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OTT-Messaging and Mobile Telecommunication: A Joint Market? - An Empirical Approach

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Abstract

OTT-messenger such as *facebook*, *WhatsApp* have gained wide popularity among mobile users while traffic of text messaging has been in strong decline in several countries. This work is the first to provide an empirical analysis how consumption of OTT-messengers affects demand for text messaging and mobile telephony services. Our findings suggest that social and messaging apps may complement demand for text messaging and mobile voice services. More generally we identify the different nature of mobile telecommunication services as key element to explain why reductions of text messaging traffic have been so drastic in some countries and why an analogue development for mobile voice is rather unlikely.

JEL classification: L96, L43, L51, C33, C36,
keywords: OTT-messenger, mobile telecommunication, market definition, regulation, mature markets, communication behavior

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1 Introduction

1,86 billion monthly active users on *facebook*, 1,2 billion on *WhatsApp*, 1 Billion on *facebook messenger* (Facebook 2017): There is no doubt that usage of over-the-top (OTT) messengers, who rely on the Internet to provide their communication services to consumers, have become mainstream in society. At the same time the mobile telecommunication industry has seen in various countries a strong decrease in usage and thus affected revenues of text messaging services (Bundesnetzagentur 2015, Ofcom 2015, AGCOM 2015). For example consumption of text messaging declined in Germany -41%, Italy: -40%, UK: -15.3%.[1] Though the rise of OTT-messengers may provide a reasonable explanation for this development, empirical research on this topic is still quite narrow. Related literature has covered fixed-to-mobile substitution (e.g. Barth and Heimeshoff 2014b), fixed-to-mobile and voice-over-ip (VoIP) substitution (Lange and Saric, 2016), analyzed competitional effects by OTTs from a theoretical perspective (Peitz and Valletti 2015, Feasey 2015) or instead analyzed the effect on text messaging and mobile voice services from data consumption in general (e.g. Gerpott et al. 2017). But none of these studies has directly addressed the effects of OTT-messenger usage on text messaging and mobile telephony with an empirical approach.

However the definition of the relevant product market for OTT-messengers is indeed highly relevant as the recent wave of mergers in the mobile industry underlines.[2] Further the mobile industry has been historically facing various regulations which do not apply to the same extend for providers of OTT-messengers (Peitz and Valletti 2015). This includes topics in data privacy but also regulation of roaming fees or termination rates. These would be in question if an analysis concludes that both types of communication services form a joint market.

This paper provides novel contributions to the empirical literature on mobile telecommunications on various levels. This work is, to the best of our knowledge, the first

[1] Numbers refer to 2014, include traffic for MMS for the UK.

[2] See for example: M.6497 Hutchison 3G Austria/Orange Austria, M.7637 Liberty Global/BASE Belgium, M.7018 Telefónica/E-Plus, M.7419 TeliaSonera/Telenor/JV, M.6992 Hutchison UK/Telefónica Ireland, M.7758 Hutchison 3G Italy/WIND/JV, M.7978 Liberty Global/Vodafone/Dutch JV, M.7944 Altice/PT Portugal, M.7421 Orange/Jazztel, M.8131 Tele2 Sverige/TDC Sverige and M.7612 Hutchison 3G UK/Telefónica UK.

to provide an empirical analysis how consumption of OTT-messengers affects the demand for text messaging and mobile telephony services. Further it is the first work to disentangle the effect of network size and incoming traffic both for text messaging and mobile voice demand. Finally it is also the first study which is based on daily consumption data from mobile users.

In particular we employ individual data of around 900 users from Norway which has been collected by a personal analytics app - *Device Analyzer* - between 2013 and 2014. By applying a linear panel estimation with instrument variables we are able to isolate the causal effect of OTT-messengers on daily demand for text messaging and voice services. Thereby the fine granulation of our data set enables us to control for various shifters of daily demand on an individual level. Our findings suggest that social and messaging apps complement demand for text messaging and mobile voice services. Those who interact with messaging apps on average 16 times more per day are ceteris paribus more likely to send one more text message per day. Lower demand effects are found for usage of social networks or phone calls instead. More generally we identify the different nature of mobile telecommunication services as key element to explain why reductions of text messaging traffic have been so drastic in some countries and why an analogue development for mobile voice is rather unlikely.

The remainder of the paper is organized as follows: Chapter 2 gives an overview on related literature. Chapter 3 describes the data used and the applied econometric model. Section 4 presents the results and robustness checks. Chapter 5 concludes.

2 Literature Review

Already before the rise of OTT-messengers the assessment of competition between different mobile services has been a major interest in mobile telecommunication research, also to define the relevant product market.[3] For example Kim et al. (2010) use monthly customer data from an undisclosed provider in Asia. They estimate a two-stage discrete/continuous choice model and find that voice and text messaging

[3] Apart from assessing competition between firms in the market (e.g. Dewenter and Haucap 2008, Karacuka et al. 2011).

are substitutes for consumers. Instead Grzybowski and Pereira (2008) find that text and voice are complements for Portuguese consumers. Their Tobit estimation is based on monthly data from telephone bills between 2003 and 2004. Andersson et al. (2009) provide an explanation for the divergence in these results: Based on quarterly data between 1996 and 2004 they find that text messaging and voice turn from substitutes into complements as their network size increases. Noteworthy is also the paper by Basalisco (2012) who estimates text messaging demand for *Vodafone* customers in various countries of the EU between 2002 and 2007. Following early contributions in the theoretical and empirical literature (Larson et al. 1990, Appelbe et al. 1992, Appelbe et al. 1988) he finds that an increase in incoming messages by 10% creates a 3.3% increase of outgoing messages. These may, jointly with network effects, lead to a multiplier effect on demand and failing to account for their confounding influence may lead to inflated demand estimates.

More recently a large strand of literature has extended the analysis of the relevant market and included fixed network services (Barth and Heimeshoff 2014b,a; Grzybowski 2014; Grzybowski and Verboven 2016; Lange and Saric 2016, or see Vogelsang 2010 for an overview on previous literature). Covering various markets in the EU these studies identify mobile telephony as the causal effect for the decline of fixed networks. Indeed quite close to the focus of this work is the analysis by Lange and Saric (2016) who also consider competition effects by VoIP services of OTTs such as *Skype* or *Viber*. Among others they find weak long-run substitution effects between VoIP services and fixed networks. However their analysis does not account for OTT-messengers like *WhatsApp* or *facebook* which are particularly popular among mobile users.

Further papers on OTT-communication services cover this topic only on a more general level. On the one hand they provide a theoretical analysis: e.g. Peitz and Valletti (2015) analyze role and functionality of OTT-services and how their presence changes the assessment of competition in the market; Feasey (2015) describes strategies by the mobile telecommunication industry to compete with OTT-messengers. On the other hand they solely focus on OTT-communication services: For example Scaglione et al. (2015) forecast the diffusion of social networks in four G7 countries; Oghuma et al. (2015) compare usage intentions for different

OTT-messengers.[4] Or finally, because it remains unknown what has actually been measured: some studies relate more generally mobile data consumption instead of OTT-messenger consumption to text messaging and voice usage (e.g. Gerpott et al. 2017, Gerpott and Meinert 2016, Gerpott 2015 or for literature overview Gerpott and Thomas 2014). Among others Gerpott (2015) identifies mobile data consumption as a causal effect for the decline of text messaging usage. However as correctly pointed out by the author, it remains unknown if the result implies that consumers have substituted to OTT-messengers or to apps of other categories instead (Gerpott 2015, p. 821). So smartphone users might have simply switched to other apps on smartphones completely unrelated to OTT-messengers. But usage behavior of smartphones might have been also completely constant throughout the period while mobile data consumption has increased due to growing sizes of web content. For example the average size of the top 100 web pages by traffic increased by 71% within the last 6 years (HTTP Archive 2017).

3 Data & Econometric Model

3.1 The Dataset

The data has been gathered as part of the personal analytics app *Device Analyzer* which is run by the Computer Laboratory of the University of Cambridge. Its intended use can be described as "Get statistics about your phone use and contribute to scientific research!". The app is available for Android OS and is offered via the Google Playstore. Technically the app is build on the API's by Google which provide standardized access to phone data on Android OS for developers. The app then takes a full log of the phone activity of participants and provides them with detailed information on smartphone usage such as calls, text and apps used. In return an anonymized version of the data is shared with researchers (Wagner et al., 2014).

The analysis is based on a sub-sample of around 900 people from Norway which

[4]It is acknowledged that usage of OTT-messengers has been also targeted in other disciplines such as Psychology. See for example Montag et al. (2015) in the context of addictive behavior.

have used the *Device Analyzer* between October 2013 and October 2014. For the analysis the raw data has been prepared and aggregated on a daily basis. Further, as we are interested in a service by service usage of communication, apps have been aggregated into two variables:

messenger for apps such as *facebook messenger* or *WhatsApp* whose design and functionality typically resemble text messaging applications on smartphones. A common feature is the communication with a known set of contacts usually via a contact list.

social for apps like *facebook* or *Google+* which usually involve additional functions to socialize with other people, post elaborate texts or media to groups and which can be also commented.

In the data set usage of messaging and social apps is quite common among users with shares of 88% and 94% respectively. Among these the popularity is particularly high for apps by *facebook* (*Facebook*, *facebook messenger*, *WhatsApp*), while other communication or social apps only have a minor importance in the sample.

In general the sample from *Device Analyzer* matches fairly well the overall trend of mobile phone usage in Norway. In figure 1 it becomes apparent that usage of traditional mobile phone services in the sample has been nearly constant during the period of analysis. Further there seems to be some seasonality for these variables between the various days. In the meantime there is a fairly strong increase both for messaging and social apps while the seasonality of these variables is less distinct. According to the Norwegian Communications Authority between 2013 and 2014 the number of text messages send increased by 1% and phone calls by 4.8% (Norwegian Communication Authority, 2015). This is particular remarkable as the overall trend for text messaging in Norway is in strong contrast to other countries in the EU such as Germany. In fact at the same time text messaging in Germany already faced a very strong decline by 41% - solely in 2014 (Bundesnetzagentur (2015), p. 60).

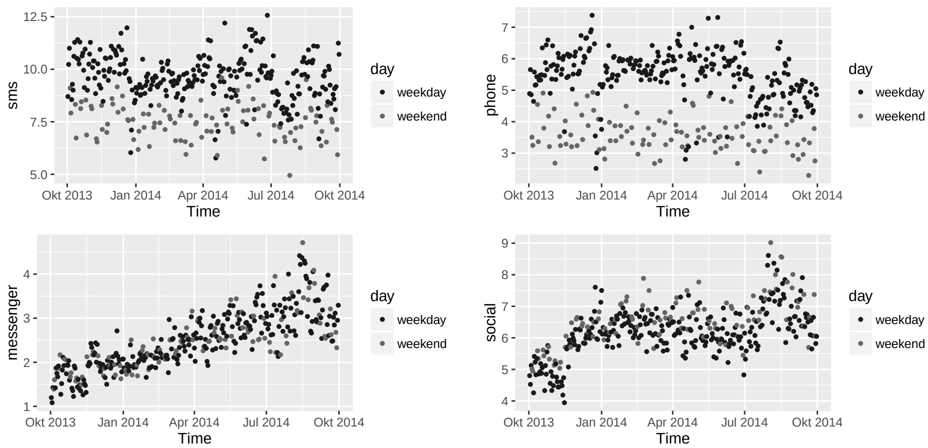

Figure 1: Usage of various mobile services by Norwegian *Device Analyzer* users between October 2013 and October 2014.

3.2 Empirical Strategy

Generally we assume that the demand for mobile telecommunication technology $k \in K = \{sms, phone\}$ is a function of the following variables:

$$Q_k^{out} = f(Q_k^{in}, I_k, P^{sub}, N_k, X) \quad (1)$$

where Q_k^{out} is the quantity demanded for outgoing and Q_k^{in} the quantity of incoming traffic of technology k, I_k is the quantity of information exchanged via technology k within a unit of Q_k^{out}, P^{sub} is a price vector of technology k and its potential substitutes with $P^{sub} = \{\text{sms, phone, messenger, social}\}$, N_k describes the network size of technology k and X is a vector of demand shifters.

In order to get a better understanding what shapes demand for technology k we account for demand effects by incoming traffic and network size. Following previous empirical works (Basalisco 2012, Garin-Munoz and Perez-Amaral 1999, Garıń-Muñoz and Pérez-Amaral 1998, Appelbe et al. 1992, Appelbe et al. 1988) we continue the analysis of these demand effects for both technologies of k. Moreover we control for information length in our estimation as it is likely to be a confounding factor for incoming and outgoing traffic.

For the time frame of the analysis we are going to assume that the choice of the mobile contract is given and assume a constant effect of prices on mobile phone usage. For other markets this might be a quite strong assumption. However, given the narrow time frame of the analysis with 12 months, the daily aggregation of the data and finally the nature of the Norwegian mobile telecommunication market this is in fact less restrictive. First of all in the period of the analysis postpaid subscriptions make up for 75% of the contracts in Norway. At *Telenor*, the largest provider in Norway with 50% market share, nearly all subscriptions include an unlimited or fixed amount of text and calls. Indeed the most popular subscription included unlimited text and calls (Norwegian Communication Authority 2015, p. 28f.). So in the analysis price effects are captured via the individual specific effect α_i. However, as roaming fees may dramatically differ from the within country subscription conditions we account for this by adding the variable R which controls for changes in the roaming status.

Those OTT-messengers which where included in the analysis essentially offer their communication services free of charge.[5] So we employ instead usage levels Q^{sub}_{kit}, both for OTT-messengers as well as mobile telecommunication services in order to measure the effect of these potential substitutes on demand for technology k. The idea is that variations in their consumption reflect ceteris paribus joint changes in supply of that service, e.g. changes in features or functionality of an OTT-messenger. Further, time dummies day have been added for j days of the week as well as public holidays in Norway to control for the seasonality which has been observed in figure 1.[6]

So taking into account the panel structure of our data we specify the daily demand decision for technology k by consumer i at time t as follows:

[5] The communication between clients of OTT-messenger is free of charge. WhatsApp charges as an annual fee of $ 0.99 USD after the first year though its price effect on demand can be considered as marginal (Web Archive, 2017).

[6] In particular this encompasses the following list of holidays and events: Christmas: 25th, 26th December 2013; New Years Eve: 1st January; Mothers Day: 9th February; Valentines Day: 14th February; Easter: 18th, 20th and 21st April; Labor Day: 1. May; Norwegian Constitution Day: 17th May; Ascension Day: 29th May; Whitmonday: 8th, 9th June; St John's Day: 23rd June.

$$Q^{out}_{kit} = \alpha_i + \beta_1 Q^{in}_{kit} + \beta_2 I_{kit} + \beta_3 Q^{sub}_{kit} + \dots$$
$$\beta_4 R_{it} + \beta_5 N_{kit} + \beta_6 \sum_j day_t + \beta_7 holiday_t + u_{kit} \quad (2)$$

Based on our assumptions and our structural model we have to assume endogeneity for two types of variables. First, incoming and outgoing traffic of a technology may be void to a simultaneity bias. Second, as we expect a substitution effect between usage of different communication services, we also need to assume that their estimation is subject to a simultaneity bias. In order to account for this we exploit the time dimension of our panel structure and use lags of the endogenous variables as instrument. This is in line with previous empirical works which have applied these type of instruments both for the case of incoming and outgoing traffic (Garin-Munoz and Perez-Amaral 1999, Garıń-Muñoz and Pérez-Amaral 1998 as well as potential substitutes (Barth and Heimeshoff 2014b, Basalisco 2012). Further to account for unobserved heterogeneity such as contract conditions of the mobile subscription or general affinity to technological change, the model is estimated by the first differences instrument variable estimator (FD-IV-estimator).[7] Transforming our model into first differences setting then yields:

$$Q^{out}_{kit} - Q^{out}_{kit-1} = \Delta Q^{out}_{kit} = \beta_1 \Delta Q^{in}_{kit} + \beta_2 \Delta I_{kit} + \beta_3 \Delta Q^{sub}_{kit} + \dots$$
$$\beta_4 \Delta R_{it} + \beta_5 \Delta N_{kit} + \beta_6 \sum_j \Delta day_t + \beta_7 \Delta holiday_t + \Delta u_{kit} \quad (3)$$

Based on our data our variables are specified in the regression as follows: Q^{out}_{kit} measures the quantity of outgoing text messages or calls and analogue Q^{in}_{kit} the ones for incoming traffic respectively. Since a missed call may trigger a consumer to call back, these variables also include unsuccessful calls to account for that demand effect. I_{kit} is specified with the average length of text messages in characters and

[7] It is acknowledged that the first-difference-estimator goes in with a loss of observations in $t = 1$. However other estimators such as the within-estimator or random-effects estimator are inconsistent when applied with weakly exogenous instruments. (Cameron and Trivedi 2005, p. 758)

call length in seconds, independent of the direction of communication. In Q_{it}^{sub} *sms* and *phone* measure the joint usage of that technology respectively, independent of the direction of communication. For the *app*-variables *messenger* and *social* it has been measured how often the app has been in foreground while the screen is on. N_{kit} is the variety of contacts communication has been exchanged with. R_{it} counts the frequency a periodical check of the roaming status has been positive. Finally all variables are estimated in levels.

4 Estimation Results

The results of the FD-IV estimation for text messaging and voice are presented in table 1 and 2 with heteroskedasticity and autocorrelation (HAC) robust standard errors. Specification 1) and 2) employ respectively the second lag of the differenced endogenous variable as instrument, specification 3) uses instead the third lag.[8] We find for both demand estimations that the results of specification 1) are in line with economic theory. Further most of the coefficients are highly significant at the 1% level and we can also reject the H0-Hypothesis of the F-test at the 1% level that the joint effect of the included variables is zero.

In more detail we find a positive demand effect on text messaging for all potential substitutes, which suggests that these services complement text messaging services in Norway rather than replacing it. A similar effect can be observed for voice calls though with a lower magnitude. These observations are in line with Andersson et al. (2009) who find that services turn from substitutes to complements as their network size increases. Given the high user share for social-, messaging apps and voice calls of users in the data set this may provide an explanation for the positive demand effect.

Among the different communication services we find the strongest effect on text messaging demand for messaging apps (See Table 1). Those consumers who interact with messengers on average 16 times more per day are more likely to sent one additional text message per day. For social apps we find a lower demand effect of

[8]For example we instrument $\Delta Q_{kit}^{\hat{in}}$ with $\Delta Q_{kit-1}^{\hat{in}}$ and $\Delta Q_{kit-2}^{\hat{in}}$ in specification 2) and 3) respectively.

	Dependent variable:		
	sms sent		
	(1)	(2)	(3)
sms received	0.593***	0.502***	0.502***
	(0.015)	(0.019)	(0.019)
phone	0.051***	0.013**	0.011
	(0.007)	(0.006)	(0.006)
messenger	0.061***	0.055***	0.047***
	(0.008)	(0.008)	(0.009)
social	0.020***	0.017***	0.016***
	(0.004)	(0.004)	(0.004)
Thursday	−0.098**	−0.079*	−0.098**
	(0.042)	(0.042)	(0.044)
Friday	0.012	0.031	−0.001
	(0.045)	(0.044)	(0.047)
Wednesday	−0.126***	−0.131***	−0.144***
	(0.043)	(0.041)	(0.040)
Monday	0.028	0.048	0.030
	(0.039)	(0.037)	(0.038)
Saturday	0.352***	0.509***	0.489***
	(0.054)	(0.054)	(0.057)
Sunday	0.255***	0.448***	0.420***
	(0.054)	(0.055)	(0.056)
holiday	0.201***	0.233***	0.216***
	(0.064)	(0.060)	(0.062)
network size		0.503***	0.508***
		(0.040)	(0.040)
sms length	−0.009***	−0.012***	−0.012***
	(0.001)	(0.001)	(0.001)
roaming duration	−0.003	−0.003	−0.003
	(0.003)	(0.003)	(0.003)
F-Statistic	2152	2844	2787
Observations	70,773	70,509	68,654
R^2	0.525	0.552	0.551
Adjusted R^2	0.525	0.552	0.551
Note:	*p<0.1; **p<0.05; ***p<0.01		
	HAC robust standard errors.		

Table 1: FD-IV estimation for text messages sent.

around one third the size, which might be reasoned with differences in design and functionality of both communication services. In contrast messaging apps which are much more focused on communication, social apps also offer other functions: e.g. browsing user profiles, read public posts from other people.

Apart from substitutes the results suggest a dominant role of incoming traffic on the demand decision: 10 more incoming text messages (phone calls) increase demand for that service ceteris paribus by 5 (6) per day. Additionally increasing the information length of text messaging (phone calls) by 83 characters (41 minutes) reduces ceteris paribus demand by one text message (phone call). Further we find for text messaging significant weekday effects with a minimum on Wednesday (-0.126) and peaks on weekends (0.352, 0.255) and holidays (0.201). The opposite is suggested for phone calls with a peak on Fridays (0.130) and minima on weekends (-0.287, -0.471) and holidays (-0.150). Finally we find a negative and small roaming though probably deflated as users spend too few time periods abroad.[9]

The results from both estimations of specification 2) highlight the strong effect of network size on demand for text messaging and voice calls respectively. For text messaging we find an increase of network size by two increases demand for text messages ceteris paribus by one per day. Further we notice that the coefficient for incoming text messages decreases by around 20% though the general interpretation remains. For phone calls we find an effect by network size which is twice as high as for text messaging and also accounts for most of the variation which has been previously attributed to incoming traffic and partly other substitutes. So the effect of substitutes becomes quite small and the effect of incoming traffic turns slightly negative.

The impact of incoming traffic provides an interesting explanation why substitution from the respective communication services is likely to have such a different effect on their demand. In this work we find a strong and significant effect of incoming traffic on text messaging demand but a slightly negative effect for phone calls. This suggests that incoming text messages are perceived as information complements which foster the exchange of more information i.e. write more text messages. In-

[9] In the data set this involves less than 10% of the observations with varying roaming durations.

	Dependent variable:		
	phone calls		
	(1)	(2)	(3)
phone ringing	0.593***	−0.032	−0.025
	(0.022)	(0.021)	(0.020)
sms	0.032***	0.012***	0.010***
	(0.003)	(0.002)	(0.002)
messenger	0.024***	0.012**	0.006
	(0.007)	(0.005)	(0.005)
social	0.011**	0.005	0.005
	(0.004)	(0.003)	(0.003)
Thursday	0.004	0.075**	0.075**
	(0.040)	(0.029)	(0.030)
Friday	0.130***	0.167***	0.171***
	(0.042)	(0.033)	(0.033)
Wednesday	−0.013	0.019	0.012
	(0.037)	(0.028)	(0.029)
Monday	−0.016	0.022	0.029
	(0.040)	(0.030)	(0.031)
Saturday	−0.287***	0.352***	0.356***
	(0.067)	(0.041)	(0.042)
Sunday	−0.471***	0.246***	0.254***
	(0.059)	(0.037)	(0.038)
holiday	−0.150***	0.081*	0.088*
	(0.056)	(0.046)	(0.046)
network size		1.049***	1.042***
		(0.016)	(0.016)
call duration	−0.0004***	−0.0003***	−0.0003***
	(0.00003)	(0.00002)	(0.00002)
roaming duration	0.005**	0.005**	0.005**
	(0.002)	(0.002)	(0.002)
F-Statistic	1261	5578	5039
Observations	70,941	70,905	69,051
R^2	0.213	0.508	0.505
Adjusted R^2	0.212	0.508	0.505
Note:			*p<0.1; **p<0.05; ***p<0.01 HAC robust standard errors.

Table 2: FD-IV estimation for phone calls.

stead, having received a phone call makes a person less likely to exchange more information or to conduct further calls. Intuitively this makes sense as a phone call allows a bi-directional exchange of information while a text message is restricted to one direction. So for text messaging the demand reduction caused by substitution effects is particularly strong, as a decrease in usage already creates a negative multiplier effect already before anyone has left the text messaging network. Interestingly for phone calls this demand reduction does not happen before people actually leave the network - though of course a periodical leave would be sufficient. Given this background it is unlikely that the market for phone calls faces a similar fast demand reduction as currently attributed to OTT-messengers in the text messaging market.

The findings of this work on the relation between incoming and outgoing information also add to an interesting discussion from previous studies. A common assumption in the theoretical literature on telephony (e.g. Kim and Lim 2001, Jeon et al. 2004) has been that consumers gain utility from incoming and outgoing traffic respectively but that their utility does not depend on each other. This separability assumption has been criticized as unrealistic by Cambini and Valletti (2008) and empirical findings from Basalisco (2012) as well as on international fixed telephony (Appelbe et al. 1988, Appelbe et al. 1992, Garin-Munoz and Perez-Amaral 1999, Garıń-Muñoz and Pérez-Amaral 1998) seem to back this result. Indeed the findings of this work suggest that this is only partially true for mobile services as the separability assumption does not apply for text messaging but likely for voice services. Thus the findings of this work on the mobile market shed new light on this topic and stress the importance for a more differentiated view on the separability assumption.

In order to ensure the validity of the results we have performed various robustness checks. As weak instruments may create a large estimation bias (Bound et al., 1995), we test our instruments to ensure their relevance. However the instruments used in this estimation seem to be quite strong. In the first stage all instruments for the respective endogenous variables are significant (p-value = 0.0000) which is further supported by the F-statistic which is higher than 10.

Another threat to the validity of our instruments might be serial correlation. As we employ lags from the (endogenous) regressors X_{it} as instruments we assume for the error term u_{it} that $E[X_{it}u_{it}] \neq 0$ but $E[X_{it-1}u_{it}] = 0$. However, this is not valid in the case of serial correlation when $E[u_{it}u_{it-1}] \neq 0$ and thus $E[X_{it-1}u_{it}] \neq 0$. Inspection of the autocorrelation and partial autocorrelation functions suggests that serial correlation of a MA(1) type is present. In line with Anderson and Hsiao (1981) we use lagged differences of order 3 as instruments instead. Though this induces only slight changes in the coefficients as becomes obvious in the comparison of specification 2) and 3) for the respective estimations. Further, as noted before, the standard errors are still valid as these have been HAC corrected.

As the analysis is based on unbalanced panel data the results might be void to an estimation bias if entry or attrition occurs in a non-random fashion. Certainly we have to assume that participants who make use of the *Device Analyzer* app are more likely to use their phone than the average mobile user. But this also implies that there is sufficient variation in usage of various communication services. Further we can assume that the type of participants is fairly constant over time within the sample. If we would expect that the composition of subjects changes systematically within the sample over time then the results of the estimation should alter when adjusting the time period of the analysis. However, we ran our set of regressions for different time periods and find no change in significance or interpretation of the regression results. We also find similar results when we test different specifications with monthly or yearly time dummies.

5 Conclusion

This paper is to the best of our knowledge the first to provide an empirical analysis of the demand effect by OTT-messengers on text messaging and mobile phone services. Based on a unique data set with daily aggregation level we employ a FD-IV-estimation and find that OTT-messengers complement usage of text messaging and mobile voice services for consumers in Norway. Thereby the fine granulation of our data set enables us to control for various demand shifters on an individual level. We find that those who interact with messaging apps on average 16 times more per day are ceteris paribus more likely to sent one more text message per day.

Lower demand effects are found for usage of social networks or on demand effects for phone calls instead.

Further we also identify the nature of mobile telecommunication services as key element in order to explain why the reduction of text messaging has been so drastic in some countries. In contrast to mobile telephony, text messaging as a one-way-communication service is also largely driven by incoming traffic. So it is already sensible to traffic reductions even before changes in network size take place. This does not apply for mobile telephony which makes it rather unlikely that this market faces a similar drastic demand reduction in the future as currently happening in the text messaging market. Our findings are in line with the overall development of the mobile telecommunication market in Norway and previous findings in the literature (Basalisco 2012, Andersson et al. 2009). Moreover various robustness checks have been conducted and different specifications have been tested in order to ensure the validity of our results.

This work has provided an analytical framework and estimates of OTT-messenger usage on demand for mobile telecommunication services in Norway. Further need for research remains on the one hand for other countries and time periods in which traffic reductions of text messaging have been quite drastic. Thus being able to describe a more complete picture of the overall effect of OTT-messengers on the mobile telecommunication market. On the other hand as the European mobile Telecommunication market is about to converge it remains interesting to see whether markets have been affected by OTT-messengers in a similar way or whether market singularities are still persistent and why.

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