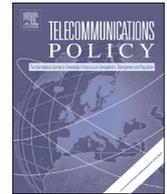




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## Mobile and more productive? Firm-level evidence on the productivity effects of mobile internet use

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### ABSTRACT

Mobile internet access allows for flexibility with respect to working time and working place. We analyse whether employees' use of mobile internet access improves firms' labour productivity. Our data set contains 2143 German firms and refers to the year 2014, when high-speed mobile internet was still at a relatively early stage of diffusion within firms. The econometric analysis shows that firms' labour productivity significantly increases with the share of employees with mobile internet access. Our instrumental variables approach suggests that mobile internet use does cause higher labour productivity.

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### 1. Introduction

Computers and the internet are well-established working tools. They have changed workplaces significantly, contributed to improving labour productivity and changed the demand for employee skills and qualifications. The technological prerequisites for mobile internet, which is diffusing rapidly through the economy, are advances in high-speed wireless connections and mobile devices such as laptops, tablets and smartphones. [McKinsey Global Institute \(2013\)](#) considers mobile internet as one of twelve disruptive technologies with a very high potential economic impact. [OECD \(2012, p. 22\)](#) motivates the transformation from the information economy to the internet economy and points out that “Wireless internet connections are the key source of recent internet growth, increasing rapidly since 2001 and overtaking fixed broadband subscriptions in 2009.” In Germany, the number of regular high speed mobile internet users increased from 13.6 million in 2008 to 52.6 million in 2014. During the same period, mobile data volume increased even more rapidly, from 11.5 to 394.8 Petabytes (see [Fig. A.1](#)).

While the role of information and communication technologies (ICT) in determining labour productivity is well studied,<sup>1</sup> there is, to the best of our knowledge, no empirical work on the firm-level productivity effects of mobile internet so far. Why would we expect productivity effects from mobile internet? One important result from the empirical analysis of ICT is that reduced communication costs support the decentralisation of organisation, such as the reduction of hierarchy levels and the implementation of autonomous working teams (see for example [Bresnahan, Brynjolfsson, & Hitt, 2002](#)). Mobile internet access can further improve information flows and communication and reduce involved costs. Employees are now able to access their firms' data and documents anywhere, at any time. This supports decentralisation in terms of organisation and

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<sup>1</sup> See for instance the literature reviews by [Draca, Sadun, and Van Reenen \(2007\)](#), [Van Reenen, Bloom, Draca, Kretschmer, and Sadun \(2010\)](#), [Bertschek \(2012\)](#), and [Cardona, Kretschmer, and Strobel \(2013\)](#).

time. By contrast, coordination costs might increase if physical meetings become more difficult to arrange since everybody wants to be flexible. Moreover, monitoring might become more difficult if employees work geographically dispersed. Thus, the net contribution of mobile internet is a priori not evident.

In our analysis, we take a firm-level perspective in order to analyse the role that employees' mobile internet access plays for firms' labour productivity. Based on a sample of 2143 firms from the German manufacturing and services industry, we estimate classical production functions. Mobile internet use as an input factor is measured by the percentage share of employees with mobile internet access in each firm. We control for ICT use at the workplace other than mobile internet access by including measures of the use of computers and access to fixed line internet. Since the estimates of the effect of mobile internet access might be prone to reverse causality, i.e. more productive firms have more resources to invest in new technologies, we apply an instrumental variables approach.

Our initial econometric analysis shows that a one percentage point higher share of employees with mobile internet access is associated with a 0.2% higher labour productivity. When controlling for potential endogeneity bias by instrumental variables estimation, we still find a significant effect of mobile internet use on firm productivity. Thus, based on our sample of 2143 German firms for the year 2014, we can claim that mobile internet access has a causal impact on firms' labour productivity.

Our paper contributes to the literature in various respects: (i) We provide first microeconomic firm-level evidence on the labour productivity effects of employees' mobile internet use. (ii) We control for computer use and fixed line internet access as further types of ICT use at the workplace. (iii) By applying an instrumental variables approach we take account of potential reverse causality between labour productivity and mobile internet use.

## 2. Related literature

To the best of our knowledge, there is no microeconomic study referring to the relationship between mobile internet use by employees and firms' labour productivity. There is, however, a quite extensive literature on the economic impact of mobile phones for small and micro enterprises in developing and emerging countries (e.g. [Aker & Mbiti, 2010](#); [Jensen, 2007](#); [Muto & Yamano, 2009](#); [Tadesse & Bahiigwa, 2015](#) and [Paunov & Rollo, 2016](#)). In general, this literature suggests that the use of mobile phones improves market outcomes. Furthermore, there exist various studies in information systems research and psychology about the implications of communication technologies and especially mobile internet use (i.e. constant connectivity) for individual employees. [Middleton and Cukier \(2006\)](#) provide a qualitative analysis on the mobile email usage patterns of individual employees. Their participants report positive aspects like allowing them to be efficient as well as negative aspects like the infringement on work-life boundaries. [Diaz, Chiaburu, Zimmerman, and Boswell \(2012\)](#) conclude that the use of communication technologies is associated with increased work satisfaction, but could also create work-life conflicts. The studies by [Dery, Kolb, and MacCormick \(2014\)](#); [Mazmanian \(2013\)](#); [Mazmanian, Orlikowski, and Yates \(2013\)](#) provide further descriptive evidence on the implications of constant connectivity and always on work practices for employees.

Apart from that, there is a broad literature on productivity effects of ICT in general as well as for fixed-line broadband internet. According to the survey by [Cardona, Kretschmer, and Strobel \(2013\)](#), the estimated production elasticity of ICT ranges on average between 0.05 and 0.06 and has increased over the period of observation. Several studies analyse the contribution of fixed-line internet to productivity. At the macro level, [Koutroumpis \(2009\)](#), [Czernich, Falck, Kretschmer, and Woessmann \(2011\)](#), [Gruber, Hätönen, and Koutroumpis \(2014\)](#) and [Kongaut and Bohlin \(2014\)](#) show that broadband internet has a positive and statistically significant impact on both productivity and growth in EU and OECD countries.<sup>2</sup> [Thompson and Garbacz \(2011\)](#) find a positive impact of fixed-line and mobile broadband on GDP per household in a sample containing high and low income countries. However, they do only find a significant impact for mobile broadband but not for fixed-line broadband internet in the subsample of high income countries. Using a novel data set at the meso-level, [Hagsten \(in press\)](#) finds a positive and significant relationship between labour productivity and the share of broadband-enabled employees in firms with the strength of relationships varying considerably across countries and industries. At the micro level, the evidence is rather mixed. Based on a cross section of firms from New Zealand collected in 2006, [Grimes, Ren, and Stevens \(2012\)](#) find that firms using fixed-line broadband internet have a 7–10% higher labour productivity. By contrast, for the early phase of broadband diffusion in Germany, 2000–2002, [Bertschek, Cerquera, and Klein \(2013\)](#) find positive and significant effects of fixed-line broadband on firms' innovation activity but not on their labour productivity. Comparable insignificant results are found by [De Stefano, Kneller, and Timmis \(2014\)](#) for British firms and by [Haller, and Lyons \(2015\)](#) for Irish firms. [Akerman, Gaarder, and Mogstad \(2015\)](#) again find, based on Norwegian data that a 10 percentage point increase in fixed-line broadband availability raises output by 0.4%. A positive relationship between innovation and employees' broadband access is also found by [Polder, Leeuwen, Mohnen, and Raymond \(2010\)](#) using Dutch firm-level data. As [Colombo, Croce, and Grilli \(2013\)](#) demonstrate for the case of small Italian firms, it is not necessarily the connection to the internet that matters but what firms do with the internet that might make them more productive. [Maliranta and Rouvinen \(2006\)](#) show, based on a sample of Finish firms surveyed in 2001, that portability and wireless connectivity of computers boost labour productivity. They measure wireless connectivity by wireless local area networks (WLAN) access whereas in our study, we capture the possibility to access the internet via cellular networks providing much greater mobility and flexibility to the user.

<sup>2</sup> See also the survey by [Holt and Jamison \(2009\)](#).

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