Market Definition of Platform Markets

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Abstract

Platform markets are characterized by the existence of indirect network effects that connect two or more market sides through a platform that internalizes these feedback effects. Conventional instruments of market definitions which consider price levels cannot easily applied in case of two-sided platform competition, as price structure of those markets are non-neutral. Instead of using prices, we use time series of quantities and simple correlation analysis to evaluate the substitutional relationship within two-sided media markets. As a benchmark model, we simulate a Cournot duopoly on order to calculate correlation coefficients for varying degrees of product differentiation and indirect network effects.

Keywords two-sided markets, market definition, printed media, network effects

1   Introduction

Market definition in two-sided markets is a complex and current challenge in antitrust analysis. While many recent cases, such as, e.g., EU ./. Google, Bundeskartellamt ./. Facebook and others deal with two-sided platform markets, no quantitative method has been developed yet which is applicable and suitable as a practical tool for market definition. As traditional methods developed for so called one-sided (or traditional) markets are no longer valid, new methods which account for the interelation of two-sided markets are typically too complex to be applied to actual cases. The interdependence of quantities and prices from both markets, caused by indirect network effects, leads to severe identification problems and therefore to demanding data requirements. For this reason, there is an emerging debate on whether or not two-sided markets should be defined at all and some authors recommend to completely abandon market definition, as it is considered useless and incoherent (Noel and Evans, 2005). However, competition authorities typically do not have the choice to completely abandon market definition. They are either obliged by law to properly define relevant markets or have at least to identify the closest competitors in order to evaluate possible effects of anticompetitive behaviour. Because of practical reasons, competition authorities therefore do typically not use quantitative methods but rather qualitative procedures to define two-sided markets.

Two-sided or platform markets, are characterized by the existence of indirect network effects. Many two-sided businesses are intermediaries or platforms that sell two different products to two different groups of agents. These two groups are interconnected by network effects as they mutually influence each other's demand. The platforms recognize the interconnection and choose the price structure according to the relative size of the indirect network effects. In a more restrictive definition of two-sided markets, Rochet and Tirole (2003) determine those markets as two-sided, if the price structure is non-neutral, i.e., the volume of transactions and the participation levels vary as the price structure varies, holding the price level constant. This definition stresses the importance of the distinction between the price level, which is the sum of the prices charged by a platform on both sides, and price structure, which is the allocation of the price level among the two sides. Traditional antitrust instruments like the SSNIP test are designed for single-sided markets, using the price level to analyze a market. Drawing from the economic literature on market definition with interdependencies in demand, it can be shown that these instruments cannot easily be applied in case of two-sided platform competition (Noel and Evans (2005), Filistrucchi, Geradin, E. v. Damme, et al. (2013)).

Although two-sided markets are not invented by the digital revolution, digital markets very often demonstrate a market structure with two or more consumer-groups that are related via indirect network effects and are connected by platforms. A very prominent example can be found within the search engine market, where Google connects at least two market-sides: the demand for search query and the demand for placing advertisement. It can easily be seen, that advertisers value a big group on the other market side, as their scope and therefore the effectiveness of advertisement grows. The value of the search query on the other market side might be influenced negatively or positively by the amount of advertisement. This indirect network effect pretty much depends on the quality of the advertisement and on the consumers demand on personalized advertisement.

Two-sided markets can also be found within more traditional markets like credit cards, newspapers or shopping malls. These markets play an important role when analyzing the nature of two-sided markets as they offer an explicit market structure and available data. Requirements that cannot easily be found within digital markets due to rapidly changing market dynamics. Nevertheless, the rapid growth of digital markets calls for an analytical tool that can be applied to define the relevant market.

As explained above, applying traditional tools like the SSNIP test - being the most important analytical tool for regulatory and antitrust cases in the EU - on a two-sided market leads to a erroneous market definition. This paper aims at filling this gap of quantitative two-sided market definition. We developed a new method for the identification of competitors in two-sided markets by using time series methods and simple correlation analysis. At first, time series on quantities from both markets are adjusted by time series models in order to prevent spurious regressions. We use quantities instead of prices as (i) substitutability is directly reflected in quantities but not necessarily in prices (ii) indirect network effects are directly linked to quantities and (iii) two-sided markets such as platform markets typically characterized by zero prices on either of the sub markets. Next, either cross-correlation functions or simple contemporary correlations are calculated to identify the substitutability of different products. The procedure is applied to reader and advertising markets of different popular magazines genres.

To evaluate the degree of substitutability between different media outlets, we first build a simple model of two-sided markets. We then use Monte Carlo simulations in order to calculate correlation coefficients for varying degrees of product differentiation as well as indirect network effects. A comparison of empirical correlations with Monte Carlo results can then be used to identify the degree of substitutability.

The paper proceeds as follows: chapter 2 presents a review of the relevant

literature on market definition on two-sided markets; chapter 3 presents a Cournot duopol model of platform competition and the results of a Monte Carlo simulation for this model; chapter 4 explains how we use empirical data to test our approach of market definition using cross-correlation functions of quantities in media markets.

2 Literature review

This paper is related to a relatively recent line of economic literature, investigating the implications of two-sided markets on competition policy and offering different approaches to deal with the feedback effects between demand on multiple market sides. While the first policy contributions mainly criticized the application of standard policy to those markets (Wright (2004); Leonello (2010); Chandra and Collard-Wexler, 2009), more recent work has also intended to suggest alternative approaches (Argentesi and Filistrucchi (2007); Song (2015)). We try to contribute to the latter by offering a new approach to define a two-sided market.

The literature of two-sided markets was pioneered by the theoretical work of Caillaud and Jullien (2003), Rochet and Tirole (2003), Evans (2003) and Armstrong (2006), whereby the definition given by Evans (2003) can be seen as a particular case of the more general definition proposed by Rochet and Tirole, 2003 (Filistrucchi, Geradin, V. Damme, et al. (2012)). Rochet and Tirole (2003) as well as Armstrong (2006) both provide a theoretical concept to analyze how platforms chose prices in a market with two consumer sides (networks) showing indirect network effects. However, there are a number of modeling differences between the two articles with regard to (a) the platform's cost structure, (b) the fee the consumers on both market sides have to pay and (c) the source of consumer heterogeneity. A more detailed discussion of these assumptions with regard to our approach is provided in Chapter 3.

As mentioned above, earlier policy contributions criticize the application of standard competition policy on markets that exhibit at least one indirect network effect. Evans (2003), Evans and Schmalensee (2007) Wright (2004) and Kaiser and Wright (2006) are prominent examples of papers that have focused on competition policy on two-sided markets. They have pointed out, that in the presence of indirect network externalities the efficient price structure does not reflect the ratio of marginal cost, nor does increased competition necessarily leads to a more efficient market outcome or merger leads to increased prices.[1] They show that relying on conventional methods to

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[1]Malam (2011) uses an oligopoly model of competition with differentiated products (based on the approach of Salop (1979)) where ad-sponsored media platforms charge a zero

analyze mergers in two-sided markets will lead to significantly different results than using methods that explicitly incorporate the two-sided nature of those markets. Evans (2003) argues that defining a relevant market for antitrust purposes looking at only one side can lead to a market definition which is too narrow. In a more recent study Evans and Noel (2008) analyze the Google and DoubleClick case, confirming, that the Lerner pricing formula does not hold for two-sided markets. While predatory pricing is a practice that harms competition in case of traditional industries[2], selling a product below marginal cost[3] can be a profit maximizing strategy rather than an attempt to predate in a two-sided market (Wright, 2004). Wright (2004) also argues, that increased competition does not necessarily lead to more efficient prices from the social point of view. An analysis of the Canadian newspaper industry shows, that mergers in two-sided markets may not necessarily lead to higher prices for either side of the market. Even a merger to monopoly might raise welfare and do so even in the absence of efficiency gains (Leonello, 2010). These papers emphasizes the need for alternative approaches to adopt competition policy that adequately hits the requirements of two-sided markets.

The actual handling of antitrust issues regarding two-sided markets often lack the identification of indirect network effects. Even if indirect network effects are detected, the definition of the relevant market still remains a challenging task. This is mainly attributable to the fact that available analytical tools of market definition are not applicable for markets with interconnected demands as they consider price levels instead of price structure. The analysis of substitutional relationships is a well-established practice to define the relevant market. The European Commission uses the hypothetical monopolist test (the SSNIP test) which identifies the smallest relevant market through demand-substitutability of a certain product. If a small but significant, non-transitory price increase (5% - 10%) is profitable for the hypothetical monopolist then there is a relevant market (Motta, 2004).

Using these analytical tools to define markets for a product offered on one side of a two-sided market can result in significantly overstating or understating the breadth of the market (Evans and Noel, 2008). Due to the fact that platforms need to balance the preferences of two (or more) different groups of consumers, they often behave in a way that would not be efficient

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price to viewers when competing simultaneously for advertisers. He shows, that mergers among ad-sponsored platforms have a competition-intensifying effect, which offsets the incentive to increase prices on the advertiser side.

[2]Industries with only one market side.

[3]Or even for free, as is the case for the search-engine market as well as many digital markets.

for traditional firms - e.g. they set prices < marginal cost (Chandra and Collard-Wexler, 2009).

The existence of positive feedback effects between demands of the two market sides calls for an optimal strategic behavior that varies widely from profit maximization on conventional one-sided markets. The SSNIP test might be applied in a modified way as shown by Filistrucchi, Geradin, E. v. Damme, et al. (2013) as well as Evans and Noel (2007), who include the profit change in consideration of demand elasticity and indirect network effects. White and Weyl (2012) present a UPP formulae for two-sided markets assuming that firms charge insulating tariffs, meaning that platforms choose quantities and then support those quantities by the corresponding insulating tariffs. Noel and Evans (2005) suggests an extension of the Critical Loss Analysis as an alternative method to define two-sided markets.[4] Although these models are correct in theory, they show various problems - like data requirements - when implemented in practice.

Filistrucchi (2008) suggests a distinction of the two-sided markets regarding the observability of transaction costs.[5] In the "payment card type" market the platform can observe the transaction cost between the two market sides, whereas in the "media type" market the transaction cost does not exist (or is not observable to the platform, e.g. reader reads an ad). In Filistrucchi, Geradin, E. v. Damme, et al. (2013) the authors point out, that in two-sided non transaction markets, two (interrelated) markets need to be defined, while in transaction markets, only one market side should be defined. Emch and Thompson (2006) and Alexandrov, Deltas, and Spulber (2011) show how a SSNIP test should be performed in a two-sided non transaction market. However, as transaction markets might exhibit asymmetric relationships in exceptional cases, this distinction cannot easily be applied. Furthermore the consideration of prices does not capture the dynamic nature of a two-sided market, where firms rather use innovation and quality as strategic parameters (Gual, 2003).

This paper contributes to the body of research that provides practical suggestions to practitioners. We use data on quantity to analyze substitutional effects on two-sided markets. The advantage of using quantity data is clear: As price levels and price structure in two sided markets are closely linked to the scope of indirect network effects, they can hardly be analyzed in the conventional way of antitrust economics.

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[4]See Evans (2012) and Filistrucchi, Geradin, V. Damme, et al. (2012) for a discussion of market definition in two-sided markets.

[5]Whereas Filistrucchi (2008) uses the terms "media type" and "payment card type", Filistrucchi, Geradin, E. v. Damme, et al. (2013) use the terms "non-transaction" and "transaction" marktes.

3   A model of two-sided markets

In order to observe quantities from two-sided markets, we first develop a model of duopolistic platforms offering differentiated products (or services) to two different groups of users. Both sides of the market are assumed to be interrelated by indirect network effects and platforms to set quantities simultaneously. Consider therefore an industry with a continuum of potential users on each side $k = a, b$ of the market, with mass normalized to unity, and two platforms, $i = 1, 2$, which enable the two groups to interact. Following Shubik and Levitan, 1980 we introduce a quadratic utility function for each side of the market as[6]

$$u_i^a = \nu^a q_i + \nu^a q_j - \frac{\beta^a q_i^2 + \beta^a q_j^2 + 2\theta q_i q_j}{2} - (p_i - ds_i)q_i \qquad (1)$$

and

$$u_i^b = \nu^b s_i + \nu^b s_j - \frac{\beta^b s_i^2 + \beta^b s_j^2 + 2\mu s_i s_j}{2} - (r_i - gq_i)s_i. \qquad (2)$$

For $i = 1, 2, i \neq j$, we assume (i) $\nu^k > 0$, (ii) $\beta^k > 0$, (iii) $\beta^k > |\theta, \mu|$, where ν^k is a fixed benefit the agent obtains if she uses platform i on market side a or b respectively.[7] Parameter $\theta \in (0, 1)$ and $\mu \in (0, 1)$ indicate the degree of substitutability of both products, with $\theta, \mu = 1$ indicating perfect substitutes and $\theta, \mu = 0$ indicating monopolistic markets. q_i and s_i measure the consumption on platform i on market side a and b respectively. By normalizing population to one, we can interpret q_i (s_i) as each individual's consumption of product i on market side a (b), or as the network size of the platform i on the respective market side.

The standard quadratic utility functions are expanded by the cost-terms $(p_i - ds_i)q_i$ and $(r_i - gq_i)s_i$, respectively (Kind, Nilssen, and Sørgard, 2009). User's utility therefore depends on respective prices (p_i and r_i) as well as on the network size of the opposite market side (ds_i and gq_i). Hence, d and g describe the magnitude and the direction of the two indirect network effects.

Solving for the FOCs of the consumer problem, given by $\frac{\delta u_i^a(q_i, q_j, s_i, p_i)}{\delta q_i} = 0$ and $\frac{\delta u_i^b(s_i, s_j, q_i, r_i)}{\delta s_i} = 0$ utility can be expressed as

$$u_i^a = \nu^a - \beta^a q_i - \theta q_j + ds_i - p_i \qquad (3)$$

and

$$u_i^b = \nu^b - \beta^b s_i - \mu s_j + gq_i - r_i. \qquad (4)$$

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[6]See also Dixit, 1979 and Kind, Nilssen, and Sorgard, 2006

[7]Weyl, 2010 refers to it as the membership benefit or cost.

User heterogeneity on each side of the market can be modeled in two dimensions: the value of membership and the value of indirect network effects.[8] Rochet and Tirole, 2003 assume $v^k = 0$ and that users have heterogeneous interaction values. Put differently, Rochet and Tirole, 2003 assume that the strength of indirect network effects vary with agents and platforms. Armstrong, 2006, in contrast, assumes that the indirect network effects d, g only depend on the market side and allows for heterogeneous membership values.[9] We follow Armstrong, 2006 in assuming that the scope of the indirect network effect depends on the market side, but not on agents or platforms. Our formulation of utility also coincides with Armstrong, 2006 in that we assume lump-sum fees rather than per-transaction fees.

Equations 3 and 4 can then be converted to obtain the inverse demand functions

$$p_i = \nu^a - \beta^a q_i - \theta q_j + d s_i \tag{5}$$

and

$$r_i = \nu^b - \beta^b s_i - \mu s_j + g q_i. \tag{6}$$

This system of inverse demands illustrates the importance of assumption (iii): The closer θ, μ to β^k, the closer substitutes are the two products, with $\theta, \mu \to \beta^k$ as the limiting case. Equations 1 and 2 imply, that consumers utility from the indirect network effect is higher the more she uses the platform (Kind, Nilssen, and Sørgard, 2009). Keeping everything else equal, demand on market side b has a positive impact on demand on market side a if the indirect network parameter has a positive sign ($d > 0$). Same is true for market side b and the parameter g. While most two-sided markets are characterized by two positive indirect network effects, especially ad-supported platforms such as media platforms are likely to show a positive as well as a negative effect. Demand for advertising increases with the size of media platform's audience. At the same time, when advertising is a nuisance to the audience, a higher amount of advertising would result in a lower demand for content.

Following Armstrong, 2006, we assume that the cost of platform i is market-side specific and that they are incurred when an user joins the platform, so that platform's i total cost is $c_i q_i + f_i s_i$ for some per-user cost c_i for serving group a and per-user cost f_i for serving group b. The profit of platform i therefore can be expressed as

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[8]Weyl, 2010, Rochet and Tirole, 2003 and Armstrong, 2006 refer to this as the interaction value or the per-transaction value.

[9]Rochet and Tirole, 2003 as well as Weyl, 2010 allow agents to be heterogeneous along the two dimensions for the monopoly case.

$$\pi_i = (p_i - c_i)q_i + (r_i - f_i)s_i. \tag{7}$$

Both platforms set q_i and s_i to maximize profits, given the choices of its rival. Substituting unique demands into 7 for $i = 1, 2$, and using first order conditions, optimal quantities, prices and profits can be derived. Subsequently, optimal quantities can be used for simulating times series and correlation coefficients.

As optimal quantities are far from being easy to interpret, we present a simpler version of q_i, s_i assuming $\nu^k, \beta^k = 1$ as well as $c_i = f_i = 0$. Equilibrium quantities are then

$$q_i = \frac{2 + d + g + \mu}{4 - (d+g)^2 + \mu\theta + 2(\mu + \theta)} \tag{8}$$

and

$$s_i = \frac{2 + d + g + \theta}{4 - (d+g)^2 + \mu\theta + 2(\mu + \theta)}. \tag{9}$$

As long as indirect network effects are positive, both quantities increase with d and g. It can also be shown that $\frac{\partial q_i}{\partial \mu} < 0$, $\frac{\partial q_i}{\partial (d+g)} > 0$, $\frac{\partial s_i}{\partial \theta} < 0$, $\frac{\partial s_i}{\partial (d+g)} > 0$ as long as $0 < (d+g) < 2$. As positive indirect network effects have a positive impact on willingness to pay, quantities are also increasing with higher network effects. A higher degree of substitutability increases competition and reduces quantities.

3.1 Monte Carlo Simulation

We are interested in the market behavior of platforms depending on a change in parameters d, g and θ, μ. More precisely our aim is to analyze the correlation coefficient of quantities depending on the degree of substitution and the indirect network effects. For this purpose, we use Monte Carlo simulation to obtain benchmark correlation coefficients, by simulating external shocks in platforms' marginal costs that follow a random walk.[10]

Marginal cost of firm i on market side k, i.e. $c_{i,t}$ and $f_{i,t}$ respectively, is generated according to equation 10 together with equation 11:

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[10]Paha (2011) elaborate a similar framework to parameterize marginal costs.

$$c_{i,t} = \begin{cases} m_1^a & \text{if } t = 1 \\ c_{i,t-1} \cdot \gamma + m_{2i,t}^a \cdot l_t^a & \text{if } t > 1 \end{cases}$$

$$f_{i,t} = \begin{cases} m_1^a & \text{if } t = 1 \\ f_{i,t-1} \cdot \gamma + m_{2i,t}^b \cdot l_t^b & \text{if } t > 1 \end{cases} \tag{10}$$

$$\left. \begin{aligned} & l_t^k \in [0; 0.01] \\ & m_1^k \in [0; 0.01] \\ & m_{2i,t}^a \sim CN(\tfrac{m_3^k+1}{2}, (\theta \cdot 10)^{-2}, m_3^k, 1) \\ & m_{2i,t}^b \sim CN(\tfrac{m_3^k+1}{2}, (\mu \cdot 10)^{-2}, m_3^k, 1) \\ & m_3^k \in [0; 0.1] \end{aligned} \right\} \tag{11}$$

In $t = 1$ marginal costs of firm i on market side k equals the base level m_1, randomly drawn from the interval $[0; 0.01]$. In subsequent periods $t > 1$ marginal costs are assumed to follow a random walk with with $0 < \gamma < 1$ (Harrington, 2008, p. 241). The asymmetric cost shock $m_{2i,t} \cdot l_t$ is assumed to occur in every period and has the same sign for all firms. It captures (i) the firm-specific cost-shock $m_{2i,t}$ and (ii) the market side specific cost-shock l_t that is common for all firms on that market side. The firm-specific term is drawn randomly from a censored normal distribution in the interval $[m_3; 1]$, with the expected value $E[m_{2i,t}]$ being the mean of the interval $[m_3; 1]$. The variance of this term is modeled to decrease in the degree of product homogeneity θ and μ respectively. The common cost shock l_t is assumed to occur every period and is randomly drawn from a uniform distribution int the interval $[0; 0.1]$ in every period.

The assumptions about the composite cost shock are rational if we assume homogeneous input-factors are purchased from a perfectly competitive market. They are relaxed by the platform-specific cost-shock which arises asymmetry between the platforms. This asymmetry might be due to individual negotiations between a platform and its service-provider. Moreover, asymmetry can be assumed to be larger, the smaller θ or mu, as a high degree of heterogeneity might cause more asymmetric input costs, while homogenous products should be produced with more symmetric input costs.[11]

We generate a dataset of $t = 1000$ two-sided markets, by randomly generating $t = 1000$ values for f_i and c_i for $\forall \theta, \mu, d, g \in [0; 1]$.[12] Using the simulated values for f_i and c_i we are able to calculate the equilibrium quantities

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[11]See (Paha, 2011, p. 17) for a motivation for this assumption.

[12]For simplicity we assume $\mu = \theta$

for every market on both market sides. As we are interested in substitutional relationship between the equilibrium quantities to define the market, we then calculate correlation coefficients from quantities. According to a Cournot duopoly we expect q_i and q_j, as well as s_i and s_j to be correlated negatively, the higher θ and μ.

Figure 1 illustrates the relation between the sum of the indirect network effects $d + g$ and the correlation of quantities $\rho(q_i, q_j)$ on market side a, depending on the substitution parameter θ. Keeping $(d + g)$ constant, a high degree of homogeneity causes negative correlations to increase, which is consistent with what we would observe in markets without indirect network effects. Homogeneous products ($\theta = 1$) cause a high degree of competition, which leads to high negative correlation of quantities, whereas a small degree of homogeneity $\theta \to 0$ results in little or no substitutional effects. Keeping instead the correlation coefficient constant, an increasing total sum of indirect network effects suggests less competition. The higher the absolute amount of $(d + g)$, the higher the negative correlation between the quantities keeping θ constant. As we assume network effects to be equal for both platforms, a higher interdependency of the markets will result in a higher correlation of quantities. Figure 2 gives another impression of the dependencies of parameters, which will be useful when estimating empirical data.

Both, indirect network effects and parameters of product differentiation are unknown in our model. Therefore, in order to get a relative exact impression of substitutability, the strength of indirect network effects have to be determined in advance. This can be achieved by either making theoretical assumptions about indirect network effects or by estimating these effects empirically. Most of the literature related to the quantification of the indirect network effects have based their analysis on electronic payments system industries (Ackerberg and Gowrisankaran, 2006), (Rysman, 2007) or magazine and newspaper industries (Kaiser and Wright, 2006), (Argentesi and Filistrucchi, 2007). Even though such an investigation on the INE gives empirical evidence, the drawback is twofold: First, many antitrust cases cannot meet the huge data requirements for an empirical investigation. Second, theoretical assumption have to be made that might not reflect the industry characteristics adequately.

To overcome problems connected with data requirements and empirical modeling, we restrict our analysis to the assumptions of our theoretical model. By simulating quantities as a function of indirect network effects as well as differentiation parameters, we are able to estimate a range of substitutability depending on different strengths of the indirect network effects. Assuming a specific range of network effects and estimating correlation coefficients can then be used to limit the most likely range of substitutability.

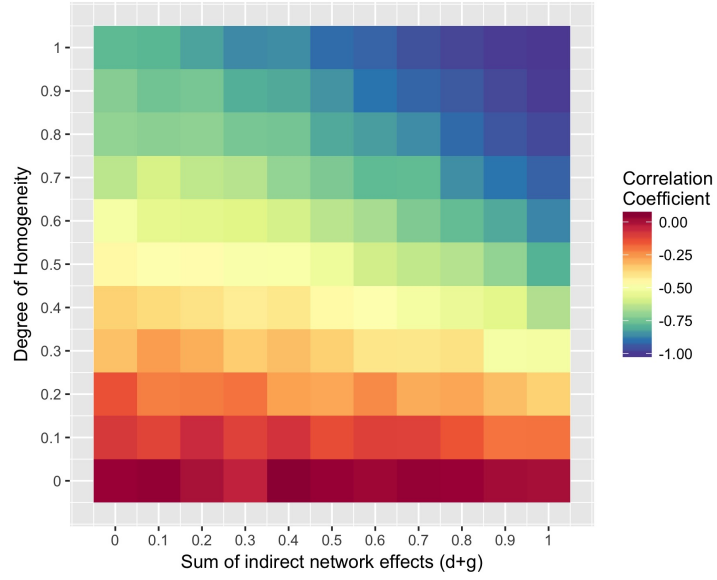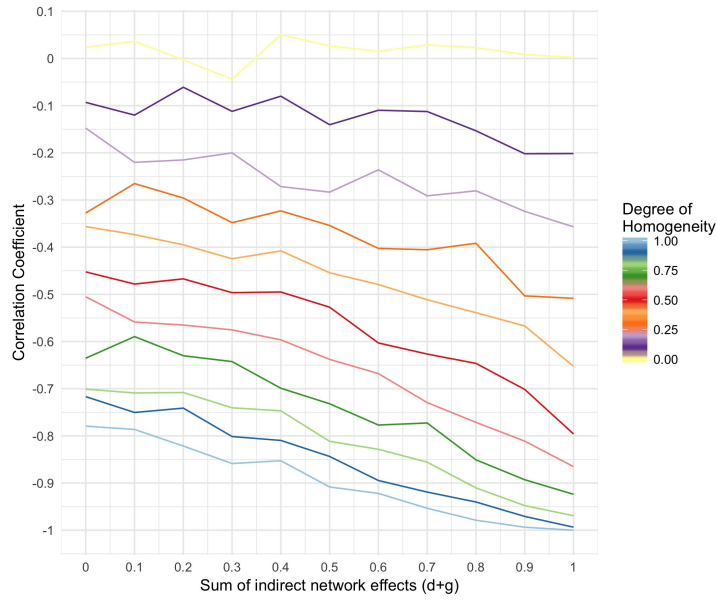Figure 1: Simulated Correlation of q_i and q_j (a)

Figure 2: Simulated Correlation of q_i and q_j (b)

4 Empirical analysis

4.1 A Simple method for detecting substitutional relationships in two-sided markets

This section presents a simple method for detecting substitutional relationships in two-sided markets using cross-correlation functions as well as simple contemporary correlations. To test our approach of identifying substitutional relationships we use data on German popular magazines which are a typical example of two-sided markets. Magazine publishers serve a reader market as well as an advertising market, which are both interrelated by indirect network effects. Furthermore, data on German popular magazines is available for a broad range of differentiates products, for both, reader advertising markets. We are therefore able to identify possible substitutional products from a relatively high number of genres. Identification of possible substitutes has to be based on plausibility considerations. As popular magazines are typically highly differentiated, characteristics such as price level, layout, frequency of publication, but also socio-demographic factors of readers can help to identify possible competitors.

As data form identical markets are typically affected by the same external influences, time series of prices and quantities are usually overlapped by common patterns. While quantities are strategic substitutes we expect to find negative contemporary correlations between substitutes. However, quantities as well as prices set by platforms from the same market or industry typically show identical patterns such as, e.g, seasonality, common trends or cyclical behavior. In order to prevent spurious regressions identical patterns have to be removed before an analysis of substitutability can be applied. For this purpose, we first apply different prewithening procedures. To prewhiten the quantities from both market sides we use different methods. At first, we apply a methods proposed by Dewenter, 2004. All series from similar markets which show the same patterns are regressed on each other including a trend and a constant. Next, different time series models such as ARMA and ARIMA models are applied for prewhitening matters (see George E. P. Box, Jenkins, and Reinsel, 2008). The results form different models are used for a comparison.

Next, we are able to calculate either simple correlation coefficients or cross correlation functions and to compare the results with simulated correlations. Using cross correlation functions instead of simple correlation coefficients allows us to analyze not only contemporary correlation but also possible effects such as shifts in quantities from one magazine to an other. These shifts typically occur with market entry of new products. Given that all competitors

compete for a longer period, contemporary correlation coefficients should be an adequate measure.

4.2 Data

Data used in this study is extracted from the online magazine database "PZ Online" (Public Magazines Online) which provides (inter alia) information on circulation, advertising volumes and prices for al high number of magazines form different genres.[13] In order to address rather different genres and markets we use data on news magazines as well as on women's and TV magazines.

To account for quantities in reader and advertising markets we use circulation numbers and advertising pages per copy, respectively. Even though the dataset contains data from 2003 to date we restrict our analysis to different two and three-year intervals (see Table 1 for an overview of our samples). The reasoning behind subsampling is two-fold: First, as data availability often plays a crucial role for any economic policy analysis, using shorter periods allows us to prove that our approach is suitable even with low data availability. Second, antitrust concerns are often related to certain periods as markets develop constantly. Additionally, during recent years, print media have been subject to decreasing circulation and declining advertising revenues due to digitalization.[14] Using data on magazine products proves that also markets with either decreasing or increasing market volumes can be subject of our approach.

Table 1: Sample Selection

Segment	Titles			Period		Frequency	Obs
News magazines	FOCUS	Der Spiegel	Stern	2004 / 33	2006 / 33	weekly	105
				2013 / 33	2015 / 33	weekly	105
TV magazines	TV Movie	TV Spielfilm	TV Digital	2007 / 15	2011 /15	biweekly	79
Women's magazines	Brigitte	Freundin	Für Sie	2007 / 15	2011 /15	biweekly	79

4.2.1 News Magazines

compare with benchmark /new simulations First published in 1947 "Der Spiegel" had a monopoly on investigative journalism for a long time when Burda-Verlag entered the market in 1993 with a news magazine, FOCUS,

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[13]PZ Online is provided by the German association of magazine publishers (Verband Deutscher Zeitschriftenverleger) to provide advertising customers with necessary information on possible advertising platforms.

[14]For more information see Cabyova, Krajcovic, and Ptacin, 2014 or Picard, 2011

claiming itself to be a close substitute to Der Spiegel. The latter instead opposed that FOCUS is an illustrative magazine similar to Stern, a magazine first published in 1946 by Gruner + Jahr (Kaltenhaeuser, 2005). In fact all three magazines differ regarding their editorial concept. Der Spiegel mainly focuses on complex political and social issues, whereas FOCUS also covers more non-political topics such as health and fitness. Stern has been a simple illustrative magazine without any political appeal until the 60s. It then started to address current political topics (Vogel, 1998). Even though all three magazines have different editorial concepts, readership of Der Spiegel, FOCUS and Stern does not differ significantly regarding their socio-demographic characteristics, but their political orientation: While FOCUS is rather a conservative outlet, the coverage of Der Spiegel can be considered as left-wing. Stern which reporting is less political, can be located somewhere in between (Kaltenhaeuser (2005)). Having this in mind, we do not expect strong competition in the reader market between the magazines as, e.g., a "left-wing" reader of Der Spiegel would probably not consider FOCUS as an adequate substitute et vice versa.[15] All three magazines offer several digital services (website and mobile apps) with mostly free content.

Advertising demand on the other side is assumed to be strongly affected by the size and the characteristics of the readership of a certain magazine. However, in contrast to the reader market, political orientation should not matter as much as socio-demographic characteristics. We therefore expect the the degree of substitutability to be higher in the advertising market. All of the magazines might therefore be competitors in the advertising market.

Graphical inspection of the time series (see figure 3) shows, that in the reader market Stern and Der Spiegel have similar sales, whereas circulation of FOCUS is considerably smaller in both time samples. The overall mean decreased between the two periods by approximately 46%, but sales of Der Spiegel are highest in both samples. Prices per copy remained the same without any fluctuations, with Der Spiegel being more expensive ($4.6EUR$) than FOCUS and Stern who charge the same price per copy ($3.9EUR$). On the advertising market, quantities of all three magazines are quite similar and show seasonal fluctuations reveals, that advertising pages of Der Spiegel are lowest in terms of absolute and total values for both samples. Nevertheless, standard deviation is rather high, indicating high degree of fluctuation.

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[15]However as some of the readers might not have strong political preferences, we expect some kind of contemporary negative correlation, as final purchasing decisions will be influenced by cover stories and content. This assumption is supported by the fact that subscription is just a minor part of total sales (about 2-3 %). We assume, if any, weak negative indirect network effects from the advertising market as the share of advertising pages per copy ranges between 2% and 8%.

Again, average quantities diminished between the time samples. This is true both for absolute and relative values. Looking at the prices per advertising side in the later sample shows, that prices for Der Spiegel is highest, followed by Stern and FOCUS.[16]

Figure 3: Time Series of news magazines

(a) Reader Market   (b) Advertising Markt
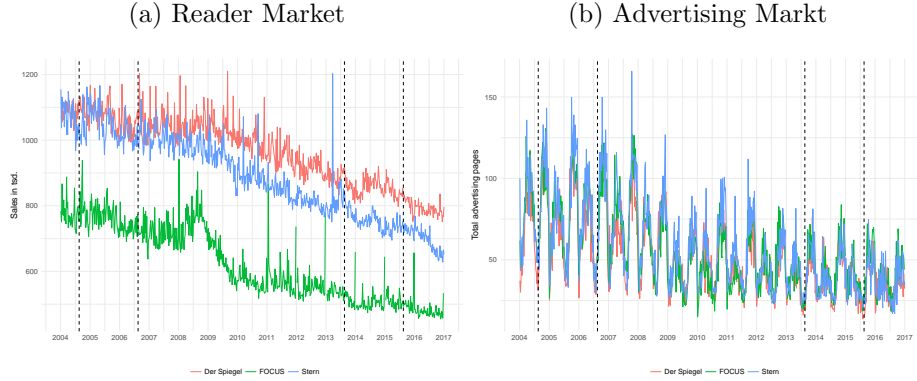
4.2.2 Program Guides

In contrast to the market for news magazines, the market for program guides consists of a relatively high number of magazines. However, the market is also strongly segmented into different sub-markets (e.g. weekly and bi-weekly, high price and low price segments). In order to test our model we chose a segment of bi-weekly magazines which are characterized by similar presentation, layout and content. A presumably high degree of substitutability can also be suspected from similar titles: TV Spielfilm, TV Movie and TV Today.

Graphical inspection supports our conjecture of substitutional products. While total sales are different in absolute values (see figure 4), all of the magazines show similar trends and peaks in our sample. While TV Spielfilm and TV Movie show very similar fluctuations and levels over the whole sample, TV Today seems to run slightly differently. However, volatility of sales is much lower compared to news magazines. Advertising volumes, again, are overlapped by stronger fluctuations showing a similar development.

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[16]There is no public available data on advertising prices before 2009. However, available data shows an increase of advertising prices from 2009 to 2016.

Figure 4: Time Series of program guides

(a) Reader Market   (b) Advertising Markt
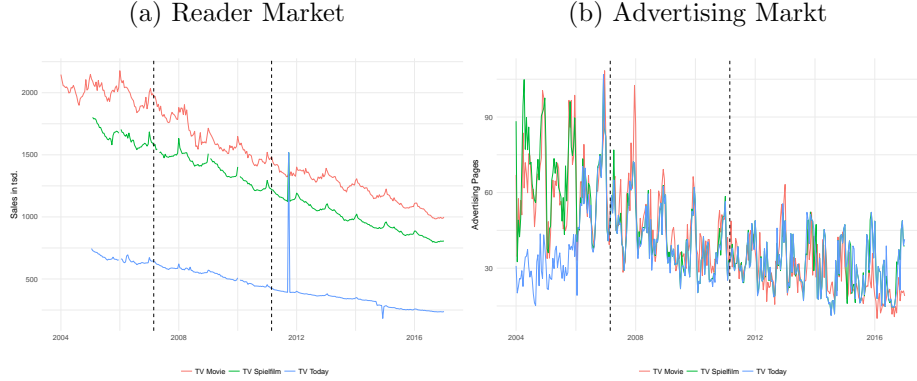

4.2.3 Women's magazines

state new results

Women's magazines are the most popular journals in Germany and also highly differentiated. While some magazines are located in a low price segment, others represent a rather glossy high price section. Journals are also differentiated with respect to content, resulting in a high number of different products, focussing on topics such as fashion, beauty, gossip and others. To test the validity of our approach, we chose the three magazines Brigitte, Freundin and Für Sie, all of them published biweekly showing similarity with respect to editorial content and copy price. The three magazines cover topics such as fashion, beauty, health and nutrition as well as reportages on special topics to reach the target audience of middle-aged women. Copy prices ranges between 2.9EUR (Für Sie) and 3.2EUR (Brigitte) and do not show any fluctuations within the time span 2003 to 2016.[17]

Inspecting time series plots of sales and advertising pages (see figure 5) reveals relative high sale numbers for Brigitte and quite lower sales for Freundin and Für Sie. All series on sales are more volatile than series on TV magazines, which is probably due to the fact that demand for women's magazines may depend on current coverage to a much higher degree. Advertising space is also volatile and characterized by seasonal fluctuation which affects all of the times series in a similar manner. However, advertising volumes is smaller for Freundin. Again, the quantities on both market sides do not show indications of negative correlations. However, as the time series seem to follow a common structural trend, the assumption of a substitutional relationship is reasonable.

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[17]Copy price of Freundin is 3EUR

Figure 5: Time Series of women magazines

(a) Reader Market   (b) Advertising Markt
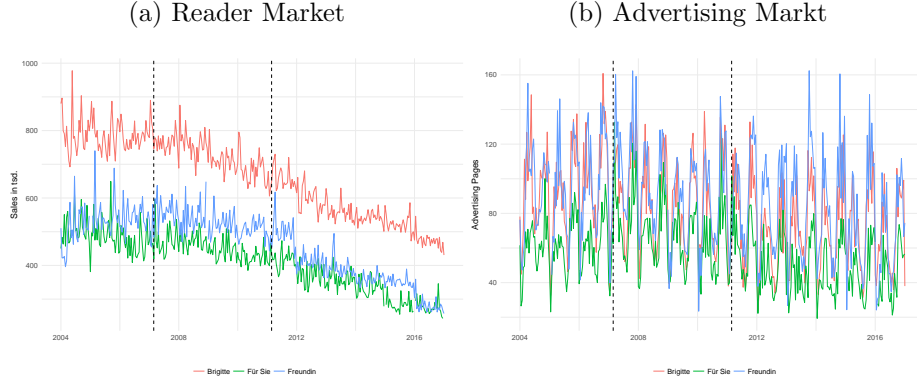
4.3 Results

4.3.1 News magazines

To prevent a possible spurious regression, at first, all time series have been analyzed with respect non-stationarity using Philipps-Perron unit roots tests. As can be seen from the results in the appendix, all of the series are found to be of order I(0). Next, different pre-whitening procedures have been applied as described above, in order to produce adjusted time series which are adequate for correlation analysis. Figures 11 and 12 present adjusted series using the appropriate ARMA process for both markets and periods. Time series are therefore adjusted for common trends and other structural components. A spurious regression should therefore be excluded.

4.3.2 Reader Market

Next, we analyze the reader market for news magazines by calculating cross-correlation functions using adjusted time series for sales. As figure 6 shows,[18] relatively small contemporary correlation coefficients exist, indicating (if any) only weak substitutional relationships between the magazines.[19] For the first period no significant contemporary correlation can be found.[20] For the

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[18](1) = 2004w33-2006w33, (2) = 2013w33-2015w33

[19]Note that $t < 0$ indicates the correlation between the current sales of the first magazine and the lagged sales of the second magazine. The dashed lines represent the respective approximated two standard error bounds $SE^+ = \frac{2}{\sqrt{n}}$ and $SE_- = \frac{-2}{\sqrt{n}}$ (Tiao and G. E. P. Box, 1981).

[20]Corresponding contemporary values can be found in table 2

second period a slightly stronger correlation indicating a weak substitutional relationship between Der Spiegel and Stern ($\rho = -0.30$) is evident.

Figure 6: CCF sales
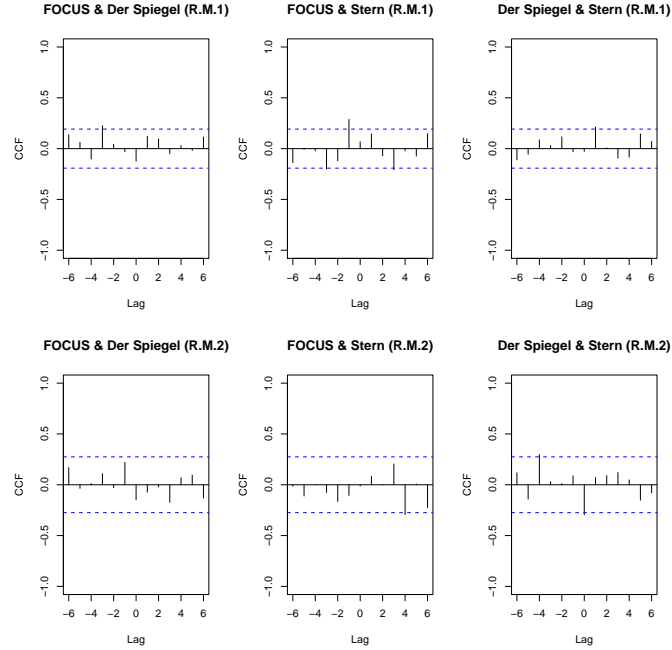
4.3.3 Advertising Market

Turning to the advertising market, figure 7 supports the assumption, that competition in this market side is much stronger. In contrast to the reader market, all contemporary correlations are statistically significant and negative. In the first sample we can find substitutional relationship among all three magazines, with a contemporary negative correlation of $\rho = -0.53$ for FOCUS & Der Spiegel being the strongest. Der Spiegel & Stern show a rather weak substitutional relationship ($\rho = -0.38$), and a contemporary correlation for FOCUS & Stern of $\rho = -0.43$. In the second period competition seems to have decreased between FOCUS & Stern, as the correlation coefficient is $\rho = -0.32$. Contemporary correlation between Der Spiegel & FOCUS ($\rho = -0.53$) and FOCUS & Stern ($\rho = -0.38$) did not change significantly. It is striking that some of the intertemporal effects of FOCUS & Stern are positive and significant. This phenomenon might be due to a common trend, that has not been filtered in the first stage. Because of the weekly data, a separated seasonal adjustment could only be carried out with an enormous effort, as irregular effects such as calendar effects or moving

festivals appear within the time series (Harvey, Koopman, and Riani, 1997). Such common structural trends are assumed to have a positive rather than a negative influence on the results.

Figure 7: CCF advertising pages/copy
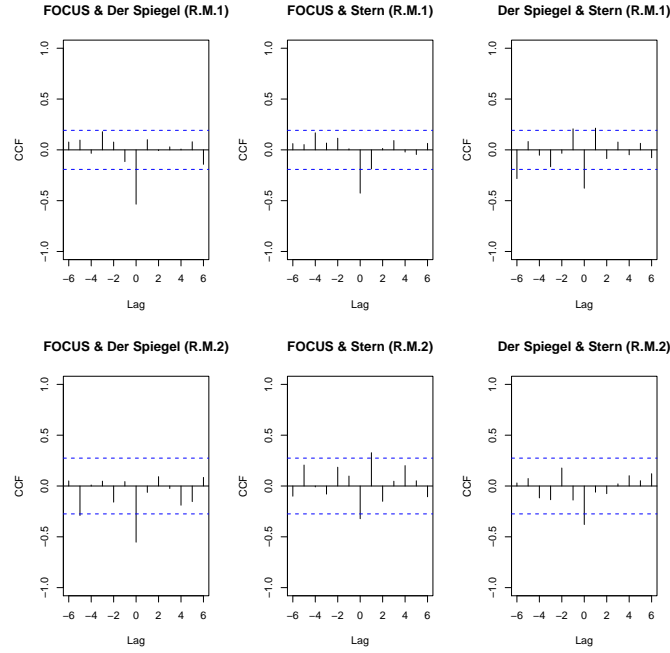
4.3.4 Comparison with Benchmark

Figure 8 shows the estimated contemporary correlation of news magazines for the second sample (2013/33-2015/33) compared with the simulated benchmark.[21] Assumptions about the amount of INE changes the indicated degree of competition: The higher the assumed sum of INE, the lower is θ. To put it differently, the same negative correlation coefficients indicate less competition if the INE is high. Assuming that total INE (from reader market to advertising market and reverse) exist and are positive, the following conclusions can be drawn: In the reader market, no significant contemporary correlation coefficients were found in the first sample. In the later sample the substitutional relationship between Der Spiegel and Stern intensified ($\rho \approx 0.3$), indicating a degree of competition of $\theta \approx 0.3 - 0.4$ depending on the assumed INE.

Turning to the advertising market, substitutional relationship between FOCUS and Der Spiegel is the strongest for both samples. If we assume, that

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[21]F=FOCUS, DS=Der Spiegel, S=Stern.

Table 2: Contemporary correlations

news magazines(1)	sales	ad pages/copy
FOCUS & Der Spiegel	-.124	-.534
FOCUS & Stern	.068	-.426
Der Spiegel & Stern	-.027	-.377
news magazines(2)		
FOCUS & Der Spiegel	-.147	-.553
FOCUS & Stern	-.012	-.322
Der Spiegel & Stern	-.296	-.379
program guides		
TV-Spielfilm & TV-Movie	-.078	.059
TV-Spielfilm & TV-Today	-.735	-.953
TV-Movie & TV-Today	-.071	-.223
women's magazines		
Brigitte & Für Sie	-.490	-.366
Brigitte & Freundin	-.090	-.414
Für Sie & Freundin	-.240	-.530

the sum of INE ranges between 0 and 0.3, we can find a degree of homogeneity of nearly $\theta \approx 0.7$, whereas INE of 0.7 to 0.9, indicate $\theta \approx 0.5 - 0.6$. Negative correlation between FOCUS & Stern decreased between the samples (from $\rho = -0.43$ to $\rho = -0.32$), suggesting a degree of homogeneity of $\theta \approx 0.3$ for the later sample (or $\theta \approx 0.2$ if we assume $d + g > 0.9$). The substitutional relationship between Der Spiegel & Stern did not change significantly between the two samples, indicating a degree of homogeneity of $\theta \approx 0.4 - 0.5$

Figure 8: cross-correlation / news magazines

(a) reader market   (b) advertising market
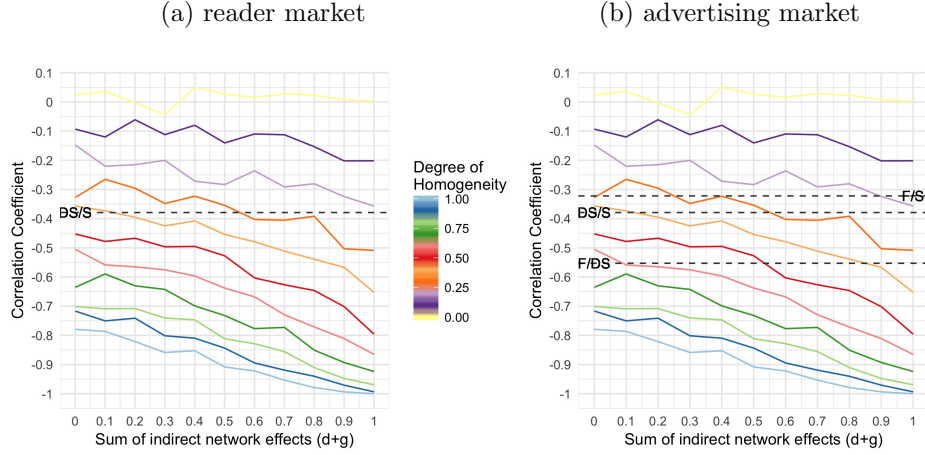
Our empirical results imply much stronger substitutional relationships in the advertising market for all pairs of magazines. This strongly supports the assumption of the dichotomy of the two market sides with respect to a market definition. Furthermore, the contemporary correlation in the advertising market increased between the two periods for FOCUS and Stern, whereas no significant change was found for the remaining two pairs. That is, the degree of competition between the last two pairs can be assumed to have remained the same.

Turning to the reader market contemporary substitutional relationship increased between the periods regarding Der Spiegel & Stern. This might be due to a change in the editorial concept of one or both magazines. No significant substitutional relationship was found for the other pairs in both samples.

Overall, the empirical results support the assumption, that the three magazines are rather substitutes in the advertising market, but seem to claim own sub-markets in the reader market within both periods.

4.3.5 Program Guides

A similar analysis has been conducted for the market of program guides, including the magazines TV-Movie, TV-Spielfilm and TV-Digital. Again, unit root tests as well as time pre-whitening have been carried out as a first step. Figure 13 includes adjusted time series for all TV magazines from both markets.

Figure 9 shows the cross-correlation functions of the reader (R.M.) and the advertising market (A.M.). The magnitude of the contemporary corre-

lation among TV-Today and TV-Spielfilm is the strongest on both market sides (with $\rho = -.74$ in the reader and $\rho = -.95$ in the advertising market, respectively). Comparing these results with our benchmark model, and assuming positive INE, the competition parameter ranges between $\theta \approx .9 - .6$ in the reader market and $\theta \approx 1 - .75$ in the advertising market. Again, the degree of competition depends on the sum of the indirect network effects: the higher the assumed INE, the lower the competition parameter for the same correlation coefficient. Contemporary correlations on the advertising market between TV-Movie and TV-Today are statistically significant but rather small in the reader market $\rho = -.22$, indicating degrees of substitutability of $\theta \approx .15$. No significant correlation can be found between TV-Spielfilm and TV-Movie.

Figure 9: CCF program guides
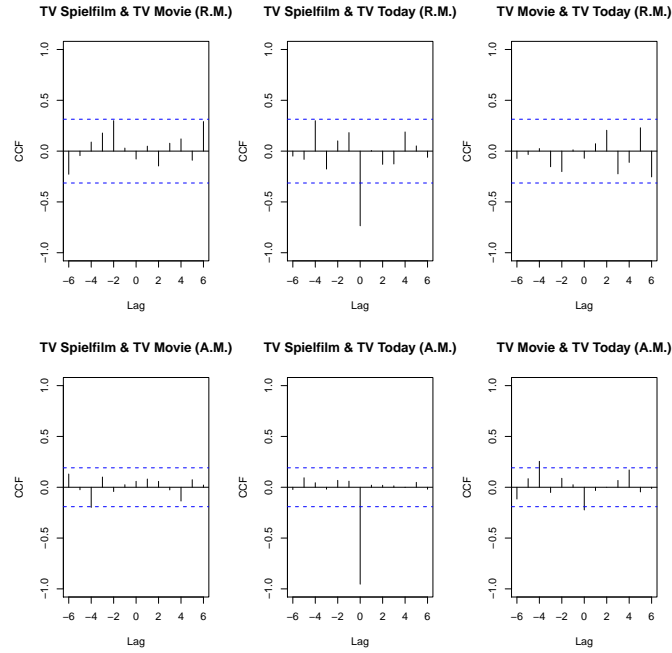
4.3.6 Women's Magazines

The ccf of the adjusted time series are shown in figure 10. As a striking outcome, contemporary correlation between Brigitte & Für Sie is higher in the reader market ($\rho = -.49$, suggesting a degree of homogeneity of $\theta \approx .4 - .5$) than in the advertising market ($\rho = -.37$, suggesting a degree of homogeneity of $\theta \approx .3 - .43$). Contemporary correlation between Brigitte & Freundin is insignificant in the reader market, but suggests a substitutional

relationship in the advertising market ($\rho = -.41$ leads to $\theta \approx .3 - .4$). Für Sie & Freundin show a even higher correlation on the reader market ($\rho = -.53$) indicating a degree of competition of $\theta \approx 0.4 - 0.5$, whereas on the reader market these magazines seem to be only weak substitutes ($\rho = -.24$ leads to $\theta \approx .15$).

Put differently, women's magazines seem to be closer substitutes in the advertising than in the reader market. Although this may seem counterintuitive, this result is typical for some media markets. As described above, even if different groups of readers do not consider some specific media outlets as substitutes, this does not necessarily imply that advertising customers do not consider the readerships of the magazines as substitutional.

Figure 10: CCF women's magazines
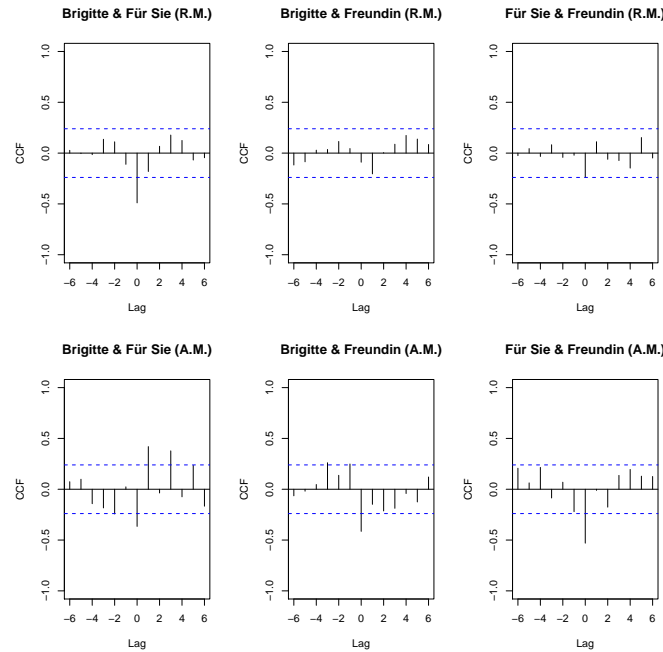
4.3.7 Program guides and women's magazines

In order to test the validity of our method we finally calculated cross correlation functions between women's magazines and TV guides. As expected, there is no evidence for any significant substitutional relationship. Neither for the reader nor for the advertising market are any statistically significant correlations to be found. This is of course not surprising at all, as TV guides and women's magazines cannot be considered substitutes in the reader market. Similar applies to the advertising market. Although there might be

some products for which advertising customers consider TV guides as well as women's magazines as a possible advertising outlets, the readerships of both types of magazines are supposed to be quite different with respect to socio-demographic characteristics. However, socio-demographics is most important for identifying advertising customers' target groups. estimate this

5   Conclusions

Market definition in two-sided markets is a complex challenge and until now no method has been developed which is applicable and suitable as a practical antitrust tool. Usual methods developed for on-sided markets are no longer valid and the interdependence of quantities and prices from both markets, caused by indirect network effects, leads to severe identification problems. For this reason, some authors recommend to completely abandon market definition as it is considered useless and incoherent (Kaplow, 2010; Evans...). However, competition authorities are either obliged to define markets or have at least to identify the closest competitors in order to evaluate effects of possibly anti-competitive behavior.

For this reason, we developed a new method for the identification of competitors in two-sided markets by using time series methods and simple correlation analysis. At first, time series on quantities from both markets are adjusted by time series models in order to prevent spurious regressions. We use quantities instead of prices as (i) substitutability is directly reflected in quantities but not necessarily in prices (ii) indirect network effects are directly linked to quantities and (iii) two-sided markets such as platform markets typically characterized by zero prices on either of the sub markets. Next, either cross-correlation functions or simple contemporary correlations are calculated to identify the substitutability of different products. The procedure is applied to reader and advertising markets of different popular magazines genres.

To evaluate the degree of substitutability between different media outlets, we first build a simple model of two-sided markets. We then use Monte Carlo simulations in order to calculate correlation coefficients for varying degrees of product differentiation as well as indirect network effects. A comparison of empirical correlations with Monte Carlo results can then be used to identify the degree of substitutability.

The conclusions from our empirical analysis is twofold: First, our method seems to be appropriate to estimate degrees of substitutability in two-sided markets. The results seem to be reasonable and valid. Correlation coefficients are surprisingly different between seemingly similar products. This applies

especially to circulation.

Second, our analysis shows that market definition is likely to be asymmetric between different markets (i.e., the reader and the advertising market). While circulation between most products shows only a moderate substitutability, correlations in advertising market seem to be much higher. These results are also in ine with our theoretical considerations.

As we have so far analysed only a small number of magazines, the next step in our analysis is to include a much higher number of outlets from different segments. Especially online platforms markets are an interesting research objects, as many recent antitrust cases affect digital platforms.

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Appendices

A   Empirical analysis

A.1   Phillips-Perron test for unit Root

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A.2   Adjusted Time Series

Figure 11: Sales of news magazines (adjusted)

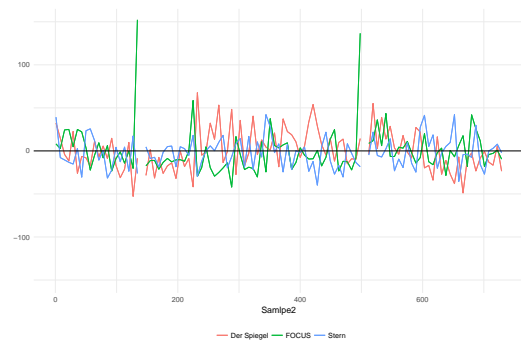(a) Sample 1   (b) Sample 2
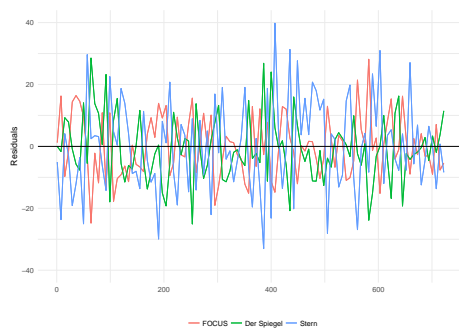

Figure 12: Advertising pages of news magazines (adjusted)
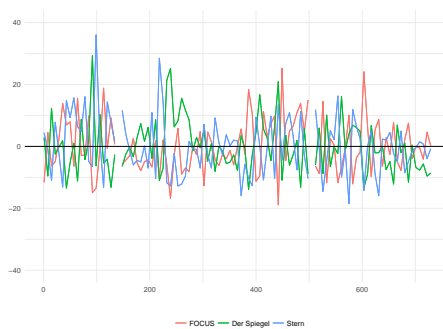
(a) Sample 1   (b) Sample 2
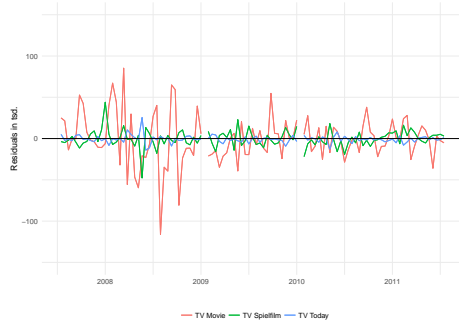
Figure 13: Time Series of program guides (adjusted)

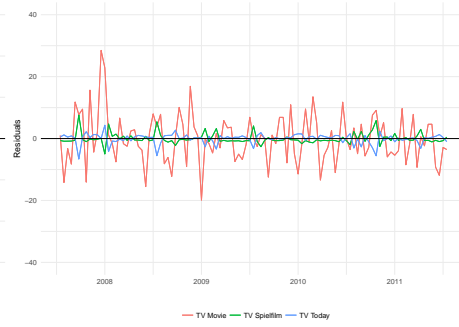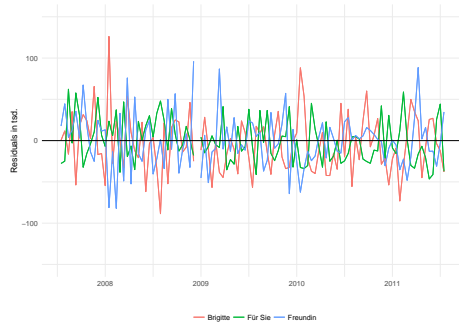(a) Sales

(b) Advertising Pages

Figure 14: Time Series of women magazines (adjusted)

(a) Sales

(b) Advertising Pages