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More than Words: A global analysis of the socio-economic impact of Rich Interaction Applications (RIAs)

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More than Words

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A global analysis of the socio-economic impact of Rich Interaction Applications (RIAs)

René Arnold¹, Christian Hildebrandt¹, Serpil Tas¹, Peter Kroon¹

Abstract

Applications such as iMessage, KakaoTalk, LINE, Signal, Skype, Snapchat, Threema, Viber, WhatsApp and WeChat have become an increasingly popular means of personal and business interaction. Surprisingly little academic effort has gone into understanding the nature and origin of these applications, yet. Policy makers and regulators on the other hand have developed pragmatic definitions of a group of applications that mimic functions of traditional Electronic Communications Services (ECS). Our paper explores whether this approach gives proper consideration to these applications' nature. Based on our indicative framework for delineating them from other OTT services, we use econometric modelling to approximate their global economic impact. We find that any static definition of these applications is bound to fall short of reality within a few months due their rapid innovation cycle. Nonetheless, we are able to identify functions that enable rich interactions among consumers and businesses as the common thread of 139 applications that we analysed. Thus, we sum them under the banner of Rich Interaction Applications (RIAs). Their constant innovation implies that they develop from baseline communications channels to applications that offer an increasingly large part of a 'full internet experience'. With this in mind, our analysis places their economic impact between baseline telecommunications services' and the internet' impact. For a 10% increase in RIAs usage GDP for the 164 countries in our panel rises by 0.33% based on the years 2000 to 2015. In sum, policy makers and regulators ought to strive for framework conditions that enable or even better facilitate innovation as well as dynamic competition. Ultimately, these are the ingredients for realizing the largest benefits for consumers and the economy.

Keywords: Competition, Regulation, Consumer Behavior, Telecommunications, Internet, ICT, OTT, Internet Services, Technological Change, Technology Adoption, Regulated Industries.

JEL Classification: L510, L860, O330, K230

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1 Introduction

In recent years, applications such as iMessage, KakaoTalk, LINE, Signal, Skype, Snapchat, Threema, Viber, WhatsApp and WeChat have become an increasingly popular means of personal and business interaction. In addition, there has been a rapid increase in the number of apps targeted at specific usage situations, such as Slack (enterprise), Disney MIX (youth and families) or Care Messenger (healthcare), and locally relevant ones, such as Hike (India), Jongla (Nigeria) and 2go (South Africa).

All of these applications enable consumers to interact in ways not possible through traditional communications channels, such as group chat, photo and video sharing. Moreover, as providers of such applications have competed with each other by innovating and rapidly adding new functionality, the range of features developed and offered has grown to include nearly the full range of common internet activities, including integration with services such as advertising and payment.

Given their popularity, these applications have sparked interest in researchers from various fields just as well as in policy makers and regulators. Despite this interest, little research has so far been conducted to understand the nature of applications such as iMessage, WhatsApp and Facebook Messenger, their origin and marked differences to other Over-The-Top (OTT) applications and services. Since it is difficult to capture the impact of something that is not well-understood, this gap in the literature may also be responsible for the apparent lack of insights as regards the economic impact of these applications. Notably, Rafert and Mate (2017) explore the economic impact of WhatsApp in the years 2012 to 2015. However, their study cannot explain the impact of the obviously wider group of applications often addressed by policy makers as having an adverse economic effects since they allegedly offer a free version of SMS thus reducing telecommunications providers revenues.

On this backdrop, the present paper seeks to achieve two research objectives. First, we set out to provide a detailed understanding of the nature and origin of the applications in question. Within that, we will assess their marked differences to other OTT applications and services. Second, based on our insights from research objective one, we provide a first approximation of their worldwide economic impact using a panel of 164 countries over the time span of 2000 to 2015.

The remainder of the paper is structured as follows. Section 2 details the background to the study and provides a brief overview of relevant previous studies. Section 3 presents the methods used for this paper emphasising our econometric approach. Section 4 presents the results. The paper culminates in a conclusion.

2 Background to the study

The popularity of iMessage, WhatsApp and others has led many researchers to investigate the impact of these applications within their respective fields. In accordance with pressing questions for telecommunications policy and regulation, Arnold et al. (2016) provide a substantial literature review on research exploring the question of whether interaction

applications are a substitute for Electronic Communications Services (ECS) (e.g. Cecere & Corrocher 2011, 2012, Gerpott 2010b, a, Gerpott & Meinert 2016, Gerpott & Thomas 2014, Kekolahti, Karikoski, & Riikonen 2015) and the impact of additional functions (e.g. Church & de Oliveira 2013, O'Hara et al. 2014, Glass & Li 2010, Karapanos, Teixeira, & Gouveia 2016). Both the cited studies and the insights by Arnold et al. (2016) support that SMS and telephony are used differently from and complementary to iMessage, WhatsApp and similar applications. They also find that additional functions providing added value to consumers appear to be the main driver for the exponential take-up of these applications.

Other researchers have addressed these applications in education (e.g. Yeboah & Ewur 2014, Bouhnik & Deshen 2014, Chipunza 2013, Fattah 2015, Gachago et al. 2015), healthcare (e.g. Anthony et al. in press, Kawai et al. 2017, Nardo et al. 2016) and linguistics (e.g. Otemuyiwa 2017, Al-Khawaldeh et al. 2016, Salem 2013). By and large, these papers show a positive impact of most prominently WhatsApp and Facebook Messenger by reducing cost of providing established services or enabling innovative ones. Commonly, the applications' ability to send, receive and share photos, videos and other rich content is instrumental for their impact.

All of these papers either dwell on individual popular examples such as iMessage, Facebook Messenger or WhatsApp or use broad catch-all phrases such as OTT communications services or instant messengers without reflection of what such definitions may imply. The present exploration of the literature does by no means comprise a full systematic literature review of studies undertaken to understand the various effects of these applications. Nonetheless, it clearly indicates that the academic literature lacks a commonly accepted definition of these applications.

Regulators and policy makers have introduced definitions of the applications in question here. Their aim is to delineate OTT services that offer communications services that may become relevant for their statutory duties. Two prominent examples are the definitions put forward recently by BEREC (2016) and the European Commission (2016) described in the following paragraph.

BEREC (2016) conceptualise three types of OTT services: (1) OTT-0, (2) OTT-1 and (3) OTT-2 services. Within that, OTT-0 and OTT-1 describe services that mimic functionalities of ECS. OTT-2 sums up all other OTT services such as video on demand or music streaming services. The European Commission (2016) includes in its proposed Electronic Communications Code 'interpersonal communications services' as part of Article 2(5), 2(6) and 2(7). They are defined as "a service normally provided for remuneration that enables direct interpersonal and interactive exchange of information via electronic communications networks between a finite number of persons, whereby the persons initiating or participating in the communication determine its recipient(s)" (2(5)). The definition explicitly excludes services "which enable interpersonal and interactive communication merely as a minor ancillary feature that is intrinsically linked to another service." The recitals shed some more light on the services that fall within the definition. There, "services like traditional voice calls [...] all types of emails, messaging services, or group chats." are explicitly mentioned as

falling within the definition while “linear broadcasting, video on demand, websites, social networks, blogs, or exchange of information between machines” are not considered interpersonal communications services (European Commission 2016, 30). Also, the definition excludes services that provide communication only as an ancillary such as (many) video games. Article 2 further distinguishes between ‘number-based interpersonal communications services’ connecting to the public switched telephone network (PSTN) or “enabling communication with a number or numbers in national or international telephone numbering plans” (2(6)) and ‘number-independent interpersonal communications services’ (2(7)).

Both definitions presented in the above apparently seek to continue traditional regulatory thinking building on the idea that services offered on the internet offering functionalities similar to traditional ECS. While Arnold et al. (2016) argue that a delineation based purely on functional similarity is problematic, they fail to provide a better approach. As its first research objective, our paper seeks to understand the nature and origin of services like iMessage, WhatsApp and Facebook Messenger and to provide an indicative framework to delineate them from other OTT services.

A better understanding of the nature of these applications is likely instrumental to explore their economic impact. The nature of telecommunications services as well as of the internet and their respective economic impacts are well-understood as the following paragraph illustrates. To the best knowledge of the authors, there is only one very recent study (Rafert & Mate 2017) that looks at WhatsApp’s global economic impact. The authors use data covering the years 2012 to 2015 and 157 countries to estimate the relationship between WhatsApp usage and GDP with panel regressions and instrumental variables. Their results suggest that a 5 percentage point increase in WhatsApp penetration in 2015 is associated with a US\$22.9 billion increase in global GDP.

Roeller & Waverman (2001) provide evidence from 21 Organisation for Economic Co-operation and Development (OECD) countries over a 20-year period for a significant positive causal link between telecommunications infrastructure and economic activity. Sridhar & Sridhar (2007) investigate the relationship between telephone penetration and economic growth using data for development countries and find a robust positive impact of telecommunications penetration on economic output. With a regression on panel data of 192 countries from 1990 to 2007 using a production function with a system of simultaneous equations, Gruber & Koutroumpis (2011) find that mobile telecommunications’ contribution to annual GDP growth is 0.11% for low income countries and 0.20% for high income countries. Czernich et al. (2011) estimate the effect of broadband infrastructure that enables high-speed internet on economic growth in OECD countries from 1996 to 2007 and find that a 10 percentage point increase in broadband penetration raises annual per capita growth by 0.9 to 1.5 percentage points. Farhadi, Ismail, & Fooladi (2012) find evidence for a positive relationship between growth rate of real GDP per capita and internet usage within a dynamic panel data approach with 159 countries over the period 2000–2009. They estimate that a 1% increase in the level of internet usage compared with the previous year will increase the economic growth rate of GDP per capita by 0.09%.

With its second research objective, our paper extends the existing literature by aiming to offer a first approximation of the economic impact of applications like iMessage, WhatsApp and Facebook Messenger as measured in GDP globally. To achieve this, we build on the insights gathered for telecommunications services' and the internet's economic impact and combine them with relevant market insights on consumer usage patterns of relevant applications.

3 Methods

To achieve our first research objective of understanding the nature of interaction applications, we conducted extensive desk research to build a bottom-up data set of applications. In total, we identified 139 applications registering their main functions in a structured data set over the months November 2016 till February 2017. To explore the history of the applications in questions, we conducted a literature review of technology-related as well as consumer behaviour studies.

To achieve the second research objective “to estimate the impact of RIAs on GDP”, we draw on the existing literature on the impact of telecommunications (voice and text functionality) on GDP and the impact of the “full internet experience” (overall functionality) on GDP. We assume that the applications such iMessage, WhatsApp, and Facebook Messenger include more and more functions. By adding more functions their impact increases moving from baseline telecommunications services to a full internet experience.

For the estimation of the impact of telecommunications and the internet on GDP, we use the World Development Indicators database of the World Bank for macroeconomic data such as the purchasing-power-parity-adjusted (PPP-adjusted) GDP per capita (GDPpc) and labor (L) and the Penn World Table data for the PPP-adjusted capital stock (K). ITU data of five indicators are used for the construction of two indices: an index for telecommunications and an index for internet usage.² For the indicators selected for the construction of our two indices, the normalization of the data is based on the recommendations of the ITU. Normalization of the data is necessary before any aggregation can be made to ensure the data set uses the same unit of measurement. The weighting of the indicators is also based on the ITU recommendations to construct both indices.

Our panel data set covers 164 countries with a time span from 2000 to 2015. We use an aggregate production function framework (Cobb–Douglas setting) that captures the effects of the inputs—capital, labor, and telecommunications or the internet (see equation 1)—on the output measure GDP:

$$GDP_{jt} = f(K_{jt}, L_{jt}, Telecom_{jt}/Internet_{jt}, t) \quad (1)$$

² The ITU ICT Development Index is a composite index (based on 11 indicators) designed to be global and reflect changes taking place in countries at different levels of ICT development. It therefore relies on a limited set of data that can be established with reasonable confidence in countries at all levels of development.

Thus, we relate national aggregate economic activity to the stock of capital K and the stock of labor L as the two main production/input factors and a *Telecom* index or an *Internet* index (see equation 2) as well as an exogenous time trend t . Therefore, we have the PPP-adjusted GDP per capita as a function of the capital/labor ratio (K/L) and an index for telecoms or an index for internet usage (based on the ITU indicators).

The econometric model is a fixed-effects (FE) specification with a Cobb–Douglas production function framework (logarithmic scale) to estimate the effect of several inputs (capital, labor, and telecommunications or internet) on the output measure (GDP per capita). Our econometric model is the following:

$$\log(GDPpc_{jt}) = \beta_0 + \beta_1 \log\left(\frac{K_{jt}}{L_{jt}}\right) + \beta_2 \log(Index_{jt}) + \alpha_j + \gamma_t + \varepsilon_{jt} \quad (2)$$

In equation 2, $\log(GDPpc_{jt})$ is the dependent variable referring to the PPP-adjusted level of GDP per capita (common logarithm of economic output) for country j in year t . β_0 , β_1 and β_2 are the parameters to be estimated. The independent variables are $\log(K_{jt}/L_{jt})$ as the common logarithm of the PPP-adjusted capital/labor ratio for country j in year t and $\log(Index_{jt})$, which refers to either the logarithmic telecom index or the logarithmic internet index for country j in year t . α_j are country FE removing time-invariant effects out of the 164 countries j in this sample and γ_t are time FE controlling for macroeconomic changes in the sample period 2000–2015. Last but not least, ε_{jt} is the residual for country j in year t consisting of unobserved effects. Robust standard errors are clustered at the country level. The unit of observation is the country year.

The empirical method is based on a linear panel FE model that enables analysis of causal relationships under relatively weak assumptions. FE models estimate average deviations from the mean. Taking the common logarithm of the dependent variable $GDPpc_{jt}$ and the independent variables (K_{jt}/L_{jt}) and $Index_{jt}$ means focusing on an elasticity analysis. The key assumptions are that unobservables are time-invariant and that all controls are exogenous with respect to the outcome and hence uncorrelated with the residual ε_{jt} . Here, γ_t stands for a set of time dummies and α_j is a vector of country binary variables. Coefficient β_2 is the parameter of interest and measures the elasticity of $GDPpc_{jt}$ to variation in the level of the respective $Index_{jt}$ for either telecom or internet usage. Thus, our specification uses the variation from differences across country-specific economic activity with respect to developments in the respective index. The model may be subject to endogeneity bias, that is, while telecom/internet usage may cause GDP per capita growth, the reverse may also be true. Since there are strong positive network externalities from telecommunications and the internet, the first effect strongly dominates the other one according to the economic literature. Thus, we can refrain from identifying the causal relationship. To account for several methodological issues, we conducted several robustness and sensitivity tests on our model specification.

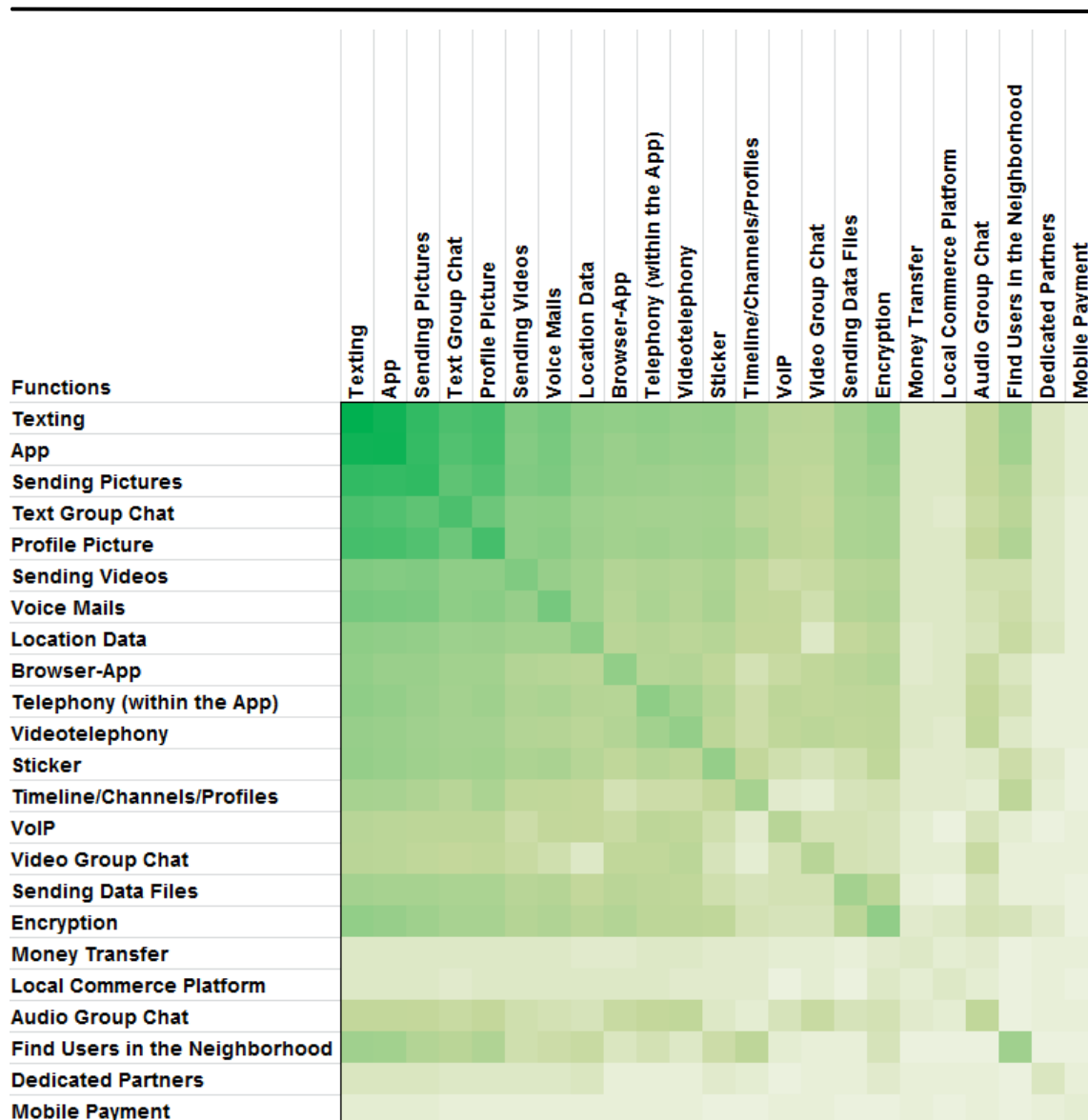
4 Results

Applications like iMessage, WhatsApp and Facebook Messenger are sometimes mischaracterized as a “free calling application” or “improved SMS”, but this does not reflect the fundamental nature of these applications that enable a full suite of interactive options. Indeed, consumer research indicates that the breadth of functions of RIAs plays an important role in their success (Arnold & Schneider 2016). Even though these applications offer text and calling functionalities, they are in fact not an identical substitute for ECS (Arnold, Schneider, & Hildebrandt 2016).

Figure 1 maps the functions of 139 applications identified in our research that are currently most used worldwide, ranging from general purpose applications such as WhatsApp, Facebook Messenger, Skype or Snapchat, to RIAs that aim at specific usage situations such as Slack, Disney MIX or Care Messenger, to locally relevant RIAs such as Hike (India), Jongla (Nigeria) and 2go (South Africa). Our aim is to explore the nature of these applications based on their functions. The share of individual applications that feature specific functions or rather combinations of functions is depicted by the shade of green used. The darker the shade, the higher the share of RIAs that feature this particular function³ or combination of functions.

³ Individual functions can be deduced from the diagonal of the matrix. For instance, the very dark shade of green for the combination of “Texting” and “Texting” indicates that almost all RIAs feature this functionality.

Figure 1: Overview of RIAs' functions



Source: WIK; number of RIAs analyzed: 139; the share of RIAs that feature a specific function or a combination of functions is indicated by the shade of green: the darker the green, the higher the share. If one follows the diagonal line, one can see the share of RIAs in our sample that feature the particular functionality denoted for that row and column.

First and foremost, Figure 1 shows the great variety of functions offered. In total, the data collection identified 23 functions that at least three RIAs in our sample shared.⁴ The most common functions revolve around texting and sending pictures; almost all RIAs feature these (between 77% and 99%) or combinations thereof. A Third of the sampled applications allow group chats using live audio or video feeds, and it has been shown that rich group chat plays an important role in the success of these applications as they are used like social networks (Seufert et al. 2016). This usage scenario frequently includes creating groups to share experiences, often including links to websites, pictures and videos. Two fifths of the RIAs in the sample also enable users to send videos (40%). Out of those, all enable texting and sending pictures.

In addition applications in our sample are also beginning to integrate services provided by commercial partners, such as hailing an Uber taxi ride through Facebook Messenger or an Ola taxi ride through Hike.⁵ Given the competitive pressure originating from the multitude of actors in the market, as well as the demonstrated economic benefits of intermediaries (Hildebrandt & Nett 2016), it is likely that more and more applications will look to integrate other services in order to enrich the consumer experience with the application.

The common thread along all functions offered is *interaction*. This interaction can happen among individual users of the service or between users and third party commercial partners. A second dominant feature is that these interactions are *rich* in the sense that they can include pictures, videos or other forms of content. Consequently, we suggest to delineate these applications from other OTT services based on their functions under the banner of *Rich Interaction Applications* (RIAs). The demand for rich interaction from consumers is all but new. Given the continuous innovation that also reflects in the evolution of these applications, the concept of RIA should not be understood as a static definition. Instead, it offers a framework to highlight marked differences to the catch-all idea of OTT applications.

When one tries to understand the origin of RIAs, one quickly finds that they follow a distinct evolutionary line from the earliest desktop-based interactive applications, e.g. MIT's Compatible Time-Sharing System (CTSS) (Van Vleck 2012), the Zephyr Notification System (DellaFera et al. 1988), the SDC⁶ time-sharing system (Hemmendinger 2014), and the bulletin board system (Rafaeli 1984, James, Wotring, & Forrest 1995) to the currently popular mobile applications.

During the late 1990s and early 2000s, flat-rate data plans made it affordable and attractive to be always online (Arnold & Waldburger 2015). The evolution of these early interaction applications coincided with a resulting steep increase in take-up of broadband access in most developed countries. During this period, AOL Instant Messenger (AIM), ICQ, MSN

⁴ Notably, the figure would feature more functions if all possible functions had been listed, i.e. also those that two or fewer RIAs feature. Furthermore, the depicted distribution may understate the variety of functions as some of them may only be available in specific countries or regions and may not have been picked up in our research due to language barriers.

⁵ Hike is a local RIA popular in India. Ola is the Indian equivalent of Uber.

⁶ The System Development Corporation (SDC) was a spin-off of the Rand Corporation. It is commonly known as the first software company. Today, it is owned by Unisys. (Source: Wikipedia site: https://en.wikipedia.org/wiki/System_Development_Corporation, accessed March 2017).

Messenger and Yahoo! Messenger were released, offering many of the functions that can be found with today's RIAs, including profile pictures, icons, away messages and chatrooms (group chats). The majority of internet users at the time had at least one instant messaging account. In fact, by the early 2000s, multi-homing had become so common that services such as Jabber offered consumers a way to integrate several instant messaging accounts. The number of messages sent during that time increased quickly.

The 2000s saw the introduction of Skype (in 2003) and the rise of social networks like Friendster, Orkut, MySpace and Facebook. All of these services feature at least a chat functionality. With increasing usage of these sites as well as more and more consumers coming online, the number of messages sent via desktop and laptop RIAs increased rapidly. For instance, Facebook launched its chat functionality in August 2008.⁷ By June 2009, the company reported that more than 1 billion messages were sent each day on its chat service.⁸

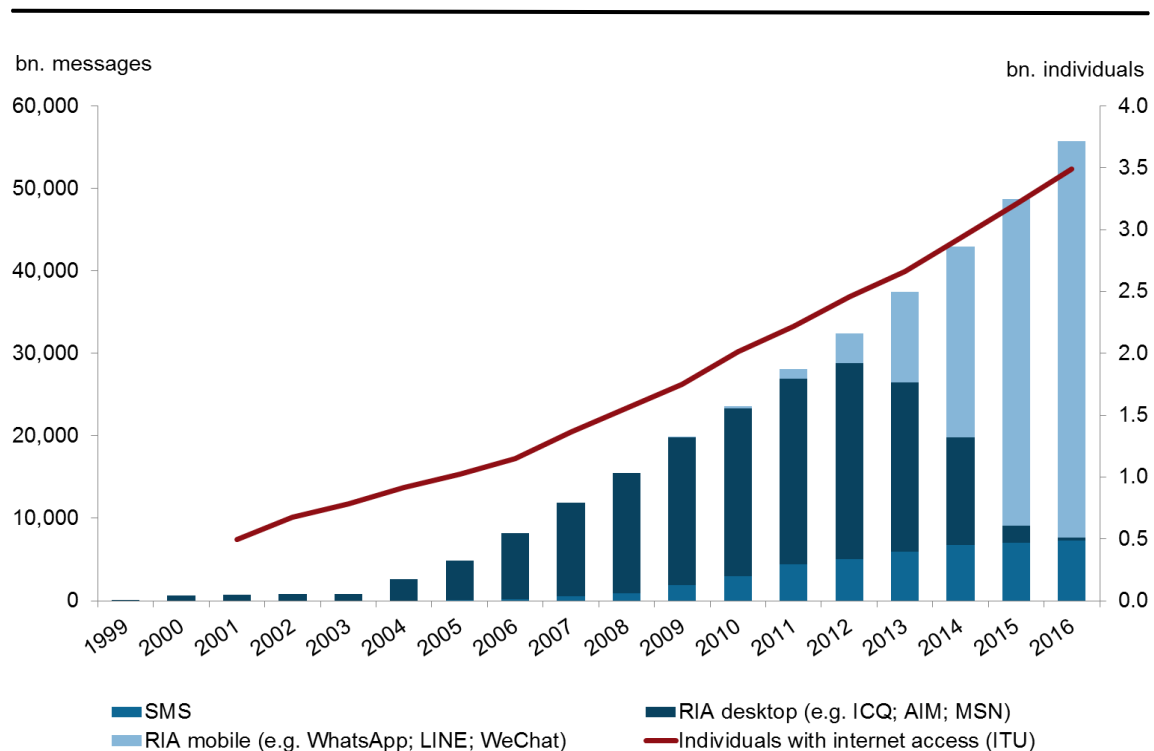
As mobile broadband connections became more affordable, consumers switched a large part of their online activity to mobile devices, including their demand for a complete RIA experience. Mobile RIAs have flourished, and the vast majority of messages that are sent today are sent via mobile RIAs such as WhatsApp, Facebook Messenger, Hike or Threema, compared to messages previously sent via desktop-/laptop-based RIAs such as AOL Instant Messenger, ICQ or Yahoo! Messenger.

Figure 2 shows our estimate of how RIA-based messaging and SMS messaging have developed in terms of total messages sent worldwide between 1999 and 2016. Worldwide, the number of SMS messages correlates strongly with the number of mobile subscriptions, showing a steady growth. The number of RIA messages sent strongly correlates with the number of people who have internet access. Essentially, the number of RIA-based messages per user has not changed significantly over time, only the technology underneath, as mobile RIAs have largely displaced desktop RIAs.

⁷ <https://www.facebook.com/notes/facebook/facebook-chat-now-were-talking/12811122130/>

⁸ <https://de-de.facebook.com/notes/facebook-engineering/chat-reaches-1-billion-messages-sent-per-day/91351698919/>

Figure 2: Number of SMS and RIA messages sent annually (worldwide in billion messages; individuals with internet access in billion)



Source: WIK estimate based on Nielsen (cf. statisticbrain.com), press releases, International Telecommunications Union (ITU) and news articles.



In sum, the above analysis of the functions of RIAs shows a provenance and evolution that is distinct from traditional telecommunications services. And, as RIAs have evolved along their own technology pathway, the user experience with RIAs is becoming closer to people's use of the internet in general. Taking the UK Office of Communications' (Ofcom's) typology of internet use, for example, we see that profile pictures and timelines accord with personal use; rich messaging functions, photo and video sharing (including through group chats), and even translation correspond to consumers' communication and social networking usage; payment and purchasing functions match transaction use (Ofcom 2015); integrated games offer entertainment use; and integration with news feeds reflect information and leisure-related usage.⁹

This evolution of RIAs is also at the bottom of our economic impact analysis. Concretely, our analysis of RIAs' impact on GDP rests on our previous finding that RIAs are developing to integrate almost all of the functionalities associated with a "full internet experience". In order to calculate the impact, we applied econometric models drawing on a panel of 164 countries and 16 consecutive years (2000 to 2015) featuring more than 2,600 observations in total.

⁹ See also Helsper, Duersen & Eynon (2016); McKinsey (2010). The following chapter elaborates in more detail the relevance of these uses and corresponding functions in consumer behavior.

Table 1 presents the results of the econometric estimation of the impact of telecommunications and the internet on global economic output per capita over the 16-year time span for 164 countries. The overall models as well as the individual coefficients are statistically significant in both equations. R-squared is around 80% in both specifications. Further tests were conducted and all of them supported the robustness of the estimates shown below.

Table 1: Impact of telecommunications and internet usage on GDP per capita

VARIABLES	(1) Log(GDPpc)	(2) Log(GDPpc)
Log(K/L)	0.168*** (0.039)	0.141*** (0.037)
Log(IndexTelecom)	0.028** (0.013)	
Log(IndexInternet)		0.041*** (0.008)
Constant	6.818*** (0.406)	7.188*** (0.386)
Observations	2,616	2,607
Number of countries	164	164
R-squared	0.800	0.814

Sources: WIK based on ITU, World Bank, and Penn World Table.

Robust standard errors in parentheses. Results referring to a 1% increase in telecoms and internet usage.

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

Column 1 presents the results for the common logarithm of the telecom index. The estimated coefficient for the telecom index is statistically significantly different from zero at the 5% level. According to this coefficient, a 10% increase in the global level of the telecom index leads to a 0.28% increase in the level of global GDP per capita. On average, this 10% increase corresponds to an economic magnitude of about US\$4.8 trillion of global GDP over the 16-year period.

Column 2 shows findings for the common logarithm of the internet index. The estimated coefficient for the internet index is statistically significant at the 1% level and reveals an even higher impact on economic output than telecommunications. The coefficient indicates that a 10% increase in the internet index results in a 0.41% increase in the level of global GDP per capita. On average, this 10% increase relates to an economic magnitude of about US\$7.0 trillion of global GDP over the 16-year period.

Our findings are consistent with the economic literature that telecommunications and internet usage are positively correlated with economic output. Our results can be interpreted as conservative estimates, in particular for the internet impact on GDP, since there are several

non-monetary aspects of internet functionality, such as reduced information, search and transaction costs, and further efficiency gains, such as rather large spillover effects due to time saved. These non-monetary aspects that are not considered in GDP tend to have quite a large effect in economic terms at a global level.

Based on these two endpoints, we estimate the impact of RIAs depending on the usage numbers for these applications presented in the Global Web Index data. We introduce them as a weighting factor. We find that, on average, a 10% increase in the global usage of RIAs leads to an increase in global GDP per capita by (approximately) 0.33%. This corresponds to an average global increase in GDP of US\$5.6 trillion from RIAs over the 16-year period. These are conservative estimates, given that many uses and impacts of the RIAs are not captured in GDP.

5 Conclusion

The present paper set out to understand the nature and origin of applications such as iMessage, WhatsApp and Facebook Messenger and to provide an indicative framework to delineate them from other OTT services. Second, the paper aimed to estimate the economic impact of these functions. It was further expected that an indicative framework to delineate the applications in question would help to develop an estimate of their economic impact.

Our investigation yielded 139 applications whose functions revolve around rich interaction. Hence, we summed up these applications under the banner of Rich Interaction Applications (RIAs). One of their key characteristics is continuous innovation resulting in them becoming closer and closer to a full internet experience. We used this insight to inform our estimate of their global economic impact.

First and foremost, this illustrates the merit of understanding the nature and origin of RIAs. In fact, we were able to trace their origin back to the earliest days of computer networks. This analysis also showed that RIAs follow a distinct evolutionary path from SMS and telephony. Therefore, it is questionable whether the same rules should be applicable to them simply because they feature among various other functions also the option to communicate via texts and calls. One may also discuss whether the vast majority of RIAs actually meet the European Commission's criterion of 'remuneration' as they are typically offered at no charge and do not charge anything for interacting with others. Nonetheless, the European Commission's definition of interpersonal communications service appears to be overall closer to our understanding of RIAs than the one put forward by BEREC. In sum, whether one looks at the core rich interaction functionality or the developing integration with the "full internet experience", any categorization (or regulatory regime) tied to the thin overlap with traditional telecommunications services truly falls short of reality (Arnold, Hildebrandt, & Waldburger 2016).

Finally, our findings support the benefits for consumers from the ongoing evolution of OTT communications services, which is likely to enable various new functionalities and business

in the near future. Speech interfaces may only be the first step in a new wave of innovation. Hence, it can be expected that RIAs' socio-economic impact is going to grow in the coming years. If the alleged like-for-like substitution is used as the initial driver for policy or regulatory actions this impetus should be reconsidered in light of RIA's actual history, actual motives for consumer preference as well as their very significant socio-economic impact. In essence, policy makers and regulators ought to strive for framework conditions that enable or even better facilitate innovation as well as dynamic competition. Ultimately, these are the ingredients for realizing the largest benefits for consumers and the economy.

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