NETWORK EFFECTS OF DIGITAL INFORMATION GOODS
A PROPOSAL FOR THE OPERATIONALIZATION OF DIRECT AND INDIRECT NETWORK EFFECTS

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ABSTRACT

Network effects ubiquitous with information goods (content, software) are a phenomenon being discussed more and more recently. Despite strong empirical support on network effects generally, there is a need in research regarding their operationalization and measurement. Our aim was to specify network effects in order to answer the question 'What exactly are network effects?'. We have identified and developed a set of indicators that determine network effects and assessed them on the information good mobile operating system. Using the mobile operating systems iOS and Android as a case most of the indicators developed for measurement of network effects are measurable. The findings of this work contribute to the ongoing exploration of network effects by demonstrating the interdependence of direct vs. indirect network effects with the growth of an installed base of an information good.

Keywords: *Direct Network Effects, Indirect Network Effects, Information Goods, Mobile Operating Systems, Network Effects*

1. INTRODUCTION

Information goods already have a significant value in modern economies and become more and more important still. Basically, an information good is everything that is or can be available in digital form, and which is regarded as useful by economic agents (Linde and Stock 2011, 24). Other types of information goods are therewith games, which are played on consoles, multimedia players, which make it possible to watch films or videos on the PC, mobile operating systems with which handhelds, smartphones, tablet PCs or the iPad run as well as music, pictures, films, news, books, ringtones etc.

In digital form, information goods only work in combination with a complement: A TV-show cannot be watched without a TV-set, an e-book cannot be enjoyed without a reader and an operating system doesn´t make sense without some kind of hardware. Information goods always show network effects, either direct or indirect. Direct network effects are: The more users join a network the greater the value for the existing users, or the more existing users there are, the greater the value for newcomers will be. Indirect network effects describe an increase in a network good's attractiveness due to increased benefits that result from available complements (Katz and Shapiro, 1985; Farrell and Klemperer, 2008).

To our best knowledge, no detailed operationalization of network effects has been achieved yet. In this paper we aim at operationalizing network effects of information goods by developing and assessing specific indicators.

We will proceed as follows. A brief overview of the status quo of research on network effects will be given in chapter 2. In chapter 3 we will develop indicators for measuring network effects and will explain our research methodology. In chapter 4 the network effects will be examined and assessed based on the information good mobile operating system. A summary and implications for further research will sum up our work in chapter 5.

2. LITERATURE REVIEW

When somebody decides to acquire new software one of the key factors for purchasing a particular software will be the prevalence of that software in the market. Information goods are more valuable for existing customers the more widely they are being used. This additional value, which stems from the total number of its users, enhances the value arising from the product itself (Buxman, 2002). In economics this is called a network effect or network externalities. Network participants increase the value of the pre-existing ones, hence the network becomes more interesting overall for further participants. Network effects are also called 'Increasing Returns to Adoption' (Arthur, 1989, 2004) or 'Demand Side Economics of Scale' (Farrell and Saloner, 1986).

External effects (externalities) are present whenever economic activities affect the welfare of uninvolved third parties, and nobody is compensated for it (e.g. Mankiw, 2011). There are positive and negative external effects. Positive network externalities are generated by new users for all those already being part of the network. Positive network externalities are at play as long as the network is not congested. Considering a mobile phone network, too many participants can also cause damage if too much traffic brings the network to a halt. The new participants have caused negative network externalities resulting in additional costs for existing customers due to hang-ups. Decreasing coordination costs because of a standard being used for software (e.g. Wintel) are positive externalities in virtual networks. Unavailable websites however is an example for a negative network externality. In addition, direct network effects can be distinguished between local and global effects (Sundararajan, 2005). Global network effects apply to all participants of a network, local network effects feature in a smaller (personal) group of users e.g. Instant Messaging.

Besides the direct network effects described earlier, there are also indirect network effects. They mainly refer to additional offers and services complementing a network good which increases the network good's attractiveness (Katz and Shapiro, 1985). For instance a computer operating system allows complementary application products such as text processing, spreadsheets and service programs e.g. anti-virus software. These examples highlight the importance of indirect network effects to the customer value. The same applies to content which can only be used if technical complements are available. For example, the more users of apps offers there are, the more companies will bring smartphones or tablets onto the market. The table below gives an overview over positive and negative network effects for information goods, distinguished between content and software.

TABLE 1: POSITIVE AND NEGATIVE NETWORK EFFECTS FOR INFORMATION GOODS

Information Good/Network Effects	Direct Network Effects	Indirect Network Effects
Software	Positive: Data transfer, cooperation, troubleshooting Possibly negative: Congestion	Positive: e.g. hardware, additional programs Possibly negative: Viruses, spyware etc.
Content	Positive: Communication advantages (having common topics of conversation, being able "to have one's say") Negative: Undesirable distribution of exclusive information	Positive: e.g. end devices, complementary content online Negative: advertising, fraudulent websites

Source: Adapted from Linde, F. and Stock, W.G. (2011), p. 59.

In summary it can be stated that network effects are omnipresent with all information goods. The degree or intensity of network effects however differs by information good.

Network externalities have been analyzed and measured for different industries in prior research. Many analyses have a theoretical approach proving the existence of network externalities and their effects on markets. A brief overview of the latest findings on network effects is to follow.

A few empirical studies have dealt with the existence of direct and indirect network effects with information goods. Gandal (1994) has done early research of direct network effects on spreadsheet applications in the US for the years 1986 to 1991 proving that users are willing to pay extra if they see a benefit resulting from compatibility of a spreadsheet program to the industry standard and access and data exchange to external databases.

Similar results are found in a research by Brynjolfsson and Kemerer (1996) for the same spreadsheet application between 1987 and 1992, also in the US proving that clients would pay more for programs offering compatibility to the industry standard as well as for those well distributed, i.e. with a big network. Gröhn (1999) has done research in Germany on network effects with software programs. Network effects were proven for programs where the users were interested in information exchange with others, looking for advice and help and using complements. His research shows that network effects are stronger the higher the importance of information exchange is.

Buxman (2002) analyzed the impact of alternative pricing strategies – in particular penetration pricing – on the distribution of standard software systems in view of the existence of network effects. The work is based on a simulation model describing the network effects. His research about the differences between installed base and network effects focuses on the installed base respectively its expected size, not addressing indirect network effects.

In the last few years, Industrial Organization literature has increasingly explored indirect network effects (Inceoglu and Park, 2010). Indirect network effects have been researched by Shurmer (1993) as well as Swann and Gill (1993). Shurmer looked at the correlation between software use and the use of complements showing a strong correlation between the installed base of the software and the use of print media as well as professional trainings as information source resp. user help. Swann and Gill looked at complements such as additional products and availability of training for spreadsheet applications. Both researches concluded that (indirect) network effects are stronger the bigger the installed base is. Srinivasan et al. (2004) conducted an expert poll amongst professors and MBA students concerning the degree of network externalities and that a product can have direct or indirect network externalities or both. It shows the different network effects without detailing the indicators used. Clement and Schollmeyer (2009) have compared existing research on network externalities for specific industries. Their meta-study focuses on research addressing the effects of network externalities on consumer's behavior. Indicators for measuring network effects are not being addressed. Inceoglu and Park (2010) analyzed the correlation between hardware demand and software supply in the DVD industry. An increase in the number of DVD titles strongly raises the demand for DVD players.

Despite strong empirical support recently on the examination of network effects in general terms, there are still substantial research opportunities. Our aim was to specify network effects in a selected industry and show tangible results. 'What exactly are network effects?' is the core question of our research. Our approach however was not to conduct another estimation but to operationalize direct and indirect network effects based on a set of indicators for both. Details of our framework as follows.

3. METHODOLOGY

While elaborating indicators for network effects it became apparent that it was useful to distinguish on one hand between those that are directly related to network effects and on the other hand those that are product features just encouraging either direct or indirect network effects. E.g. the number of integrated communication applications (like instant messengers) being offered to download support direct network effects, but are not network effects themselves. Hence, it has been discussed and decided to work with a subdivision, i.e. product features encouraging network effects – both direct and indirect ones – and network effects themselves. The two key questions for developing detailed indicators for network effects then were:

1) Which product features encourage or support network effects?

2) Which indicators precisely describe direct and indirect network effects?

TABLE 2: POSSIBLE INDICATORS TO SPECIFY SUPPORTING PRODUCT FEATURES AND NETWORK EFFECTS

	Direct network effects	Indirect Network effects
Product features that support network effects	Integrated technologies Integrated communication applications	File formats System interfaces Source code access (open source)
Network effects	Data exchange Information exchange Mutual support Product evaluations	End devices Media reviews Additional applications Additional content Additional media Content and software suppliers Accessories Professional trainings

As per the above table, we have identified the following product features that encourage and support network effects: integrated technologies, integrated communication applications, file formats, system interfaces and source code access. They are now being described, their impact on fostering network effects is explained and first indicators to prove their existence and strength are developed.

Integrated technologies are pre-installed systems for data exchange such as GSM, Bluetooth or near field communication (NFC). NFC e.g. allows for transactions similar to using a credit or debit card by touching a payment terminal or using a payment app. An NFC enabled device can also act as an ID card or medical ID card. The type and number of integrated technologies being available is usually stated in the product specifications.

While integrated technologies allow for data exchange between different devices *integrated communication applications* allow users to communicate with each other, e.g. by ICQ, Skype, and other types of instant messengers like the facebook messaging system. The type and number of integrated communication applications that can be installed is predetermined by the product, partly through the technical architecture of the system and partly through regulations of the according mobile OS Developer, e.g. Apple or Google.

Both integrated technologies and integrated communication applications support direct network effects by allowing the devices to interact and enabling its users to communicate with each other.

Information can be encoded for storage in different *file formats*, e.g. text files as DOCX or PDF or multimedia files as WMA or AAC. File formats are divided into proprietary and open formats - some competing, others supporting each other. Not all software can be used, hence the file format becomes a crucial product feature supporting indirect network effects, because it determines which complements can be utilized. It is usually stated in the product specifications of an information good which file formats can be used.

System interfaces are tools that enable interaction between hardware- (e.g. graphic card) and/or software-components (e.g. internet browser) via an input/output system and an associated protocol. In addition to hardware and software interfaces, a device interface allows for communication between the device/computer and the user by peripheral components such as keyboards for example or touchpads. System interfaces support indirect network effects, because they allow complements to connect. The product specifications show which system interfaces can be used.

Source code access means that the programming language of an information good is accessible, for example the source code of Android. Open source code can be altered and enhanced by its users or be adapted to suit certain needs. File formats, system interfaces and source code access support indirect network effects as they offer the possibility to enlarge the supply of devices and applications. In particular source code access makes it easier for programmers to develop new code.

In addition to the product features just mentioned that encourage and support network effects, the following indicators fully specify and describe network effects: Data exchange, information exchange, mutual support and product evaluations are specifying direct network effects and end devices, media reviews, additional applications, additional content, additional media, content and software suppliers, accessories and professional trainings are further operationalizing indirect network effects. As above all of the indicators will be described, then starting points for their measurement are given and it will also be explained why they are representing network effects.

Data exchange means that there is no communication between humans, but machine-to-machine communication. Data exchange relates to processes like mobile phone tracking or geotagging. We have looked at programs that support this kind of exchange for each information good. For those programs identified it would be necessary to measure the amount of data exchange.

Information exchange refers to any interaction between users of a certain information good. This can either be face-to-face communication, personal communication supported by electronic means or transferring processable files. The information users exchange can be the informationgood itself (e.g. news) as well as any kind of information relating to it (e.g. blog posts). To measure the extent of information exchange it would be necessary to count the number of communication processes between users.

Mutual support relates to the communication between consumers or between users and product professionals, e.g. via FAQs and forums. To allocate the direct network effects of mutual support the intensity of communication could be measured by the number of threads and answers in different forums.

Product evaluations are reviews based on the personal experiences of users. They can facilitate the usage of an information good or the purchase decision of potential consumers. The impact of product evaluations on information goods can be measured by the number of reviews available at consumer review portals such as ciao.de or epinions.com.

All of the four indicators mentioned are considered as direct network effects because they increase the benefit for the participants as well as for the newcomers of a network. The following eight indicators represent indirect network effects. All of them are complements for digital information goods and hence increase the users´ benefit.

End devices are compulsory complements for digital information goods, for example a DVD-Player for DVDs or a reader for ebooks. The supply of end devices could be analyzed by sales figures to determine the interdependency between information goods and end devices.

Media reviews are reports which analyze and evaluate information goods. They are published by product specialists in newspapers, trade journals and portals. For example media reviews can be found in portals like extremetech.com or computershopper.com. To prove the quantity of media reviews, the number of reviews in the different sources has to be counted.

Additional applications, content and media are supplementary products and background information to the basic product, e.g. Apps for the iPhone, making of-movies, special interest titles etc. Press releases and product related data sheets reveal information about available additional applications.

Content and software suppliers are publishers of complements to the basic product, e.g. complementary software. For measurement the number of suppliers has to be counted.

Accessories include all the components which complement the basic good. The complementary goods can be "essential" or just "nice to have". Those are for example: Protection covers or headsets. To examine the number of accessories, former and current offers have to be analyzed.

Professional trainings are professionally organized workshops for end-users to learn how to handle the information good. For measurement their numbers have to be counted.

Our aim was to find out whether the proposed product features and network effects are measurable at all and whether they can be related to distribution figures of the information good as the relevant indicator for success. Since the developed indicators are supposed to be universal, we don’t expect that they are all applicable or measurable when applied to a distinct case.

4. RESEARCH AND FINDINGS ON MOBILE OPERATING SYSTEMS

In this section the different indicators for product features and network effects will be applied to our case – mobile operating systems. Firstly, it is checked whether the defined indicators can be observed at all. Secondly, the possibilities of actually measuring the indicators are examined. Thirdly, we are looking for interdependencies by mapping data for the different criteria with the installed base, i.e. the number of units of the information good sold. Where possible we worked with time graphs, e.g. between mobile OS distributed and postings in forums. Indicators we weren’t able to assess are mentioned in our findings.

The market of mobile operating systems is rapidly growing. Because sales figures of mobile operating systems are not available, we measure the installed base in end devices. Sales figures about end devices are easily accessible through several market research companies. End devices are strict complements because no mobile OS can be used without an appropriate handset. According to Gartner the smartphone market (mobile communication devices – tablet pcs were not considered) increased from 15 percent in Q1 2010 to 24 percent in Q1 2011 (Gartner, 2011). Each Smartphone needs a sophisticated mobile operating system. For this reason Gartner predicts a growth of 136% in the mobile operating systems market from 2011 to 2015 (Gartner, 2011). Currently there are more than 161 million iOS devices (Apple, 2011) and more than 113 million Android devices sold (Gartner, 2011). Further data on the mobile OS distribution is following in the next sections.

4.1 Product features that support network effects

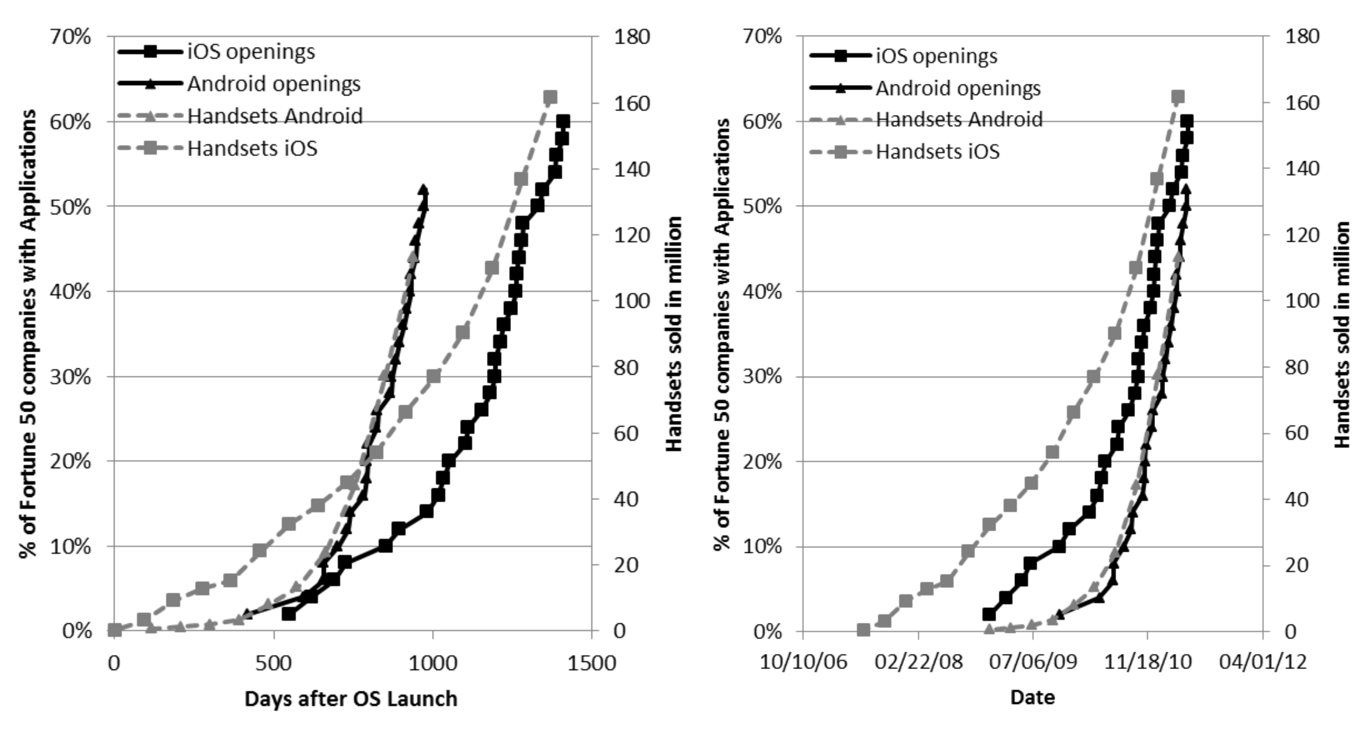
4.1.1 Direct network effects

Integrated technologies weren't observed, because they are mostly standardized communication technology, for example GSM technology. *Integrated communication applications* like email or short messaging services are independent of the respective OS. Both cannot indicate support for network effects for a single OS and have therefore not been examined in this paper.

4.1.2 Indirect network effects

Considering *System interfaces* we analyzed the opening of big IT Systems like banking or public transportation systems towards a mobile OS, that makes these IT Systems complementary to the OS. To get an opportunity to measure the opening of big IT Systems we regarded the first fifty companies of the Fortune 500 List (CNN, 2011) and searched the Apple Appstore and the Android Market for applications of these big companies. We assumed that these companies had to open their IT-Systems to the application (e.g. Bank of America has an online banking application, to do banking the bank system must be opened towards the application).
Unfortunately there is no declaration of the release date of applications in the application stores. The only declaration is the date of the last update. So we decided to use the oldest available date of user reviews or the date of the last update. The results of this short analysis are mapped in figure 1 with the growth of the handset distribution. The growth of the handset distribution belongs to the right y-axis. The left diagram shows the growth in days after the launch of the mobile OS. The right diagram shows the growth by date.
The curves of the system openings (left y-axis) are all very similar to the handset distribution. Exactly like the applications in general the iOS opening had a headstart against the Android OS, but the Android OS has a stronger growth. Based on this, the iOS system today shows stronger network effects in terms of the number of system interfaces than the Android OS, but this is probably going to change in the near future because the acceleration rate for Android is clearly higher.

FIGURE 1: GROWTH OF EXTERNAL IT SYSTEM OPENINGS



Sources: Apple 2011, Gartner 2011, CNN 2011, Android Market 2011

iOS is a propriety system which does not grant *access to* its *source code*. Android is officially named *open source* but is mainly developed by Google. Therefore there is no real open source developer community for both systems. Vision mobile, a market analysis and strategy firm which is specialized in the mobile sector, has released a study about the openness of open source projects. Openness is measured in four indicators (Vision Mobile, 2011):

1. **Access**: availability of the latest source code, developer support mechanisms, public roadmap, and transparency of decision-making
2. **Development**: the ability of developers to influence the content and direction of the project
3. **Derivatives**: the ability for developers to create and distribute derivatives of the source code in the form of spinoff projects, handsets or applications.

4. **Community**: a community structure that does not discriminate between developers

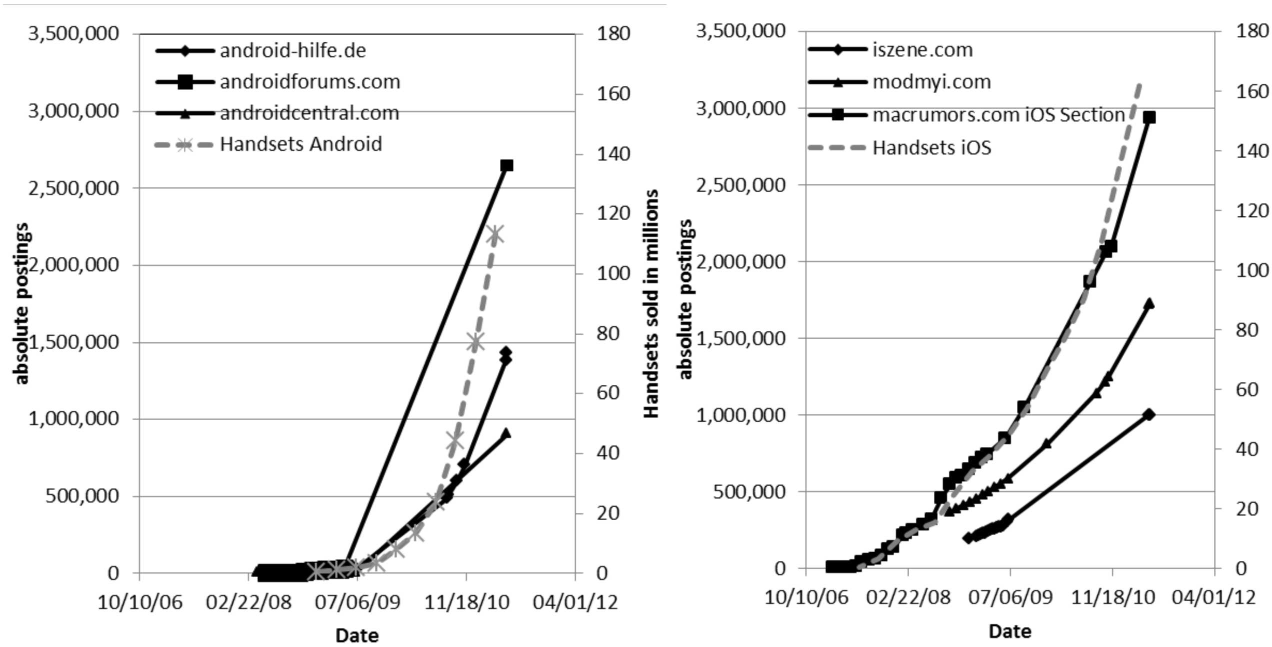
According to this study Android is the open source project with the lowest openness with an Open Governance Index of 23 percent openness. All other researched projects have at least 58 percent, e.g. Symbian. The highest Open Governance Index of 84 percent is attributed to the Integrated Development Environment (IDE) Eclipse.

4.2 Network Effects

4.2.1 Direct network effects

To prove *mutual support* between users we measured the growth of threads and posts in internet forums about the mobile OS. To find suitable forums we used the Google search function and looked at the three forums with the biggest user base. To get older values of threads and numbers of postings we used the Internet Archive (a non-profit organisation which collects and saves older versions of websites and other digital content, compare www.archive.org), where older images of web pages are available. The following graph in figure 2 shows the growth of the postings in the biggest Android and the biggest iOS forums combined with the distribution of handsets of iOS and Android (Apple, 2011; Gartner, 2011). The growth of the handset distribution belongs to the right y-axis again. The graphs show that the postings increase in line with the growth of the handset distribution. Both mobile OS show strong direct network effects represented by mutual support.

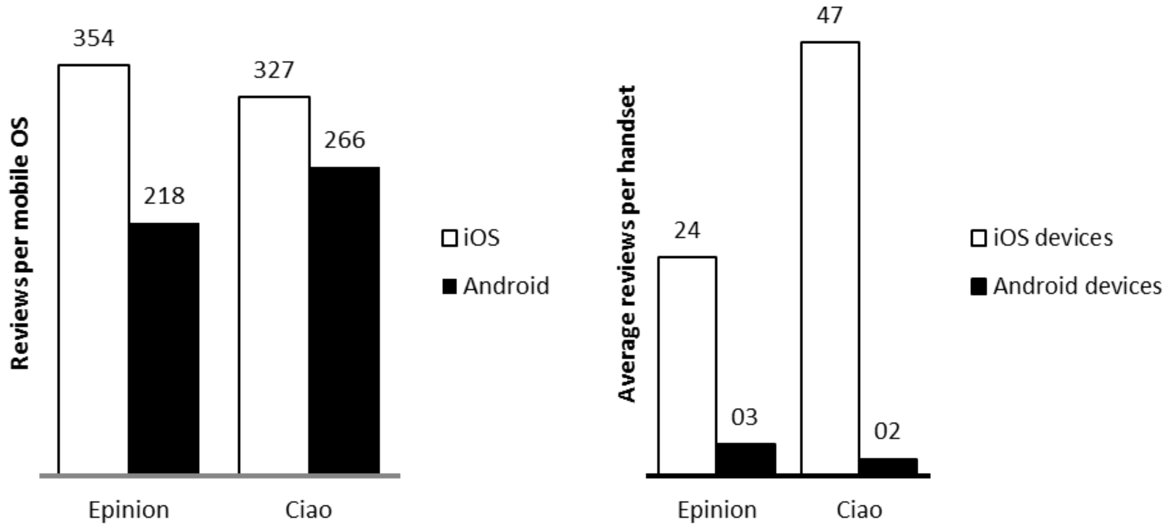
FIGURE 2: POSTINGS ABOUT THE MOBILE OPERATING SYSTEMS IN SPECIFIC FORUMS



Sources: Apple 2011, Gartner 2011, Internet Archive 2011, own research

We measured *product evaluations* by the numbers of consumer reviews at the two consumer review portals ciao.de (2011) and epinions.com (2011). The number of product reviews are indications of product know how available on the market and of the likelihood that people will communicate about the product or certain product features (communication likelihood). Higher numbers indicate quantitatively more consumer product know how and communication likelihood. Unfortunately only static numbers of product reviews are obtainable. The numbers are shown in figure 3. At both consumer review portals epinion and ciao the iOS has more reviews on handsets than the Android OS. This indicates more consumer product know how and communication likelihood of the iOS compared to the Android OS. Furthermore the information asymmetry considering iOS seems lower with regard to the reviews per different handset. Ciao database has 146 Android devices and 7 iOS devices listed, epinion database has a total number of 64 Android devices and 15 iOS devices. The data show that each iOS device, for example the iPhone 3G has 23.6 reviews on average at epinion and 46.7 on average at ciao. In contrast to that each Android device, for example the htc nexus, has only 3.4 reviews on average at epinion and 1.8 on average at ciao. Figure 3 shows the results on the right: iOS has far more reviews per handset than Android.

FIGURE 3: CONSUMER REVIEWS AT EPINION AND CIAO

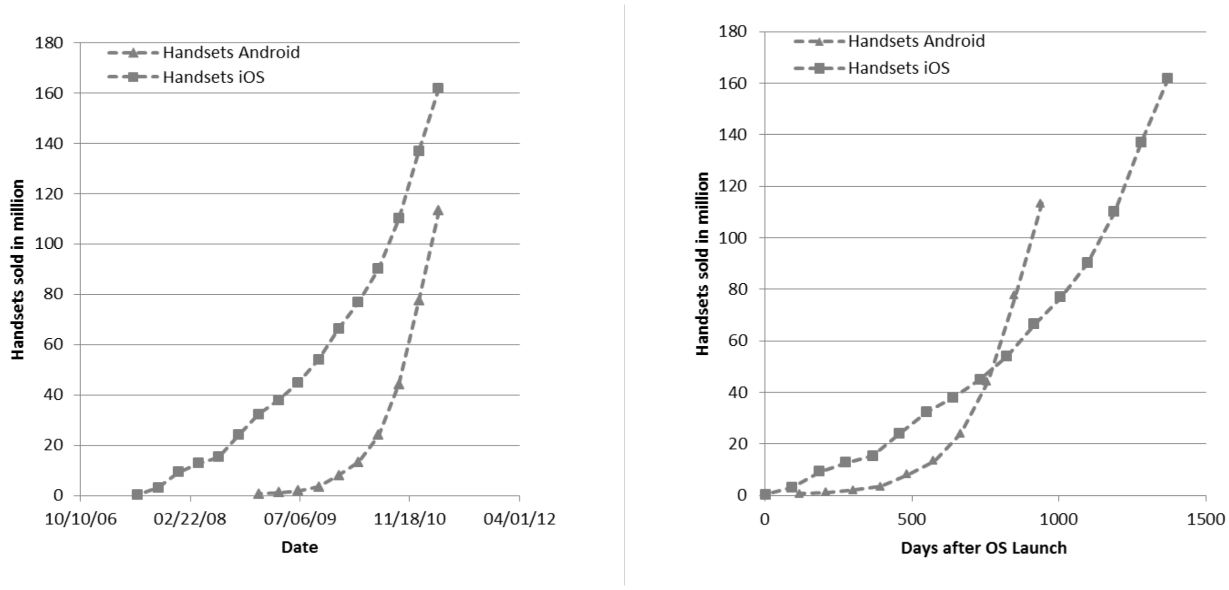


Source: ciao.de 2011, epinions.com 2011

4.2.2 Indirect network effects

End devices are strict complements because no mobile OS can be used without an appropriate handset. The effect of this complementarity is, that the distribution of the mobile OS and the end devices are equal. Figure 4 shows the distribution of iOS and Android Handsets. iOS has more handsets sold, but the growth rate of Android is much stronger.

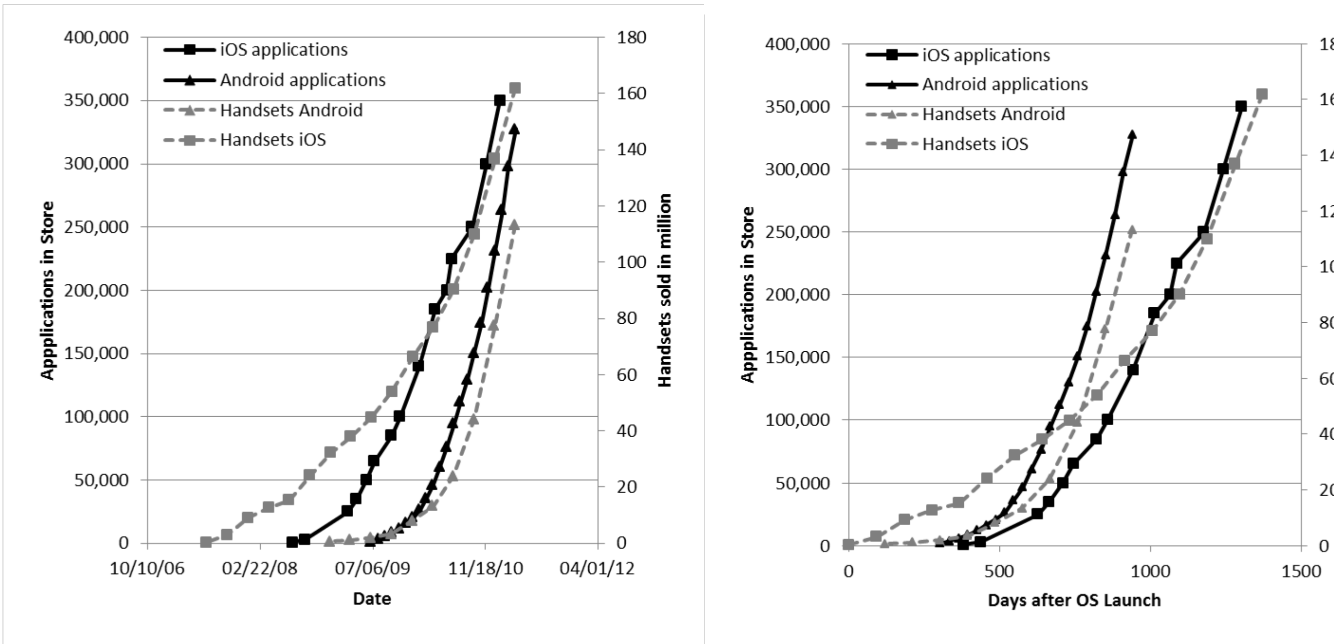
FIGURE 4: GROWTH OF END DEVICES



Source: Apple 2011, Gartner 2011

Parts of the inbuilt mobile OS functionalities are *additional applications* for example a clock, browser etc. With the opportunity of upgrading the functionality through new applications the user gets a bigger utility of his device. A big installed base is stimulating developers to produce applications. New applications are again stimulating consumers to purchase a phone with the appropriate OS. Figure 5 shows the growth of available applications of each mobile OS combined with the growth of the handset distribution. The figure shows that the growth of the applications are in line with the growth of the handset distribution. The Android OS has a stronger growth than the iOS. But as the figure shows the iOS currently has a bigger availability of applications. With the stronger growth of the Android OS applications Android is most likely to take the lead in the near future. At the moment the iOS has bigger network effects in terms of additional applications. But the analysis reveals that the Android OS has gained momentum and is most likely to overtake the iOS system in terms of additional applications in the near future.

FIGURE 5: GROWTH OF APPLICATIONS

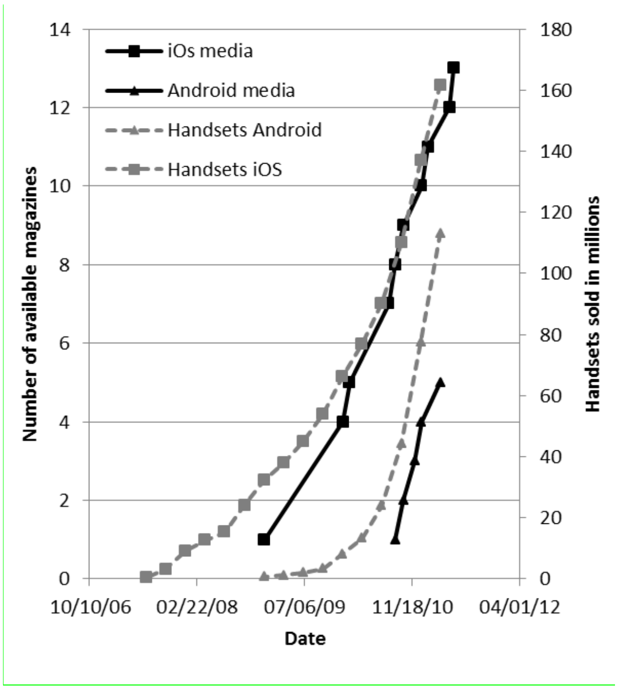


Source: Apple 2011, androlib.com 2011, Gartner 2011

We tried to get a hold of exclusive application numbers, i.e. applications only available for one OS. To get numbers we identified the top ten applications in two categories. The categories were total apps (top apps paid, top apps free) and top apps productivity (paid and free) in both application stores. In the second step we analyzed the other application store regarding the observed top applications and vice versa. We searched for the exact counterpart in the application store of the other OS (same developer, same name etc.) and skipped substitutes. Then we calculated the percentage of applications which are available only in one store. Both OS's had an exclusive application percentage of 60% in our analysis.

Additional media like press products are another kind of complement being analyzed. We looked at the offerings of several newsstands and recorded all magazines dedicated to mobile operating systems. In a second step we researched the release of the first issues of the magazines. The results are shown in the graph below. Figure 6 displays that the press releases are going along with the growth of mobile OS users. So far iOS has significantly more press products reporting on related subjects. Android is far behind in this field.

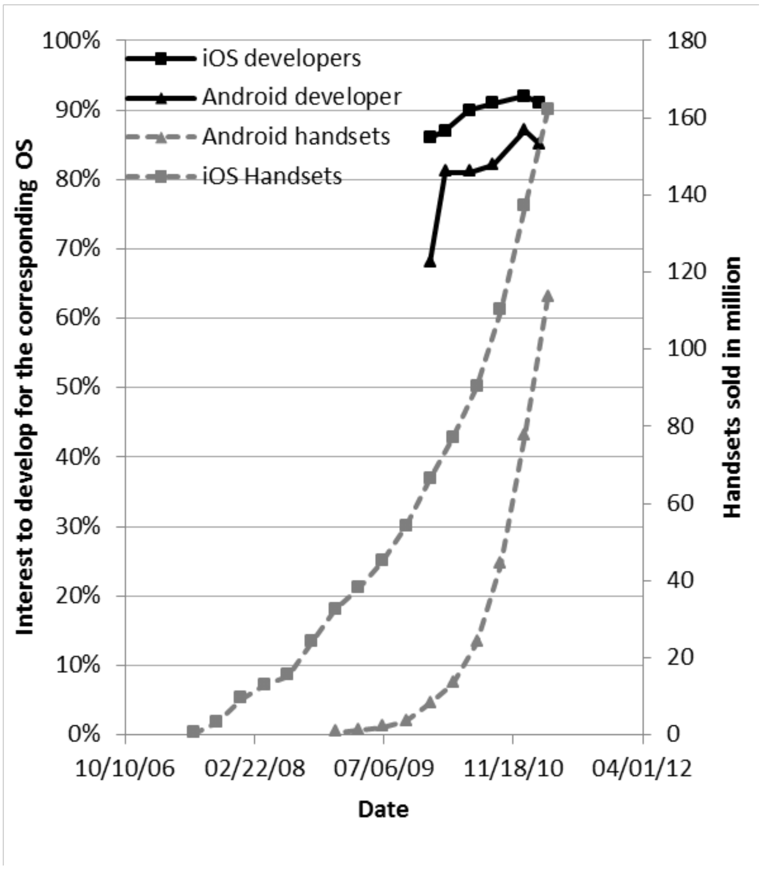
FIGURE 6: GROWTH OF ADDITIONAL MEDIA



Source: Apple 2011, Gartner 2011, own research

IDC surveyed *content and software suppliers* (IDC 2011) to show how interested software developers are to produce applications for a specific mobile OS. In figure 7 IDC data are compared with the handset distribution of the specific mobile OS. Unfortunately IDC data only cover the years 2010 and 2011. Nevertheless the available data show an increase in developer interest in line with the growth of the handset distribution. It also displays that the number of iOS-developers is slightly higher than those for Android.

FIGURE 7: INTEREST OF DEVELOPERS TOWARDS A SPECIFIC MOBILE OS



Source: Apple 2011, Gartner 2011, IDC 2011

According to our research there are no *professional trainings* being offered for end users teaching them how to handle one of the mobile OS´s.

4.3 Findings

The aim of our research was to develop indicators for network effects and relate them to a certain case, here mobile operating systems. We found two sorts of indicators: those for product features just supporting network effects and those really representing network effects. Though we were able to track most of our indicators, the following could not be observed on mobile operating systems: integrated technologies, integrated communication applications, file formats, data or information exchange, media reviews, additional content and accessories.

As a product feature, integrated technologies are mostly standardized, for example the GSM technology. These technologies are not system dependent and are therefore not examined here (compare 4.1.1).

Integrated communication applications are also mostly system independent like short messaging service or email, therefore we haven't included these applications either. File formats weren't examined either. Many file formats are accessible through mobile OS's. But it is difficult to get data about the file format support because there are different ways of support. There is native support through the OS as well as support through additional applications.

As a possible measure for network effects we initially considered data exchange. Data exchange is mainly driven by standardized communication technologies and additional applications. So there is no individual influence of the OS towards data exchange. Hence we dropped this criterion referring to OS. Information exchange couldn't be assessed because the number of communication processes between users is not measurable. Information exchange can become manifest in for example a direct talk, in a telephone message or via electronic chat. Because communication acts are very heterogeneous and fast moving an all-encompassing measurement is too complex. Media reviews are too scattered to be examined in our short research period. Measuring additional content is also a challenge because additional content like movies or music is mainly available via additional applications. In a first step it would be necessary to identify the applications which are delivering additional content to the OS and in a second step to measure the quantity and quality (e.g. bitrate) of the additional content delivered. Getting data to measure this retrospectively is very difficult. Accessories are mainly handset accessories and not OS accessories.

A summary of our findings is displayed in table 3. Where possible we have qualified existing network effects ranging from no effect (0) to strong effects (+++).

TABLE 3: PROOF OF INDICATORS FOR NETWORK EFFECTS ON MOBILE OPERATING SYSTEMS

	Direct network effects	iOS	Android	Indirect network effects	iOS	Android
Product features that support network effects	Integrated technologies	n.a.	n.a.	File formats	n.a.	n.a.
	Integrated communication applications	n.a.	n.a.	System interfaces	+++	++
				Source code access (Open Source)	0	+
	Direct network effects			**Indirect network effects**		
Network effects	Date exchange	n.a.	n.a.	End devices	+++	++
	Information exchange	n.a.	n.a.	Media reviews	n.a.	n.a.
	Mutual support	+++	+++	Additional applications	+++	++
	Product evaluations	+++	++	Additional content	n.a.	n.a.
				Additional media	++	+
				Content and software suppliers	+++	++
				Accessories	n.a.	n.a.
				Professional trainings	0	0
0 = no effect + = weak ++ = medium +++ = strong n.a.= not available						

The analysis did provide strong evidence towards the existence of network effects according to most indicators – though time-consuming at times. Overall both mobile operating systems show very strong network effects. It is obvious that the iOS System at the moment exhibits stronger network effects. More iOS-handsets have been sold resulting in a bigger application and user base. More of the big IT-Systems are connected to iOS (system interfaces), it has to deal with lower information asymmetries in terms of a higher number of product evaluations, more press products are reporting on it, and there are more content and software suppliers. The communication and mutual support between users seems more or less equal. At the end of our research it became obvious that the growth rate of the Android OS is stronger and it will most likely replace the iOS system as system with stronger network effects. The only advantage for Android we observed is the source code access. Even though the Open Governance Index is rather low it will most likely help to further accelerate network effects. This in turn should boost the sales numbers of the Android System.

4 SUMMARY AND IMPLICATIONS FOR FUTURE RESEARCH

The aim of our research was to describe and measure network effects in more detail than so far done. For this reason we developed different sorts of indicators. On one hand those that are related to the product itself. Certain product features such as integrated technologies (e.g. UMTS, Bluetooth) or system interfaces (e.g. graphical user interfaces) are just fostering network effects. They had to be distinguished from those indicators that are actually representing network effects and make them measurable. We identified five product features, two relating to direct and three relating to indirect network effects. As potentially measurable indicators for network effects we determined four corresponding to direct and eight to indirect network effects. The first test of this conceptual framework being introduced in this paper shows that network effects can very well be operationalized and explored further. By applying our indicators to two operating systems we found that most of them were verifiable. As a result of this first test we can state that all indicators developed are existing. Some of them are not assessable with regards to mobile operating systems. Especially for direct network effects only two out of six of our indicators (mutual support and product evaluations) were observable. Far more confirmation can be stated for indirect network effects. More indicators that were mostly measurable (seven out of eleven) could be found. One important question showing up is to further investigate on the importance of direct vs. indirect network effects for the growth of an installed base of an information good.

Furthermore this analysis was able to identify a relation between network effects and the OS distribution. It is obvious that there is reciprocity between the growth of the installed base and network effects. Nevertheless differences shown between both OS can so far not be interpreted as causal relationships between information good and associated network effects. We assume that a growing installed base is fueling network effects and those again drive the growth of the installed base. A strong prediction that derives from our data is, that the Android OS will soon overtake the lead in numbers of the installed base and in terms of network effects as well.

Without more detailed data in terms of shorter time periods (daily vs. monthly) there is a limitation to our research. To define the impact, the direction and the interdependency of network effects there is a strong need for more detailed data. For example a continuous weekly or even daily and not just an unsteady collection of the growth of users and postings could show the impact of new device releases on the user base of forums to estimate for example mutual support more precisely. To identify the impact of a growing user base in forums in relation to handset sales there is a requirement for a user poll, which could exhibit the importance of low information asymmetries which equals high product transparency in the pre-purchase phase. If the poll would reveal that high product transparency in the pre-purchase phase is important for future handset sales, then it is evident that a growing forum user base is an important factor to influence handset sales positively. Another example of useful, more detailed data would be the measurement of daily device sales. With this information the impact of exclusive application releases on the distribution could be identified. So the main goal to expedite this research would be to obtain more detailed data to work with. The framework developed to identify network effects should also be tested further with other information goods.

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