model to analyze the effects of website presence and content overlap between the print version and the companion website. He uses panel data on 556 US magazines from 40 markets for the period 1996 to 2001. Simon does not find evidence for complementarities between online contents and magazine circulation. His results suggest that a magazine’s print circulation on average declines by about three per cent when it offers a website.

### **3.2 Existing survey evidence**

The survey evidence that we found in the existing literature points at some limited cannibalization effects. Mitchell (2001) refers to a survey among 255 US editors and publishers which finds that half of all survey participants fear that their online operations may inflict long-run harm on their print business. There exists two online consumer surveys. Evidence for the US from 1997, cited in Barsh et al. (1999) suggests that 16 per cent of Internet users say they spend less time reading magazines because of time they spend on the internet. Filistrucchi (2004) cites an Italian study from 2001 that finds that 26 per cent of the survey respondents report to read less newspapers and magazines because they use the Internet.

Even though all three studies point in the same direction, we have some reservations against these types of surveys since (i) they do not provide actual counter-factual evidence since they do not describe actual consumption behavior, (ii) survey respondents tend to overstate both their online and offline consumption behavior as described by Deleersnyders et al. (2002), (iii) there are apparent sampling problems and (iv) there are problems with the accuracy of survey conduct. The latter two

points are particularly relevant for online surveys (Dillman 2000) and, hence, for the consumer surveys from Italy and the US.

## 4 Data and Econometric Methodology

### 4.1 Data

#### Data sources and number of observations

We use publicly available data on magazine circulation, advertising pages and website visits from URLs <http://medialine.focus.de> and <http://www.ivw-online.de> respectively. The data spans the period I/1998 and II/2004, or 26 quarters (periods). In this respect, the time series dimension of our data is fairly large. We discard all magazines as well as their websites if they come with less than ten observations. That leaves us with 42 magazines, of which 13 appear all 26 periods and 22 magazines in 20 or more periods. Our unrestricted sample contains 811 observations, the restricted sample contains 549 observations.

We regard our website visits information as reliable for two reasons: (i) magazines use this data to sell advertising space and (ii) it is collected by an impartial non-profit public utility institution, the “Information Association for the Determination of the Spread of Advertising Media” (“Informationsgemeinschaft zur Feststellung der Verbreitung von Werbeträgern e.V.”, IVW) — the German equivalent to the US Audit Bureau of Circulation. IVW ascertains, monitors and publishes circulation and magazine dissemination information with, according to IVW’s statutes, the aim to facilitate open competition between the suppliers of advertising space. IVW as well is the original source of the circulation data we use in this study. Suppliers of online advertising space may join IVW and, once their membership is approved, they are endowed with the IVW’s technical equipment for measuring website visits.

It is not surprising that many magazine websites are not tracked by the IVW data, due to the fact that quite a few German magazine websites contain very little advertising. Thus, they do not need to gather visits data from a publisher’s point of view. Therefore, we thus suspect our data to contain just a fraction of all magazine websites, although but we lack consistent information on website presence of the magazines from out of our sample. We do believe, however, that our data covers the most relevant fraction of magazine websites — in terms of complementarities and substitutabilities between the websites and the print versions — since magazine websites containing advertising are most likely to be professionally managed and

frequently updated.

We set a lower limit of 20 or more consecutive observations per magazine in order to enhance the feasibility of Mean Group Estimation.<sup>19</sup> We reduce the minimum number of consecutive observations to ten in Subsection 5.3. We measure website visits as the total number of “website visits” per quarter (which we compare to the total circulation and advertising pages per quarter). The companion websites in our sample attract on average 6.9 mio. website visits per quarter, the most recent figure for II/2004 is 8.1 mio. That compares to an average circulation of the magazines in our sample of 547.852 and an average number of advertising pages of 433. The most recent figures here are 445.625 and 370 respectively.

Appendix A describes our data and variable definitions more thoroughly.

Figures 1 to 3 display the means as well as the 95 per cent confidence intervals of the seasonally adjusted quarter-by-quarter growth rates of circulation, advertising pages and website visits. We adjust for seasonality by running magazine-specific OLS regressions on a set of seasonal dummies and a linear trend. If statistically significant seasonality is found, we then remove the seasonal part. The figures show that there is substantial heterogeneity across magazines in our sample with respect to all three variables. There also is an evident break in some of the time series for website visits in I/2002. This is due to a change in the technology installed to measure the number of website visits. We account for the break in the empirical analysis below by including dummy variables at the known breakpoint.

Insert Figures 1 to 3 about here!

### **Comparison of magazines in sample and out of sample**

The magazines in our sample constitute a substantial fraction of the German magazine market. They make between 10.1 and 20.3 per cent (mean 18.0 per cent) of total circulation, between 23.8 and 43.4 per cent of total advertising pages (mean 37.3 per cent) and between 8.8 and 21.1 per cent of all titles (mean 17.8 per cent). The respective mean figures for the last period of observation, the second quarter of 2004, are 18.3 per cent, 40.0 per cent and 20.3 per cent.

The magazines in our sample are significantly larger with respect to their individual circulation and advertising market shares, i.e. we compare the mean and median

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<sup>19</sup>There are five regressors in each equation while two initial observations are lost due to taking lags and first-differences.

market shares of the magazines in our sample to the mean and median market shares of the magazines out of our sample. The median circulation share of the magazines in our sample is 0.31 per cent, comparing to a median circulation share of the magazines out of our sample of 0.25 per cent. This difference also is statistically highly significant.<sup>20</sup> We also maintain that the magazines in our sample possess a statistically highly significantly advertising market share, both in terms of means and medians. The median advertising share of the magazines in our sample is 0.86 per cent (mean 1.13 per cent, standard error 0.97 per cent), which compares to a median advertising share of 0.32 per cent (mean 0.36 per cent, standard error 0.36 per cent) for the magazines out of our sample.

In addition, the magazines in our sample have a significantly larger share of readers, who regularly use the Internet (over the entire period 1998 to 2004), both in terms of means and medians. Figure 4 displays the mean share of regular online users, who read magazines contained in our sample, and the corresponding mean share for readers on out-of-sample magazines. The figure shows slow growth in online shares between 1998 and 1999 with minimal differences between the magazines inside and outside our sample and steady growth in online shares thereafter.<sup>21</sup>

Insert Figure 4 about here!

## 4.2 Methodology

We apply the Granger (1969) non-causality (GnC) methodology to test for causalities between circulation and website visits, as well as between advertising demand and website visits. One variable, say,  $x$ , is Granger-causal for another,  $y$ , if — conditional on past values of  $y$  — the inclusion of past values of  $x$  significantly helps in improving the predictability of  $y$ . We rely on this definition in order to identify the relationships between circulation (and advertising demand) and website visits from

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<sup>20</sup>There is, however, no difference in mean circulation between the magazines inside and outside our sample, which indicates that there are some particularly large magazines in our sample. The mean circulation share of magazines in our sample is 0.556 per cent, which compares to a mean share of magazines out of our sample of 0.554 per cent (standard errors 0.550 and 1.320 per cent respectively).

<sup>21</sup>The data on magazine reader characteristics we use here was also provided by “Arbeitsgemeinschaft Media-Analyse” (AG.MA), and is based consumer survey data annually collected by the “Institut für Demoskopie, Allensbach”.

their covariations over time within a dynamic model.<sup>22</sup>

Our basic empirical model is a bivariate vector autoregression (VAR) for the log of circulation,  $c_{it}$  (or advertising pages,  $a_{it}$ ), and the log of visits to the companion website,  $v_{it}$ , of magazine  $i$  in periods  $t = 1, 2, \dots, T_i$ . The VAR is a standard vehicle for GnC analysis, as it allows for shocks in both the real and the virtual markets to be correlated, and to have lagged effects within a particular market (“own-effects”) as well as lagged “cross-effects” between markets. The following model exposition deals with circulation and website visits, only since the setup is analogous for advertising demand and website visits.

The magazine-specific model is formulated in terms of the approximate quarterly growth rates of circulation and website visits,  $\Delta \mathbf{X}_{it} = (\Delta c_{it}, \Delta v_{it})'$ ,

$$\Delta \mathbf{X}_{it} = \mathbf{\Gamma}_i \Delta \mathbf{X}_{it-1} + \theta_{0i} D_{it} + \theta_{1i} D_{it-1} + \mu_i + \epsilon_{it}, \quad t = 1, 2, \dots, T_i, \quad i = 1, 2, \dots, N, \quad (1)$$

where  $\mu_i = (\mu_{ki}, \mu_{vi})'$  denotes a vector of drift parameters. The subscripts  $k$  and  $v$  denote drift parameters for either circulation ( $k = c$ ), or advertising ( $k = a$ ) and website visits respectively. The error term  $\epsilon_{it}$  is assumed to be independently and identically distributed across  $i$  and  $t$ , with mean zero and a variance matrix  $\mathbf{\Omega}_i$  which may differ across magazines.<sup>23</sup>

The parameters of main interest for the GnC analysis are contained in the matrix

$$\mathbf{\Gamma}_i = \begin{pmatrix} \gamma_{11i} & \gamma_{12i} \\ \gamma_{21i} & \gamma_{22i} \end{pmatrix}.$$

We can state the Granger non-causality (GnC) hypotheses as follows:

$H_v : \gamma_{12i} = 0$  is the hypothesis of Granger non-causality from website visits to circulation for magazine  $i$ .

Depending on whether we are concerned with the relationship between website visits and circulation, or with the relationship between website visits and advertising, the second hypothesis is:

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<sup>22</sup>See Dekimpe and Hanssens (2000) for a recent overview of the use of time series techniques in the marketing literature, including the Granger causality concept.

<sup>23</sup>We apply covariance estimates that are robust to heteroscedasticity throughout. The magazine-specific models are found to be reasonably well specified by standard tests of misspecification. The assumption of  $\epsilon_{it}$  being independent across magazines is commonplace in panel data analysis. In Section 5.3 we provide one check on this assumption by including common time effects.

$H_c : \gamma_{21i} = 0$  is the hypothesis of Granger non-causality from circulation to website visits for magazine  $i$ .

$H_a : \gamma_{21i} = 0$  is the hypothesis of Granger non-causality from advertising to website visits for magazine  $i$ .

The test results of the Granger non-causality tests are displayed in our result tables.

The remaining terms in Equation (1) take account of potential deterministic trends in circulation and visits through the drift term  $\mu_i$ , and the instantaneous and lagged effects of the change in the measurement technology which took place in 2002/I via the term  $D_{it}$  (an impulse dummy that takes the value one in 2002/I and zero elsewhere) and its lagged value,  $D_{it-1}$ .

Equation (1) is specified in the first differences of  $c_{it}$  and  $v_{it}$  and imposes a unit root on both variables. This is consistent with standard panel unit root tests and graphical evidence of nonstationarity of the variables analyzed here. There remains, though, a possibility that the stochastic trends impelling circulation and website visits are shared between the variables in which case they would be properly modelled as cointegrated time series. Equation (1) leaves no role for such a relationship. The main reason for this short-run focus of the analysis is that any empirical evidence on a long-run relationship would be tenuous at best when based on 26 quarterly observations. Our main analysis, therefore, relies on the first-differenced specification in Equation (1) but we will show results that take into account a potential cointegrating relationship between the variables as a robustness check in Section 5.3 below.

We exploit the fact that the data on many magazines in our sample have reasonable time-series dimensions to specify  $N$  magazine-specific vector autoregressions. This allows for full heterogeneity in terms of the parameters from the outset. Clearly, magazine-specific estimates potentially lack precision and will be inefficient, if the parameters factually are homogenous across magazines. To investigate the effects of possible parameter heterogeneity across magazines, we employ two different strategies for aggregating the information on individual magazines: (i) traditional panel data methods which impose some degree of homogeneity in parameters across magazines, and (ii) the so-called “Mean Group” approach proposed by Pesaran and Smith (1995) which allows for fully heterogeneous parameters, while estimating their mean across magazines. The Mean Group estimate of  $\mathbf{\Gamma}$  is obtained as the average of the magazine-specific estimates,  $\hat{\mathbf{\Gamma}} = 1/N \sum_{i=1}^N \hat{\mathbf{\Gamma}}_i$ . Pesaran and Smith (1995) argue that averaging across individuals is often preferable to pooled estimation for panels of dimensions like ours.<sup>24</sup> In between the fully homogeneous pooled OLS estima-

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<sup>24</sup>Pesaran and Smith (1995) give no firm guidance on the relevant ranges of  $N$  and  $T$  although



tor and the fully heterogenous Mean Group estimator we also consider the Within Group estimator that imposes  $\mathbf{\Gamma}_i = \mathbf{\Gamma}$ , while allowing magazine-specific intercepts in terms of  $\mu_i$ , e.g. magazine specific time trends.<sup>25</sup>

## 5 Results

### 5.1 Circulation and Website Visits

Table 1 displays our basic results on the presence of Granger causality between circulation and website visits. All additional tables presented in this paper appear in the same format. We report three sets of estimates: (i) “Mean Group” estimates, (ii) “Within Group” estimates and (iii) “Pooled” estimates.

The “Mean Group” estimates are obtained from averaging parameter estimates for each magazine. The “Within Group” are obtained from imposing parameter homogeneity on the parameters of primary interest, the parameter matrix  $\mathbf{\Gamma}_i$ , but not on the drift parameters  $\mu_i$ . The “Pooled” estimates are obtained from pooled OLS estimation, where all parameters are restricted to be equal across magazines.

For each of the three estimators we report the own-effects — i.e. the effect of past circulation on current circulation and the effect of past website visits on current website visits — and the cross-effects (the effects of past website visits on current circulation and the effects of past circulation on current website visits). We also report the marginal significance level ( $p$ -value) for our tests of Granger non-causality. If the  $p$ -value is below 0.1, we cannot reject Granger non-causality at the ten percent marginal significance level.

Table 1 shows very clearly that we find statistically significant evidence for positive Granger causality running from website visits to circulation. The point estimate for the causal effect of website visits on circulation ranges between 0.041 (standard error 0.021) for the Mean Group estimation, and 0.030 (standard error 0.011) for both

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their empirical application (on labour demand) has data for 38 industries over 29 years. Other applications (Pesaran et al., 1999) have  $N = 10$ ,  $T = 17$  (energy demand relations in Asian economies) and  $N = 23$ ,  $T = 32$  (consumption functions in OECD countries).

<sup>25</sup>The kind of finite  $T$  biases usually associated with pooled OLS and Within Group estimation of dynamic panel data models, see Arellano (2003), are expected to be less of a problem here as we have a reasonable  $T_i$  for most magazines. For our main results we will require at least 20 consecutive observations over time. We will also present results for a broader set of magazines for which we have at least 10 consecutive observations as a robustness check in section 5.3.

the Within Group and Pooled OLS estimates. These coefficient estimates directly translate in growth rates: a one per cent increase in website visits causes an increase in circulation by between 0.041 per cent (standard error 0.016 per cent) and 0.030 per cent (standard error 0.011 per cent). The tests for Granger non-causality reject website visits being Granger non-causal to magazine circulation at the usual significance levels. Hence, we find evidence for statistically significant, but economically small, positive effects of website visits on magazine circulation.

By contrast, our estimation results do not provide any evidence for Granger causality of circulation on website visits.

Moreover, Table 1 shows that past circulation has statistically highly significant, but economically small, negative effect on current circulation. The numerical effect varies between 0.285 per cent (standard error 0.068 per cent) and 0.373 per cent (standard error 0.043 per cent). The contrary is true for website visits where high past traffic causes high current traffic with the numerical effects ranging between 0.194 per cent (standard error 0.086 per cent) and 0.245 per cent (standard error 0.072 per cent).

Insert Table 1 and Table 2 about here!
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The fact that the statistically significant estimates of our basic model, as shown in Table 1, are fairly similar to one another across specifications, suggests that there is no significant bias being introduced by pooling the magazines.

Furthermore, in Table 2 we further investigate the heterogeneity issue by reporting separate estimates for two groups of magazines: a group of seven magazines that the German magazine industry (Jahreszeitenverlag 2002) classifies as “News Magazines”, and a group of 15 remaining magazines.<sup>26</sup> The news magazine group consists of magazines which focus on business and economics — these are “Impulse”, “Manager Magazin”, “DMEuro”, “Finanzen”, “Wirtschaftswoche”, “Börse Online” and “Capital” — as well as of magazines that mainly deal with politics but also contain articles on business and economics — these are “Der Spiegel”, “FOCUS” and “Stern”. We do not consider a further differentiation of magazines to be useful,

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<sup>26</sup>We left out one magazine that Jahreszeitenverlag (2002) classifies as a news magazine, “Guter Rat”, from the news magazine group. This magazine is mainly concerned with consumer reports on a wide range of different consumer products and financial products, which is why it was allocated to the heterogenous group of “other” magazines. All other magazines in the news magazine group are indeed news magazines in a narrow sense.

since the remaining magazine subgroups contain four magazines at most.

The main finding from Table 2 is that there is no evidence for Granger causality in any direction for news magazines while for non-news magazines there is, as in our base results from Table 1, statistically significant evidence for Granger causality running from website visits to magazine circulation. The parameter estimates for non-news magazines are slightly larger than in our base specification, but they are also slightly less precisely estimated. Both the loss in precision and the insignificant results for news magazine may, however, be due to substantial drops in sample size.

The results of Table 1 imply that our evidence of positive causality running from website visits to magazine circulation from the full sample estimation is mainly driven by the group of non-news magazines. This is in contrast to the findings of Pauwels and Dans (2001) who identified economic newspapers as most likely to benefit from having a companion website.

The coefficient estimates for effects of past circulation on current circulation, and of past website visits on current website visits (the “own effects”) bear the same signs as in the base model shown in Table 1.

## 5.2 Advertising Pages and Website Visits

The evidence on Granger causality for the case of advertising pages and website visits is presented in Table 3, which shows our base model for advertising and website visits for the full sample, and Table 4, which displays estimation results for a sample split into news magazines and remaining magazines.

Table 3 shows that there is a positive and statistically significant Granger causality running from website visits to advertising pages. The causal effect of a one per cent increase in past website visits on current circulation is moderate and ranges between 0.042 per cent (standard error 0.035 per cent) and 0.046 per cent (standard error 0.024 per cent). The effect is fairly robust across specifications and significant according to the within group and pooled OLS estimation, which benefit from the gain in efficiency from pooling the magazines. As for the relationship between website visits and circulation, there is no evidence for Granger causality going in the opposite direction. The parameter estimates are fairly close to one another across the different estimators.

Insert Table 3 and Table 4 about here!
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Table 4 reports separate estimates for news magazines and for the remainder group of 15 magazines. We find some evidence for Granger causality running from website visits to advertising for the news magazines. There is, however, no evidence for such a causality for the set of non-news magazines. We also do not find evidence for Granger causality running from advertising to website visits in either sub-sample.

The fact that website visits do affect the number of advertising pages for the news magazine group while circulation does not seem to be much affected suggests that the positive effect of website visits on advertising demand is not just a reflection of advertisers reacting positively to increased circulation. It may rather reflect a more general “awareness effect” of increased website visits which enhances the attractiveness of the print version magazine to potential advertisers.

### 5.3 Robustness checks

We conduct three checks on the robustness of our estimation results: (i) we reduce the required minimum number of observations per magazine from 20 to 10, (ii) we allow for a full set of time dummy variables to take into account possible habit formation effects and (iii) we consider the presence of a steady state relationship between website visits and circulation as well as between website visits and advertising.

To start with, our results reported in Table 1 to Table 4 are based on a total of 505 effective observations on 22 magazines, with the required minimum number of consecutive observations per magazine being set to 20. The left-hand parts of Table 5 and Table 6 are based on a less restricted sample with 727 observations and 41 magazines, while the right-hand parts of Table 5 and Table 6 are based on the restricted sample with 505 observations, and refer to estimations which include a full set of time dummies.

A comparison of Tables 1 and 5 demonstrates a very similar picture for the significant estimates: There is significant evidence of causality from website visits to circulation, but not vice-versa. For advertising pages it can be seen, by comparing Tables 3 and 6, that the increased number of observations enhances the significance of all coefficients. In fact, the full sample shows evidence of a two-way causality for the case of advertising pages.

Insert Table 5 about here!

As a second robustness check we include a full set of time dummies in the pooled OLS estimation. We apply this in order to control for general effects that are common to the magazines, such as the fact that more and more users have become connected to the internet during the period considered, see Figure 4. Both for the case of circulation in Table 5 and for advertising pages in Table 6 there is indeed evidence of significant time effects in the website visits equation (the  $p$ -values of excluding the time effects are 0.00 in both cases). However, the estimates of  $\Gamma$  are little affected. The basic findings on Granger causality for the case of circulation are left unaltered by this extension, although there is now less evidence of causality in either direction for advertising demand.

Insert Table 6 about here!

The final check examines whether our findings are robust in relation to the potential presence of a steady state relationship between website visits and circulation (or the number of advertising pages). In effect, the log-levels of the variables would be cointegrated, and a so-called error correction term combining the lagged values of  $c_t$  and  $v_t$  (or  $a_t$  and  $v_t$ ) would be present in Equation (1). Statistical inference on cointegration in general and in heterogeneous panels in particular is non-standard.<sup>27</sup> The present case is further complicated by the presence of a break in the time series of website visits.<sup>28</sup> We will not attempt to establish if any steady-state relationship is in fact present or not in this data set. As argued above, this might not be feasible, even if our sample has a fairly long time series dimension. Instead, we will focus on the causality issue and check if the above conclusions derived from models with no levels relationship hold in an extended specification which allows for such a relationship. Specifically, for each magazine we use a maximum likelihood estimator along the lines of Johansen (1996) which allows for a linear trend and a levels break after 2001/IV. We obtain the coefficients of the cointegrating relationship by averaging across magazines. This is the approach advocated by Pesaran and Smith (1995).

For the case of circulation and website visits, we find a Mean Group estimate of the long-run elasticity of 0.10. Pesaran, Shin and Smith (1999) noted that the estimator could be sensitive to outliers. Our magazine-specific estimates are, in fact, quite dispersed, although the median estimate of .05 is not too different from the mean. On

<sup>27</sup>See Larsson et al. (2001) and Pedroni (2004) on the estimation and test of cointegrating relations from heterogeneous panels.

<sup>28</sup>See Johansen et al. (2000) for inference on cointegration in time series with breaks at a known date.

the contrary, for the system of advertising pages and website visits, the Mean Group estimate of 2.2 is heavily influenced by a very large estimate for a single magazine, the football magazine “Kicker Sport” (www.kicker.de). However, the median estimate of .09 is not too different from a mean of .05 of all magazines except “Kicker Sport”. We take the latter as the preferred estimate of the long-run elasticity. Table 7 reports the results on Granger causality, when an error-correction term calculated from the long-run elasticities has been added to the model. For the “Circulation” system, the short-run effect of lagged visits on current circulation remains positive, although, now, less significant with a  $p$ -value of 0.2. There is still no evidence of causality in the opposite direction. The “Advertising pages” system results confirm our previous findings that lagged visits impact positively on the current amount of advertising. Again, there are indications of a two-way causality result for advertising pages, as established in Table 6, when we looked at all magazines.

Insert Table 7 about here!
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Overall, we can conclude that there is robust evidence of circulation being positively Granger-caused by the number of visits to the companion website. While there is some evidence of advertising pages being Granger-caused by website visits in the main sample, the evidence is not as robust to model extensions. Finally, there is little evidence to suggest Granger causality in the opposite direction in the case of circulation, while the robustness checks indicate two-way causality in the case of the number of advertising pages.

## 6 Conclusion

Print media managers, editors, publishers and industry observers alike tend to believe that the internet cannibalizes circulation and advertising. Most print media today maintain own websites, which means that, if market participants are right, print media cannibalize themselves. It is also acknowledged, however, that companion websites may have positive effects on circulation and advertising through two main channels: (i) “awareness” (consumers and advertisers become aware of the quality of the print medium via the companion website) and (ii) additional service (which may lead to an increased consumer loyalty). Print media circulation may, in addition, benefit from online subscription possibilities.

Existing studies on the relationship between “real” and “virtual” media markets come to quite divergent conclusions depending on data and methodology. They also

suffer from two important drawbacks: they (i) only consider website presence and do not use information on the intensity of website use and (ii) use data prior and up to 2001, when internet penetration rates were substantially lower than they are today.

By studying the causal relationships between website visits and circulation as well as print media advertising using quarterly data for the German magazine market spanning the period I/1998 to II/2004, we try to overcome both flaws in the existing studies. We also apply an econometric methodology, which is substantially more flexible than in related papers.

Our main result is that we find statistically highly significant evidence for a positive causal effect of website visits on circulation. There is no evidence for causalities running in the other direction. Both results are robust to a number of specification tests. We also provide some evidence for increased advertising caused by increased website traffic. This evidence is, however, less robust to model extensions.

While our result of positive causal effects of website visits on circulation is statistically highly significant, it is very small in numerical magnitude. Our point estimate of the effect of a one percent change in website visits on magazine circulation ranges from 0.041 percent to 0.03 percent. The elasticities related to website visits and advertising pages are between 0.042 percent and 0.045 percent.

In conclusion, we hence cannot share the pessimistic view of print media market participants, for whom the internet cannibalizes print media. On the contrary, we find that companion websites increase circulation, albeit to a fairly small extent. Whether this effect is due to an increased awareness or due to an additional service rendered by the websites remains an issue for further research.

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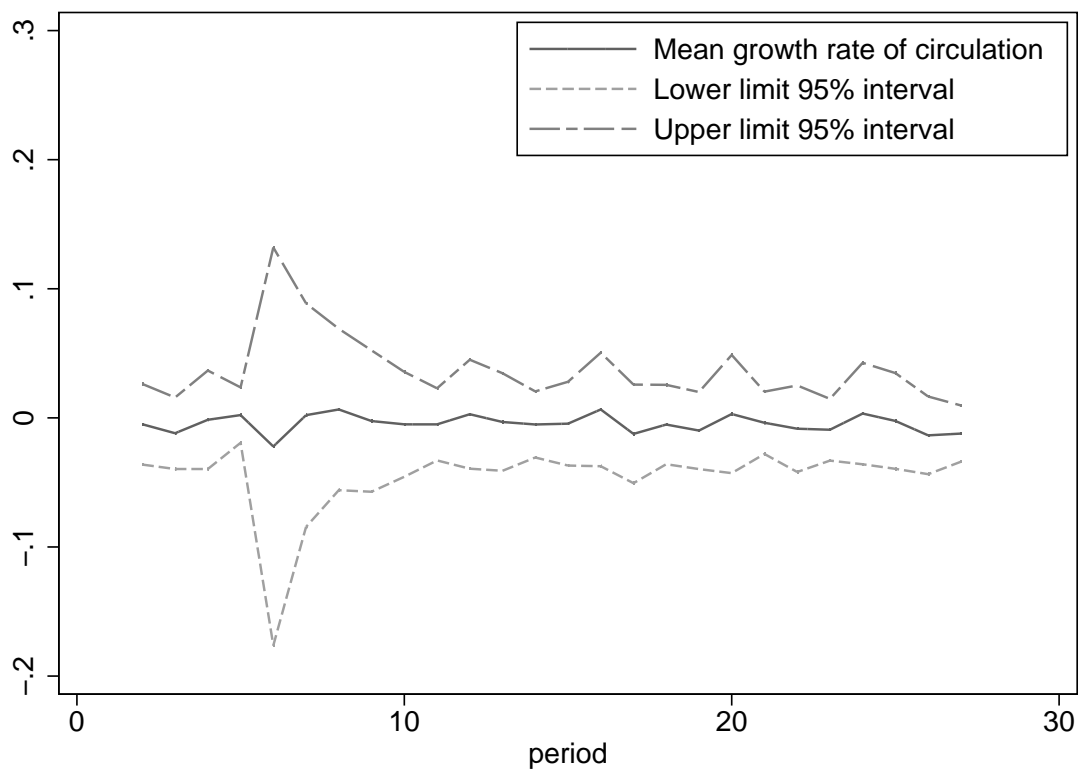
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Figure 1: Mean and 95 per cent interval of the quarterly growth rate of circulation



**Figure 1** displays the means and 95 per cent interval of the quarterly growth rates of circulation. The variation in the data stems from the variation across magazines.

Figure 2: Mean and 95 per cent interval of the quarterly growth rate of advertising pages

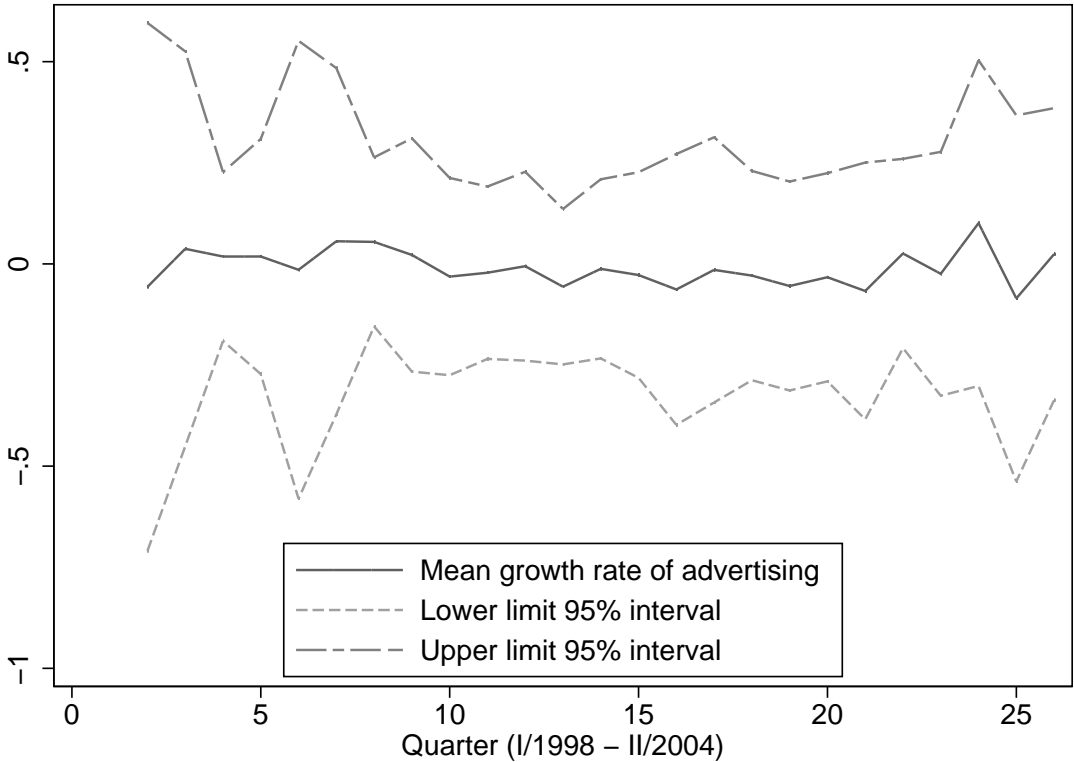
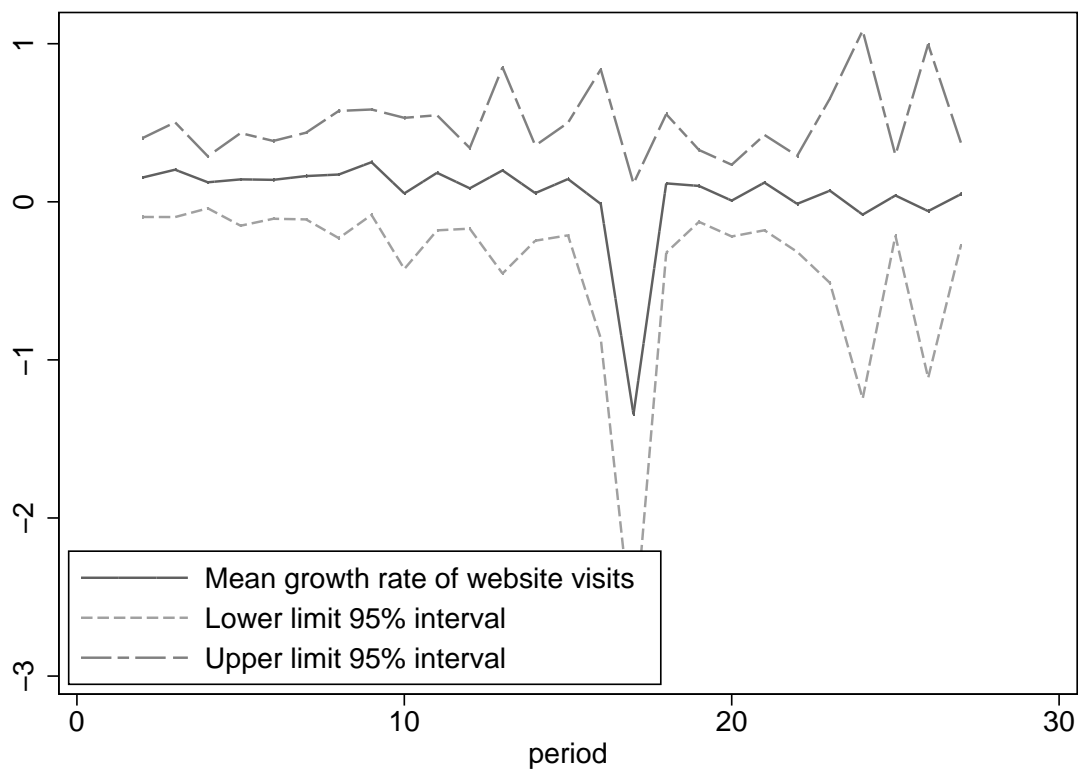


Figure 2 displays the means and 95 per cent interval of the growth rates of advertising pages. The variation in the data stems from the variation across magazines.

Figure 3: Mean and 95 per cent interval of the growth rate of website visits



**Figure 3** displays the means and 95 per cent interval of the growth rate of website visits. The variation in the data stems from the variation across magazines.

Figure 4: Mean share of magazine readers who regularly use the Internet for magazines inside and outside the sample

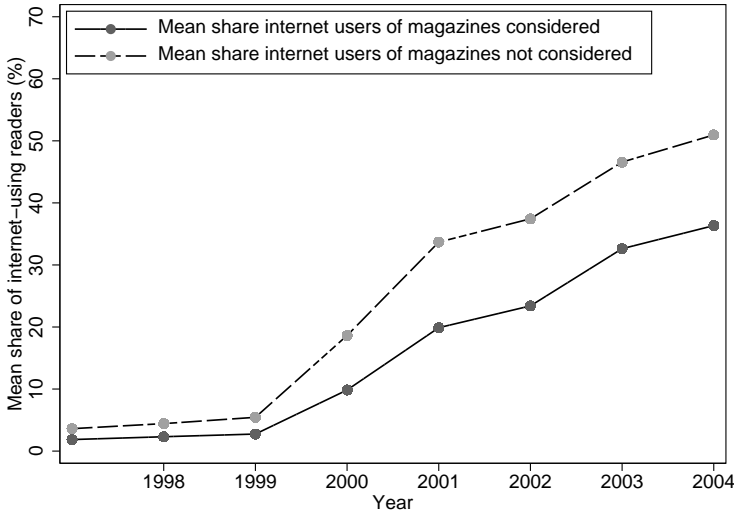


Figure 4 displays the mean share of readers who regularly use the Internet for the magazines inside and outside our sample.

Table 1: Tests of Granger non-causality: circulation and website visits.

	<i>Mean Group</i>		<i>Within Group</i>		<i>Pooled OLS</i>	
	<i>Circ.</i>	<i>Visits</i>	<i>Circ.</i>	<i>Visits</i>	<i>Circ.</i>	<i>Visits</i>
	$\Delta c_{it}$	$\Delta v_{it}$	$\Delta c_{it}$	$\Delta v_{it}$	$\Delta c_{it}$	$\Delta v_{it}$
$\Delta c_{it-1}$	-0.321*** (0.084)	-0.221 (0.290)	-0.373*** (0.043)	0.112 (0.173)	-0.285*** (0.068)	0.134 (0.190)
$\Delta v_{it-1}$	0.041* (0.021)	0.194*** (0.086)	0.030*** (0.011)	0.204*** (0.045)	0.030*** (0.011)	0.245*** (0.072)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.05	$H_a$ 0.54	$H_v$ 0.01	$H_a$ 0.52	$H_v$ 0.01	$H_a$ 0.48

*Note:* “Circ.” is the equation for the quarterly circulation of a magazine. “Visits” is the equation for the number of website visits at the companion website. The regressions use 22 magazines with 20 or more quarterly observations in the period I/1998 to II/2004. The total number of observations is 505. The numbers in parentheses are robust standard errors. The regressions include a constant term and impulse dummies for I/2002 and II/2002. The asterisks “\*\*\*” and “\*” denote significance at the one and ten per cent level respectively. The Granger non-causality (GnC) tests refer to tests for causality running from website visits to advertising ( $H_v$ ) and to tests for causality running from advertising to website visits ( $H_a$ ).

*Reading example:* a one per cent increase in circulation in the previous time period leads to a 0.321 per cent decrease in circulation in the present period (standard error 0.084 per cent); a one per cent increase in website visits in the previous time period leads to a 0.041 per cent increase in circulation in the present period (standard error 0.021 per cent).

Table 2: Tests of Granger non-causality for “News magazines” and for “Other magazines”: circulation and website visits.

	<i>Mean Group</i>		<i>Within Group</i>		<i>Pooled OLS</i>	
	<i>Circ.</i> $\Delta c_{it}$	<i>Visits</i> $\Delta v_{it}$	<i>Circ.</i> $\Delta c_{it}$	<i>Visits</i> $\Delta v_{it}$	<i>Circ.</i> $\Delta c_{it}$	<i>Visits</i> $\Delta v_{it}$
<i>News magazines (162 observations)</i>						
$\Delta c_{it-1}$	-0.224** (0.102)	-0.111 (0.740)	-0.115 (0.073)	-0.117 (0.406)	-0.090 (0.136)	-0.137 (0.492)
$\Delta v_{it-1}$	0.030 (0.030)	0.218* (0.114)	0.009 (0.015)	0.157* (0.081)	0.009 (0.013)	0.212** (0.099)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.32	$H_a$ 0.88	$H_v$ 0.55	$H_a$ 0.77	$H_v$ 0.51	$H_a$ 0.78
<i>Other magazines (343 observations)</i>						
$\Delta c_{it-1}$	-0.367*** (0.116)	-0.271 (0.427)	-0.431*** (0.053)	0.164 (0.190)	-0.339*** (0.075)	0.179 (0.196)
$\Delta v_{it-1}$	0.047* (0.028)	0.183 (0.117)	0.038** (0.015)	0.232*** (0.055)	0.037** (0.017)	0.265*** (0.096)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.10	$H_a$ 0.53	$H_a$ 0.01	$H_a$ 0.39	$H_a$ 0.03	$H_a$ 0.36

*Note:* “Circ.” is the equation for the quarterly circulation of a magazine. “Visits” is the equation for the number of website visits at the companion website. The regressions use 7 “News magazines” and 15 “Other magazines” with 20 or more quarterly observations in the period I/1998 to II/2004. The numbers in parentheses are robust standard errors. The regressions include a constant term and impulse dummies for I/2002 and II/2002. The asterisks “\*\*\*”, “\*\*” and “\*” denote significance at the one, five and ten per cent level respectively. The Granger non-causality (GnC) tests refer to tests for causality running from website visits to advertising ( $H_v$ ) and to tests for causality running from advertising to website visits ( $H_a$ ).

*Reading example for news magazines:* a one per cent increase in circulation in the previous time period leads to a 0.224 per cent decrease in circulation in the present period (standard error 0.102 per cent); a one per cent increase in website visits in the previous time period leads to a 0.03 per cent increase in circulation in the present period (standard error 0.03 per cent).



Table 3: Tests of Granger non-causality: advertising pages and website visits.

	<i>Mean Group</i>		<i>Within Group</i>		<i>Pooled OLS</i>	
	<i>Advert.</i>	<i>Visits</i>	<i>Advert.</i>	<i>Visits</i>	<i>Advert.</i>	<i>Visits</i>
	$\Delta c_{it}$	$\Delta a_{it}$	$\Delta c_{it}$	$\Delta a_{it}$	$\Delta c_{it}$	$\Delta a_{it}$
$\Delta a_{it-1}$	-0.223*** (0.062)	0.011 (0.112)	-0.351*** (0.040)	0.061 (0.074)	-0.340*** (0.117)	0.055 (0.058)
$\Delta v_{it-1}$	0.045 (0.035)	0.170** (0.082)	0.046* (0.024)	0.205*** (0.045)	0.042** (0.021)	0.247*** (0.072)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.20	$H_c$ 0.93	$H_v$ 0.06	$H_c$ 0.41	$H_v$ 0.05	$H_c$ 0.34

*Note:* “Advert.” is the equation for the number of advertising pages per quarter of a magazine. “Visits” is the equation for the number of website visits at the companion website. The regressions use 22 magazines with 20 or more quarterly observations in the period I/1998 to II/2004. The total number of observations is 505. The numbers in parentheses are robust standard errors. The regressions include a constant term and impulse dummies for I/2002 and II/2002. The asterisks “\*\*\*”, “\*\*” and “\*” denote significance at the one, five and ten per cent level respectively. The Granger non-causality (GnC) tests refer to tests for causality running from website visits to circulation ( $H_v$ ) and to tests for causality running from circulation to website visits ( $H_c$ ).

*Reading example:* a one per cent increase in circulation in the previous time period leads to a 0.223 per cent decrease in circulation in the present period (standard error 0.062 per cent); a one per cent increase in website visits in the previous time period leads to a 0.045 per cent increase in circulation in the present period (standard error 0.035 per cent).

Table 4: Tests of Granger non-causality for “News magazines” and for “Other magazines”: advertising pages and website visit.

	<i>Mean Group</i>		<i>Within Group</i>		<i>Pooled OLS</i>	
	<i>Advert.</i>	<i>Visits</i>	<i>Advert.</i>	<i>Visits</i>	<i>Advert.</i>	<i>Visits</i>
	$\Delta a_{it}$	$\Delta v_{it}$	$\Delta a_{it}$	$\Delta v_{it}$	$\Delta a_{it}$	$\Delta v_{it}$
<i>News magazines (162 observations)</i>						
$\Delta a_{it-1}$	-0.097 (0.082)	0.170 (0.294)	-0.382*** (0.065)	0.127 (0.096)	-0.382** (0.190)	0.136* (0.073)
$\Delta v_{it-1}$	0.124 (0.078)	0.227* (0.120)	0.089* (0.054)	0.161** (0.080)	0.084*** (0.026)	0.214** (0.100)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.11	$H_c$ 0.56	$H_v$ 0.10	$H_c$ 0.19	$H_v$ 0.00	$H_c$ 0.07
<i>Other magazines (343 observations)</i>						
$\Delta a_{it-1}$	-0.282* (0.085)	-0.063 (0.104)	-0.287*** (0.055)	-0.085 (0.120)	-0.265*** (0.051)	-0.098 (0.110)
$\Delta v_{it-1}$	0.009 (0.039)	0.142 (0.110)	0.022 (0.025)	0.244*** (0.056)	0.019 (0.026)	0.279*** (0.096)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.82	$H_c$ 0.54	$H_v$ 0.39	$H_c$ 0.48	$H_v$ 0.46	$H_c$ 0.37

*Note:* “Advert.” denotes the equation for the number of advertising pages per quarter of a magazine. “Visits” is the equation for the number of website visits at the companion website. The regressions use 7 “News magazines” and 15 “Other magazines” with 20 or more quarterly observations in the period I/1998 to II/2004. The numbers in parentheses are robust standard errors. The regressions include a constant term and impulse dummies for I/2002 and II/2002. The asterisks “\*\*\*”, “\*\*” and “\*” denote significance at the one, five and per cent level respectively. The Granger non-causality (GnC) tests refer to tests for causality running from website visits to circulation ( $H_v$ ) and to tests for causality running from circulation to website visits ( $H_c$ ).

*Reading example for news magazines:* a one per cent increase in circulation in the previous time period leads to a 0.097 per cent decrease in circulation in the present period (standard error 0.082 per cent); a one per cent increase in website visits in the previous time period leads to a 0.124 per cent increase in circulation in the present period (standard error 0.078 per cent).

Table 5: Robustness checks: Circulation and website visits.

	<i>All Magazines</i>		<i>Time Effects</i>	
	<i>(Ten or more observations)</i>		<i>(20 or more observations)</i>	
	<i>Circ.</i>	<i>Visits</i>	<i>Circ.</i>	<i>Visits</i>
	$\Delta c_{it}$	$\Delta v_{it}$	$\Delta c_{it}$	$\Delta v_{it}$
$\Delta c_{it-1}$	-0.262*** (0.055)	0.153 (0.145)	-0.265*** (0.068)	0.124 (0.172)
$\Delta v_{it-1}$	0.032*** (0.010)	0.202*** (0.056)	0.029** (0.012)	0.172** (0.079)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.00	$H_c$ 0.29	$H_v$ 0.02	$H_c$ 0.47
Number of observations	727	727	505	505
Number of magazines	42	42	22	22

*Note:* Pooled OLS estimates. “Circ.” denotes the equation for the quarterly circulation of a magazine. “Visits” is the equation for the number of website visits at the companion website. The regressions use quarterly observations in the period I/1998 to II/2004. The numbers in parentheses are robust standard errors. The regressions include a constant. “All magazines” includes dummies for I/2002 and II/2002. “Time Effects” columns include a full set of time dummies. The asterisks “\*\*\*” and “\*\*” denote significance at the one and five per cent level respectively. The Granger non-causality (GnC) tests refer to tests for causality running from website visits to circulation ( $H_v$ ) and to tests for causality running from circulation to website visits ( $H_c$ ).

*Reading example:* a one per cent increase in circulation in the previous time period leads to a 0.262 per cent decrease in circulation in the present period (standard error 0.055 per cent); a one per cent increase in website visits in the previous time period leads to a 0.032 per cent increase in circulation in the present period (standard error 0.01 per cent).

Table 6: Robustness checks: advertising pages and website visits.

	<i>All Magazines</i>		<i>Time Effects</i>	
	<i>(Ten or more observations)</i>		<i>(20 or more observations)</i>	
	<i>Advertising Pages</i>	<i>Visits</i>	<i>Advertising Pages</i>	<i>Visits</i>
	$\Delta a_{it}$	$\Delta v_{it}$	$\Delta a_{it}$	$\Delta v_{it}$
$\Delta a_{it-1}$	-0.433*** (0.080)	0.114** (0.052)	-0.376*** (0.109)	0.014 (0.062)
$\Delta v_{it-1}$	0.058*** (0.019)	0.203** (0.056)	0.025 (0.023)	0.175** (0.079)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.00	$H_a$ 0.03	$H_v$ 0.27	$H_a$ 0.82
Number of observations	727	727	505	505
Number of magazines	42	42	22	22

*Note:* Pooled OLS estimates. “Advertising pages ” denotes the equation for the number of advertising pages of a magazine. “Visits” is the equation for the number of website visits at the companion website. The regressions use quarterly observations in the period I/1998 to II/2004. The numbers in parentheses are robust standard errors. The regressions include a constant term. “All magazines” includes impulse dummies for I/2002 and II/2002. “Time Effects” includes a full set of time dummies. The asterisks “\*\*\*” and “\*\*” denote significance at the one and five per cent level respectively. The Granger non-causality (GnC) tests refer to tests for causality running from website visits to advertising ( $H_v$ ) and to tests for causality running from advertising to website visits ( $H_a$ ).

*Reading example:* a one per cent increase in circulation in the previous time period leads to a 0.443 per cent decrease in circulation in the present period (standard error 0.08 per cent); a one per cent increase in website visits in the previous time period leads to a 0.058 per cent increase in circulation in the present period (standard error 0.019 per cent).

Table 7: Robustness check: allowance for a levels' relationship.

	<i>Circulation</i>			<i>Advertising Pages</i>	
	<i>Circ.</i>	<i>Visits</i>		<i>Advert.</i>	<i>Visits</i>
	$\Delta c_{it}$	$\Delta v_{it}$		$\Delta c_{it}$	$\Delta v_{it}$
$\Delta c_{it-1}$	-0.256*** (0.076)	-0.369 (0.405)	$\Delta a_{it-1}$	-0.257*** (0.070)	-0.579* (0.335)
$\Delta v_{it-1}$	0.023 (0.019)	0.071 (0.081)	$\Delta v_{it-1}$	0.038** (0.018)	0.031 (0.075)
GnC Hypothesis ( <i>p</i> -value)	$H_v$ 0.22	$H_c$ 0.36		$H_v$ 0.03	$H_a$ 0.08
Long-run elasticity	0.101		0.049		

*Note:* Mean Group estimates. “Circulation” denotes a system which includes circulation and website visits. “Advertising pages” denotes a system which includes the number of advertising pages and website visits. “Long-run elasticity” is the pooled Mean Group estimate of the coefficient of a cointegrating relationship between  $c_t$  ( $a_t$ ) and  $v_t$  in the “Circulation” (“Advertising pages”) system. The cointegrating relationship includes a linear trend and a step dummy which takes the value 0 until 2001/IV and 1 thereafter. The regressions use 22 magazines with 20 or more quarterly observations in the period I/1998 to II/2004. The total number of observations is 505. The numbers in parentheses are robust standard errors. The regressions include a constant term and impulse dummies for I/2002 and II/2002. The asterisks “\*\*\*”, “\*\*” and “\*” denote significance at the one, five and ten per cent level respectively. The Granger non-causality (GnC) tests refer to tests for causality running from website visits to circulation ( $H_v$ ) and to tests for causality running from circulation to website visits ( $H_c$ ) in case of the “Circulation” system. In case of the “Advertising” system, the tests refer to causality running from website visits to advertising ( $H_v$ ) and from advertising to website visits ( $H_a$ ).

*Reading example:* a one per cent increase in circulation in the previous time period leads to a 0.256 per cent decrease in circulation in the present period (standard error 0.076 per cent); a one per cent increase in website visits in the previous time period leads to a 0.023 per cent increase in circulation in the present period (standard error 0.019 per cent).

## Appendix A: Data and definitions

### Data

Our econometric analysis combines two data sets: (i) data on website visits and (ii) data on magazine circulation as well as advertising pages. Both data sets are collected by the same institution, the “Information Association for the Determination of the Spread of Advertising Media” (“Informationsgemeinschaft zur Feststellung der Verbreitung von Werbeträgern e.V.”, IVW) and can be downloaded free of charge from the Internet at <http://www.ivwonline.de> and <http://medialine.focus.de>.<sup>29</sup> IVW ascertains, monitors and publishes circulation and magazine dissemination information as well as website visits. Magazines freely choose to join IVW to be able to provide potential advertisers with reliable figures on circulation and website visits. The IVW fees, which need to be paid for the collection of circulation data, range between 309 Euros (for magazines with a circulation of less than 5,000 copies in the last quarter of the respective earlier year) and 8,895 Euros (for magazines with a circulation of more than 5,000,000 copies). The fees, which depend on the average number of website visits, range between 300 Euros and 1,200 Euros.

### Definitions

Total circulation is measured as the residual between the number of magazine copies produced and the number of magazines returned to the publisher. A specific feature of the German magazine market is that publishers are obliged to pertaining unsold copies from distributors. There is a possibility of cheating on behalf of the publisher here, and cheating indeed has occurred in the past (with severe reputation damages to the cheating magazines), even though this had not been the case for the magazines in our sample. IVW tries to ascertain the figures submitted by the publisher by drawing stratified random samples at newsstands and by extrapolating actual circulation based on this data.

A “Page Visit” is defined as a successful and non-interrupted contact between an Internet browser and the magazine website from another URL. “Non-interrupted” means that, if a website is accessed once and the user continues to surf on the same website by clicking on different contents, this still is counted as a single access.

There is, however, a measurement problem in our data, due to the fact that “unique users” cannot ultimately be circumscribed due to the strict German data secrecy law and since website providers do not ask users to identify themselves. Accessing the websites in our sample is free of charge, so unique users cannot be identified

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<sup>29</sup>The data we used are publicly available from URL <http://www.ulrichkaiser.com/papers/granger.html>.

from payment information either.

The information on website visits is gathered from so-called “log-files”, i.e. the protocol of all accessed documents and user data submitted to the Internet server.

Apart from the unique user issue, there also is a second measurement problem: more than one user can be attached to a single IP address, for example since dynamic IP addresses are used, which consequently means that many user visits might go unnoticed in our data. The use of “firewalls” creates the same type of measurement problem, since it translates several internal IP addresses into a single IP address, which means that website accesses by multiple users behind the same firewall are counted as one access. An IP address is an identifier for a computer or device on a network.

Website visits are technically measured by analyzing “clickstreams”. A clickstream is the continuum of one or more website visits. The IVW measurement method analyzes when a visit begins within a clickstream, thereby only considering website accesses from the outside. A so-called “referrer variables”, which are transferred by the web browser to the server log file, are used here. The starting point for a new visit is if a user accesses the website from the outside.

Even though we do have data on the number of “Page Impressions” — i.e. the access of an Internet site — as an alternative indicator of website visits we abstain from using it since it also measures the appearance of frames as a page impression which implies that a single website with, say, ten frames would be counted as ten Page Impressions.