The impact of telecommunication technologies on competition in services and goods markets: Empirical evidence*

Vahagn Jerbashian Anna Kochanova[†]

CERGE-EI[‡]

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Abstract

In this paper we empirically show that a more intensive use and wider adoption of telecommunication technologies significantly increases the level of product market competition in services and goods markets. Our result is consistent with the view that the use of telecommunication technologies can lower the costs of entry. This finding is robust to various measures of competition and a range of specification checks.

Keywords: Telecommunication technologies; Entry costs; Product market competition

JEL classifications: L16; O33; O25

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[†]Correspondence address: CERGE-EI, P.O. Box 882, Politickych veznu 7, Prague, 111 21, Czech Republic. Tel.: (+420) 224005123; E-mail: Vahagn.Jerbashian@cerge-ei.cz and Anna.Kochanova@cerge-ei.cz.

[‡]CERGE-EI is a joint workplace of the Center for Economic Research and Graduate Education, Charles University in Prague and the Economics Institute of Academy of Sciences of the Czech Republic.

1 Introduction

"...[I]n most of the economy IT [the information technologies] will help to increase competition.

Broadly speaking, the Internet reduces barriers to entry, because [for instance] it is cheaper to set up a business online than to open a traditional shop or office. The Internet also makes it easier for consumers to compare prices. Both these factors increase competition."

The Economist, September 21, 2000

The internet is a type of telecommunication technology. Conjectures like this in *The Economist* indicate that there can be a positive relationship between the more intensive use and the wider adoption (hereafter, diffusion) of telecommunication technologies and competition in services and goods markets (for similar arguments see also Leff, 1984; McFarlan, 1984; Varian, Litan, Elder, & Shutter, 2002; OECD, 2008; and Czernich, Falck, Kretschmer, & Woesmann, 2011). Another mechanism behind such a relation is that telecommunication technologies can lower information acquisition costs, which are argued to be significant for the decision on entry into a market (see, for example, Geroski, 1995a).

These arguments are certainly not conclusive, however. It may be argued as well that the diffusion of telecommunication technologies can help firms loosen competition. For example, firms can use the internet and other types of telecommunication networks for (extensive) advertisement of their products. The advertisement, then, can increase product differentiation and help to gain market power (Comanor & Wilson, 1974).

This study empirically investigates the relation between the country-wide diffusion of telecommunication technologies and the competition in services and goods markets. In order to alleviate endogeneity concerns we use a difference-in-differences framework in the spirit of Rajan & Zingales (1998). More specifically, we ask whether in countries where, *a priori*, the diffusion of telecommunication technologies is higher, the intensity of product market competition is different in the industries that depend more on these technologies compared to the industries that depend less. We use evidence from 21 EU countries in order to establish our results.

Our results suggest that the diffusion of telecommunication technologies has a strong positive effect on the intensity of competition in services and goods markets. This supports conjectures such as in the quote above from *The Economist*. According to the standard theoretical inference, our results imply that the diffusion of telecommunication technologies increases allocative efficiency in the economy.

Moreover, in line with many empirical studies (e.g., Nickell, Wadhwani, & Wall, 1992; Nickell, 1996; and Disney, Haskel, & Heden, 2003) our findings imply significant productivity gains due to the diffusion of telecommunication technologies (for a theory behind the results of these studies see Hart, 1983). According to, for example, Aghion, Bloom, Blundell, Griffith, & Howitt (2005) the diffusion may also imply higher innovative activity (see also Geroski, 1995b; Blundell, Griffith, & van Reenen, 1999).[1]

Our study also contributes to the ongoing debate about the impact of telecommunication technologies, as well as of information and communication technologies (ICT), on economic performance. Macro-level empirical studies suggest that the diffusion of these technologies has a positive impact on development level and growth (e.g., Madden & Savage, 2000; Roller & Waverman, 2001; Datta & Agarwal, 2004; and Czernich *et al.*, 2011). In turn, micro-level empirical studies suggest that the use of telecommunication technologies and ICT can reduce price dispersion and average prices in online markets (e.g., Jensen, 2007; Lee, 1998; Strader & Shaw, 1999; and Brynjolfsson & Smith, 2000). There can be various drivers behind these results. For instance, the literature on the economics of ICT (e.g., Jorgenson, Ho, & Stiroh, 2005; and Vourvachaki, 2010) emphasizes the productivity improvements/cost reductions that stem from the "direct" application of ICT (for example, the switch from mail to e-mail). The literature on the economics of telecommunications, in addition, argues that the use of these technologies can improve access to information. In line with Stigler (1961), this literature further argues that it would reduce distortions and frictions in the markets (e.g., Leff, 1984; Jensen, 2007; and Brynjolfsson & Smith, 2000). Our empirical findings offer support for these conjectures. They imply that the diffusion of telecommunication technologies intensifies the competition in services and goods markets (i.e., reduces mark-ups). Meanwhile, given that the latter can matter, for example, for allocative and productive efficiency, our results suggest another driver behind the results of these macro- and micro-level empirical studies. In this respect, they also add to the suggestions of the literature on general ICT, and indicate that the economic benefits from a particular type of ICT, telecommunication technologies, may come not only from direct use but also from intensified competition.

The results of this study can be interesting also for policymakers. The results imply that policies that motivate the diffusion of telecommunication technologies can complement competition/antitrust policies.

[1] It has to be noted that Aghion *et al.* (2005) finds an inverted U-shape relationship between the number of patents issued and the intensity of competition. Therefore, according to this paper our results imply higher innovative activity at least for lower levels of competition.

Having mentioned what we identify in this study, it is also worth mentioning what we do not intend to identify. The diffusion of telecommunication technologies can reduce some of the costs of entry. However, it is ultimately the corresponding changes in firms' and consumers' behavior that would affect the competition in services and goods markets. Given the data we have, we neither can nor intend to identify exactly how those changes would happen.

In addition to the literature on the economics of ICT and particularly on the economics of telecommunications, this paper is related to studies that try to identify the determinants of product market competition. Although competition seems to be an important engine of economic activity, to our best knowledge, there are very few such studies. There is evidence, for example, that railroad networks intensified competition in the US shipping industry in the 19th century (Holmes & Schmitz, 2001). There is also evidence that policies, including but not limited to those that intend to promote entry and competition, can affect the intensity of competition in various markets (see, for instance, Creusen, Minne, & van der Wiel, 2006; and Feldkircher, Martin, & Worz, 2010). Our study is related to these studies to the extent that telecommunication technologies, similar to the railroad, are general purpose technologies. Moreover, according to our results, the policies that promote the diffusion of telecommunication technologies should affect the intensity of competition in services and goods markets.

There is also a vast amount of theoretical studies that analyze the effect of search frictions on price dispersion (see, for instance, Salop & Stiglitz, 1977; Reinganum, 1979; and Varian, 1980). The typical model assumes that consumers know only the distribution of prices and have search costs. These costs are argued to be lower in electronic marketplaces compared to regular ones (e.g., Bakos, 1991). This motivates many empirical studies that try to find whether there is a significant difference in terms of price dispersion, as well as average prices, between electronic and regular market places (e.g., Lee, 1998; Strader & Shaw, 1999; Brynjolfsson & Smith, 2000; and Brown & Goolsbee, 2002). Our study is related to these papers to the extent that the diffusion of telecommunication technologies also can lower consumers' search costs and these, together with price dispersion, can be related to the intensity of competition. In this respect, while these studies focus on particular markets (e.g., books, CDs, and life insurance) and market places, our inference is for (virtually) the entire economy.

The next section describes the theoretical background, motivates the methodology, and formally defines the objective of this study. The third section describes the data and its sources. The fourth section summarizes the results. The last section concludes. The tables of basic statistics, correlations, and regression results are presented at the end of the paper.

2 Theoretical background and methodology

2.1 How telecommunications can matter

The entry (and the potential entry) of firms can strengthen competition and reduce relative price distortions, which are due to monopolistic pricing.

It is argued that information acquisition costs matter for firms' decision to enter into a market (see, for instance, Demsetz, 1982; Hausch & Li, 1993; and Geroski, 1995a). Meanwhile, this decision can be affected as well by transaction and initial investment costs. For instance, a firm which considers entry into a market would need to gather information about that market and use resources for initial investments in office equipment and software.

It seems that it is a common thought in the literature that the use of telecommunication technologies can reduce the information acquisition and transaction costs (see, for instance, Leff, 1984; Norton, 1992; Roller & Waverman, 2001; Jensen, 2007; and Czernich *et al.*, 2011). Some of the contemporary observations which can support these arguments are that these technologies enable internet and internet banking. The internet in many cases can serve as a very cheap source of information, whereas intenet banking can reduce some of the transaction costs. In turn, following Etro (2009) it can be argued that the diffusion of telecommunication technologies can reduce the initial investment costs in computer software and hardware. This can be the case since these technologies support and enable cloud computing.

These arguments indicate that there can be a positive link between the diffusion of telecommunication technologies and the (potential) entry of firms. Therefore, they indicate that the diffusion can intensify the competition in services and goods markets. However, these arguments are certainly not conclusive. In this regard, it may be argued as well that the diffusion of telecommunication technologies can help firms gain market power. An example of such actions can be the (extensive) advertisement of products over the internet and other types of telecommunication networks. The advertisements may help to increase product differentiation, thus, it may help to gain market power (see, for instance, Comanor & Wilson, 1974). Another related example would be that lower information acquisition costs would help in learning about the demand and the general market environment. Therefore, they can help in increasing product differentiation and price discrimination. A quite recent example is that, currently, online firms are able to track, for instance, via search keywords, visited web sites, and IP address the preferences and location of the users. They use that information for targeting marketing appeals. In Appendix T.1 we offer a very stylized and simplistic model that delivers predictions in line with our inferences.

2.2 Methodology

Having contrasting theoretical arguments in hand, in this study we try to identify the relation between the diffusion of telecommunication technologies and the competition in services and goods markets. Doing so is not straightforward, however. According to many theoretical models, the level of competition in services and goods markets matters for resource allocation in an economy (see, for instance, van de Klundert & Smulders, 1997; and Jerbashian, 2011).[2] This in its turn can matter for the country-wide diffusion of telecommunication technologies, which is largely a market outcome. Therefore, according to the theory, there can be a reverse causality between the diffusion of telecommunication technologies and competition in the services and goods markets.

Nevertheless, there is a seemingly intuitive variation that can be used in order to alleviate the reverse causality problem. The effect of the diffusion of telecommunication technologies on the costs of entry would be different for industries that depend more heavily on these technologies compared to industries that depend less. Such variation can arise because the industries that depend more heavily on telecommunication technologies *ceteris paribus* would increase their demand for these technologies more due to that diffusion. In turn, in line with the arguments offered in Leff (1984) or Jensen (2007), the increased demand can result in more information about the industry. An observation that supports these arguments is that telecommunication technologies are used exactly for transmitting and disclosing information. A further supporting observation is that these days, for instance, computer producers and retailers seem to be more widely known than the core manufacturers, when the former use significantly more of these technologies.[3] According to these arguments the diffusion will alter the information acquisition costs disproportionately in industries that depend more heavily on telecommunication technologies.

Our test looks for exactly such a disparity. We test whether in countries where, *a priori*, the diffusion of telecommunication technologies is higher, the intensity of

[2]See also Nickell (1996), Blundell *et al.* (1999), and Aghion *et al.* (2005) for empirical papers that utilize similar arguments.

[3]In addition, Jensen (2007) argues that the diffusion of telecommunication technologies has increased the availability of information about the fishing industry/market in Kerala, India, through increased communication between fishermen.

product market competition is different in the industries that depend more on these technologies. Such a test permits also country and industry fixed effects. These can be important for capturing, for instance, regulatory differences and the variation in the fixed costs of entry into different industries. Moreover, with such a test our inference would not depend on a particular country-level model of competition. This can allow us to avoid using country-level variables and instead focus on the varying effects of those variables across industries that are expected to be the most responsive to them. Country-level variables included in regressions can create ambiguities in the interpretation of the results since, for instance, they can absorb some of the variation in the data that is actually attributable to the direct effect of the variable of interest.

For constructing the test we need to identify industries' dependence on telecommunication technologies. In a country, a naive measure of an industry's dependence would be its share of expenditures on telecommunications out of total expenditures on intermediates. The problem with this measure is that it reflects both the supply and the demand of those technologies, when we need only the demand.

In order to alleviate this problem we try to identify the industries' dependence on telecommunication technologies from US data. This involves three important assumptions. The first and second are that in the United States the supply of telecommunication technologies is perfectly elastic and frictionless, respectively. The first assumption can be supported by an argument that the marginal cost of production in the telecommunications industry is very low (for a similar argument see Noam, 1992; and Laffont & Tirole, 2000). Meanwhile, the second can find support in the observation that the US has one of the most developed information and communication technologies sectors. Moreover, it tends to have exemplary regulations/reforms for the telecommunications industry and the lowest market prices for telecommunication goods in the world. The second assumption requires also the demand for telecommunication technologies to be largely unaffected by frictions in the supply of other goods/services, if any. This seems to be not very unrealistic given the seemingly low substitutability of telecommunication goods with the rest and the relatively frictionless environment in US markets. The third assumption is that the dependence identified from the US data also holds in other countries. More rigorously, we assume that there is some technological reason which creates variation in the industries' dependence on telecommunication technologies. Further, we assume that these technological differences persist across countries so that the dependence identified from the US data would be applicable for the countries in our sample.

These assumptions may seem to be rather strong. All we actually need, however, is that the rank ordering of the expenditure share on telecommunications in the United States corresponds to the rank ordering of the technological need/dependence of the industries. We need as well that rank ordering to carry over to the rest of the countries in our sample.[4] This would mean that, for example, the retail trade industry depends more on telecommunication technologies than the mining of metal ores in all of the countries in our sample.

There is at least one argument that can motivate why this rank ordering, perhaps together with the actual dependence level, can carry over to rest of the countries. The share of expenditures on telecommunications is virtually constant in the steady state equilibrium. Therefore, much of the variation within industries may arise from shocks that would change the relative demand for telecommunication technologies.[5] An example of such a shock would be a factor-biased technological innovation. As long as, however, there is technological convergence across countries and these shocks are worldwide, our measure would be a valid proxy. From another perspective, if our proxy is noisy, our findings may only suffer from attenuation bias.

We, nevertheless, perform several robustness checks. Given that the shocks may not be worldwide, for a robustness check we employ also the shares of expenditures on telecommunications in Japan and the United Kingdom. These countries tend to have relatively well developed ICT sectors and relatively high telecommunication technologies diffusion. Therefore, it may be reasonable to expect that our assumptions are also valid for them. At the same time, these countries tend to have a different industrial composition than the United States, which would be another type of robustness check.

For the same purpose, we also employ the share of expenditures on telecommunications in 1994 in the United States since it can be argued that European countries tend to be somewhat behind it in terms of the use of ICT.[6]

The basic test

Our hypothesis is that in countries where, *ex ante*, the diffusion of telecommunication technologies is higher, *ex post*, the level of product market competition is different in industries that depend more on these technologies compared to the industries that depend less. One of the advantages of trying to test exactly this hypothesis

[4]Rajan & Zingales (1998) have similar assumptions in the context of capital markets.

[5]Clearly, the shocks also can generate variation out of the steady state equilibrium.

[6]We could use any date prior to 1997 and after 1993. It turns out that as we go towards 1993 our results become more pronounced and significant. This may partly stem from the technological lag between the European Union countries and the United States.

is that we need not explain the drivers behind the diffusion of telecommunication technologies, economic/market or regulatory. In order for the diffusion to matter in such a setup, we need only to have a "world" where the diffusion cannot happen instantaneously or is costly. Either of these assumptions seems plausible given that the diffusion requires building infrastructure.

Given the hypothesis, our dependent variable is the level of product market competition in industry i and country c (averaged over the time/sample period). Assuming that we are able to measure the level of competition, industry i's dependence on telecommunication technologies, and the diffusion of those technologies in country c, after controlling for industry and country effects, in our empirical specifications we should find that the coefficient of the interaction between the diffusion and dependence is different from zero. Therefore, in the empirical specification we need only to take into account the explanatory variables that vary with industry and country. These are the interaction between the initial/*ex ante* level of the diffusion of telecommunication technologies in country c and the dependence on those technologies of industry i – the variable of interest – and the initial level of the share of an industry in a country in total sales/revenue (industry share).[7] The last one can capture potential convergence effects. For instance, it can correct for the possibility that the larger industries in a country experience lower entry rates (see, for instance, Klapper, Laeven, & Rajan, 2006). This then can affect the intensity of competition.

Our (baseline) empirical specification is then

$$\begin{aligned} \text{Competition}_{i,c} &= \alpha_{1,i} + \alpha_{2,c} \\ &\quad + \alpha_3 \cdot (\text{industry } i\text{'s dependence} \times \text{the diffusion in country } c) \\ &\quad + \alpha_4 \cdot \text{industry share}_{i,c} + \varepsilon_{i,c}, \end{aligned} \tag{1}$$

where $\varepsilon_{i,c}$ is the error term and our focus is on the coefficient of the interaction term α_3. If we follow, for instance, Leff (1984) and Jensen (2007), and believe that cheaper information reduces the costs of entry, then we expect to have positive α_3 (negative if we use an inverse measure for competition).

[7]Our results are not qualitatively different if instead of the share in sales we use the share in value-added.

3 Measures and data

Our empirical analysis is for 21 countries from the European Union. It focuses on the period 1997–2006. We concentrate on this set of countries since we use the OECD STAN and Amadeus databases and want to focus on a somewhat coherent sample. We need these databases in order to construct the measures of competition, for instance. Particularly, we need the Amadeus database for constructing competition measures such as the Herfindahl index and the market share of the four largest firms, which require firm-level data and tend to be widely used both in the literature and by regulatory institutions. Although we could employ data starting from 1993, we do not do so since we have very few (firm-level) observations in the Amadeus database for the period 1993–1996. We could as well employ data until 2008. We do not do so since we want to avoid incorporating data from the recent financial crisis.[8]

That we use data from a rather homogenous set of countries involves tradeoffs. It can eliminate the influence of various unobservable factors on our inference, for example. However, at the same time it can weaken our inference from cross-country comparisons.

In order to estimate the specification we need appropriate measures for the diffusion of telecommunication technologies, the level of industries' dependence on these technologies, and the competition in services and goods markets.

3.1 Country-level variables

Measures for the diffusion of telecommunication technologies

Our primary measure for the diffusion of telecommunication technologies (hereafter, telecom diffusion) is the number of fixed lines and mobile telephone subscribers per capita (hereafter, telecom subscribers).[9] This variable may also measure the availability of the telecommunications infrastructure and is extensively applied in that context (see, for instance, Roller & Waverman, 2001). However, it may not fully reflect the use and the quality of the telecommunication technologies, which can matter for the costs associated with information transmission.

For a robustness check of our main results, we also use the revenue of the telecommunications industry per capita (hereafter, telecom revenue) as the telecom

[8] The telecommunication goods consumption patterns indicate strong differences between pre- and post-financial crisis periods, and no visible differences around the dot-com bubble period 1999–2001.

[9] Adding also internet subscribers can lead to significant double counting since, for example, fixed lines are used extensively for dial-up and DSL internet. However, as a robustness check we use internet subscribers separately as a telecom diffusion measure. Our results remain qualitatively the same.

diffusion measure, which can better account for use and quality. Nevertheless, from the between-countries-comparison perspective, this measure may fail to correctly reflect the amount of telecommunication goods produced since it could be higher, for instance, simply because prices are higher.[10]

These measures can indicate the adoption and use of telecommunication technologies in the entire economy. This is important for us since potential entrepreneurs can use their personal/private telecommunications for acquiring information, while entrepreneurs and firms can use corporate ones. However, clearly at least some part of the use if measured in this manner will be hard to associate with the competition in goods and services markets. An example would be cheat-chat over the phone. From this perspective, therefore, using these measures can play against us since it can bias our results towards zero. In other words, we would find the interaction term to be insignificant in some of the cases when it is significant.

We obtain the data for these measures from the GMID and ITU databases. Tables 1 and 2 offer the country-level variables and correlations between them.

3.2 Industry-level variables

Measures for the dependence on telecommunication technologies

To identify the dependence on telecommunication technologies (hereafter, telecom dependence) we use data for the share of expenditures on telecommunications from the United States. Our most disaggregated data for that is at the 2-digit industry level. We obtain these data from the input-output tables of the Bureau of Economic Analysis (BEA). The original data are in NAICS 2007 and have a time span 1993–2007. We transform it to ISIC rev. 3.1 (hereafter, ISIC), in order to align it with the rest of our data and exclude the industries that are expected to have large state involvement (80, 85, 90, and 91 of ISIC).[11] Further, we average it over the period 1997–2006 and use the average as a measure for the dependence.[12]

Figure 1 provides further support for the validity of this measure. It suggests that the share of expenditures on telecommunications in the United States virtually has not changed. A simple ANOVA exercise on our sample confirms this observation

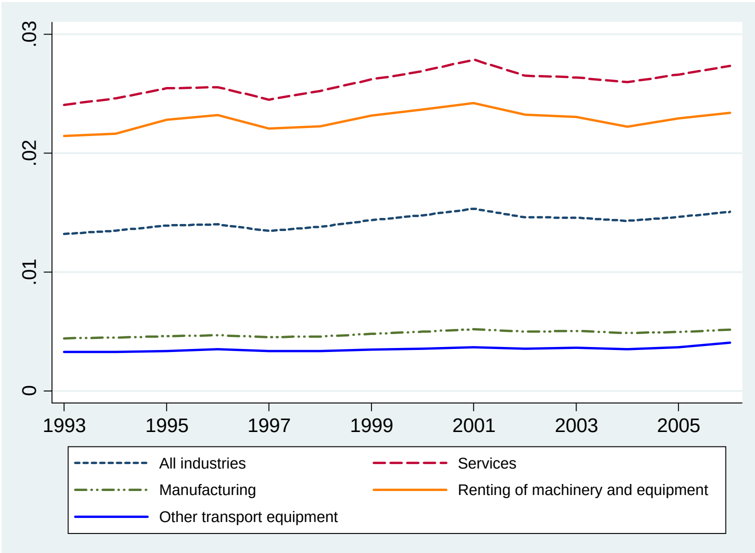
[10] This problem may be alleviated with a purchasing power parity index for the telecommunications industry. We are not aware of any source of such data. Nevertheless, we have checked that our results are qualitatively not different if we adjust the revenue measure by a price measure such as the price of a 3-minute local mobile phone call.

[11] Our results are robust to their inclusion.

[12] We have to acknowledge that this is far from a perfect measure, since it may not be representative for industries where there are significant outliers in terms of telecommunication goods consumption. However, it seems to be the best given the data that we were able to obtain.

and shows that the industry-level variation accounts for 99.48% of the total, while time variation accounts for only 0.52%.[13]

Figure 1: The share of expenditures on telecommunications in the US



Note: This figure shows the share of expenditures on telecommunications (our measure of dependence on telecommunication technologies) in all industries in the US in the goods/manufacturing sector, the services sector, the renting of machinery and equipment industry, and the other transport equipment industry in the period 1993–2006. The data are from the Bureau of Economic Analysis.

For a robustness check we also obtain data for Japan and the United Kingdom. The data is from the input-output tables from the OECD STAN database. It has a structure similar to the 2-digit ISIC, though it is slightly more aggregated. Moreover, it is only for 1995, 2000, and 2005. In our specifications we use the average of these three years. For a comparison, we have also obtained data from the OECD STAN database for United States industries.

Table 3 offers the industry level variation of these measures. It also offers the share of expenditures on telecommunications in industries averaged for all the European Union countries in our sample (see also Table C in Appendix D.3 for the industry-time variation in the US). We derived the latter from the OECD STAN database. We use these data for computing rank correlations between our dependence measures and the shares of expenditures on telecommunications in industries in the European Union countries. Table 4 reports the rank correlations. They are highly significant and range from 0.6 to 0.9 with a mean 0.8, which provides further support for our telecom dependence measures.

[13] The same exercise for services industries yields virtually the same results (98.59% instead of 99.48%), even though Figure 1 seems to visually suggest that there was time variation in these industries.

Measures for competition and the share of sales

We use five measures of product market competition averaged over the period 1997–2006. These measures tend to be the most widely applied and/or theoretically robust.

Following Nickell (1996) and Aghion *et al.* (2005), our primary (inverse) measure of product market competition is the price cost margin (PCM). Under the assumption of constant marginal cost, it is the empirical analogue of the Lerner index. Therefore, it tends to be the reference competition measure and is widely applied in the recent empirical literature.

Using industry-level data, PCM is a weighted sum of Lerner indices in the industry across firms, where the weights are the market shares of the firms. In industry i, country c, and at time t, PCM is given by

$$PCM_{i,c,t} = \frac{(Revenue - Variable\ cost)_{i,c,t}}{Revenue_{i,c,t}}, \tag{2}$$

where the variable costs include labor compensation and intermediate inputs.[14]

Our second (inverse) measure for the intensity of competition is the profit elasticity (PE), introduced in Boone, Ours, & Wiel (2007) and Boone (2008). Profit elasticity captures the relation between profits and efficiency. This relation can be argued to become steeper as competition intensifies since in a more competitive environment the same percentage increase in costs reduces the profits more. In a given pair of industry and country and for all time periods PE is estimated using the following empirical specification

$$\ln \pi_{f,t} = \beta_{1,f} + \beta_{2,t} + \beta_{3,t} \ln \left(\frac{Variable\ cost}{Revenue} \right)_{f,t} + \eta_{f,t}, \tag{3}$$

where f stands for firm-level observations and $\eta_{f,t}$ is an error term. PE in industry i, country c, and time t is the estimated coefficient $\hat{\beta}_{3,i,c,t}$.[15]

The third and fourth (inverse) measures that we use are concentration mea-

[14]We follow Collins & Preston (1969) and Boone, Griffith, & Harrison (2005) while specifying PCM. In contrast, if we followed Aghion *et al.* (2005), we would have in the numerator net operating surplus minus financial costs. We do not prefer that measure since we have much less data for it. Meanwhile, it is highly correlated with our measure (0.7) and our results are qualitatively the same with it.

According to Carlin, Schaffer, & Seabright (2004), PCM is highly correlated with the percieved measures of competition such as the number of competititors that the firms report. Moreover, it tends to reflect the industry/market structure fairly well according to, for instance, Collins & Preston (1969).

[15]Clearly, it can be argued that due to simultaneity there is an identification problem here. We do not intend to solve that problem in this study.

sures. The third one is the Herfindahl index (HI), which is defined as the sum of the squared market shares of firms within an industry. Formally,

$$HI_{i,c,t} = \sum_{f=1}^{N_{i,c,t}} \left(\frac{Revenue_{f,i,c,t}}{\sum_{f=1}^{N_{i,j,t}} Revenue_{f,i,c,t}} \right)^2, \tag{4}$$

where N is the number of firms. The fourth one is the market share (MS) of the four largest firms in terms of revenues in each industry. Formally,

$$MS_{i,c,t} = \frac{\sum_{\tilde{f}=1}^{4} Revenue_{\tilde{f},i,c,t}}{\sum_{f=1}^{N_{i,c,t}} Revenue_{f,i,c,t}}, \tag{5}$$

where $\tilde{f} = 1, 2, 3, 4$ are the largest firms in industry i and country c at time t.

The fifth measure of competition is the number of firms in each industry, $N_{i,c,t}$. It may seem to be the most simplistic and the most disputable at the same time. It would relatively firmly approximate the intensity of competition in situations close to symmetric equilibrium.

Even though these measures are widely applied, it has to be acknowledged that in certain cases they may not fully reflect the intensity of product market competition. For instance, when the competition intensifies from more aggressive conduct some firms may leave the market. In such a situation the Herfindahl index, being a concentration measure, can fail, suggesting that the intensity of competition has decreased. In the same situation a similar problem can arise with the market share of the four largest firms when, for instance, one or several of the largest firms leave the market.[16] Meanwhile, the price cost margin may fail in such a case when, for instance, inefficient firms leave the market. This would increase the weight of more efficient firms and, therefore, can increase the price cost margin (for further discussion see Tirole, 1988; and Boone *et al.,* 2007). Given its definition, this problem is not present, however, in the measure of competition PE. Nevertheless, given that all our measures have a somewhat different nature (i.e., can reflect different forces behind the intensity of competition) it seems reasonable to use them for robustness checks of our results. It is worth noting also that averaging over time would alleviate some of these concerns since in such a case we focus on a rather long-term level of competition.

The data for the price cost margin and number of firms we take from the OECD STAN database. We use the Amadeus database for the Herfindahl index,

[16] Another possible criticism that applies to concentration measures such as MS and HI is that these are more tied to the geographic and product boundaries of the market in which the firms operate (Aghion *et al.,* 2005).

the market share of the four largest firms, and the profit elasticity since we need firm-level data for these measures.

The Amadeus database has several features that need to be highlighted. First, in this database there is virtually no data for the financial intermediation and insurance and pension funding industries. Therefore, our analysis for competition measures from Amadeus does not contain those industries.[17] Second, the industry classifications vary over time and across countries. In order to align them with the rest of our data, we have transformed them to the 2-digit ISIC format. Third, this database does not cover the universe of firms and may not have a representative sample. For instance, according to Klapper *et al.* (2006), it tends to overstate the percentage of large firms. This can affect the competition measures identified from that database.

Our industry and country fixed effects are likely to reduce such biases, nevertheless, we perform several robustness checks. Klapper *et al.* (2006) compare their data from Amadeus with data from Eurostat in terms of the within-industry distribution of the size of the firms. They keep only the industries and countries which are sufficiently close to the data from Eurostat. We check that all our results hold for the sample of countries and industries which were employed in Klapper *et al.* (2006). This sample excludes Portugal and Ireland and ISIC industries 10-14, 40, 41, 90-93. We also calculate the price cost margin from firm-level data from the Amadeus database (PCMa) and check that all our results hold for the sample of countries and industries that have sufficiently close PCM and PCMa [i.e., the square of the percentage difference, $\left(\frac{PCM-PCMa}{PCM}\right)^2$, is less than its median in the entire sample, 0.21].[18]

In the same spirit, we calculate the number of firms from the Amadeus database and check that all our results hold also for that measure. We describe further that database and our data cleaning procedure in Appendix D.2.

Finally, the share of an industry in a country in total sales in 1997 we obtain from the OECD STAN database.

Tables 5–6 report the descriptive statistics and correlations between the competition measures. Tables 7–8 report the descriptive statistics and correlations between the remaining industry level variables. Table A in Appendix D.1 further

[17]We could use the Bank Scope database for these industries. We do not do so since in this database, similar to the Amadeus database, the firms that have exited prior to the release/edition of the database are excluded from the sample. We are able to tackle that problem in the Amadeus database by combining several releases.

[18]Table B in Appendix D.3 offers the frequency of having a higher-than-median (0.21) squared percentage difference between PCM and PCMa for the industries in our sample. The highest frequency is in the services industries and industries associated with mining.

details the variable definitions and the sources of all variables.

4 Results

In Table 9, column (I), we present our main results from the baseline specification (1). The dependent variable is our main (inverse) measure of product market competition PCM, averaged over the period 1997–2006. Meanwhile, in the interaction term we have our main measures of telecom dependence and telecom diffusion. These are the share of expenditures on telecommunications in the US, which we identify from the BEA database and average over the period 1997–2006, and the logarithm of the fixed and mobile telephone subscribers per capita in 1997.

The estimate of the coefficient on the interaction term is negative and significant at the 1% level [-2.72 (SE 0.37)].[19] Given that smaller values of PCM correspond to higher competition intensity, this indicates that in industries that depend more on telecommunication technologies, competition is more intensive in countries with higher telecom diffusion. Telecom diffusion, therefore, has a positive effect on the intensity of competition in the services and goods markets.

Since we have a difference-in-differences estimate, one way to compute the magnitude of our result is as follows. We take the countries that rank in the 25th and 75th percentiles of the level of telecom diffusion and compute the difference between the logarithms of telecom diffusion levels. The countries are Estonia (25th) and France (75th) in our sample. Further, we take the industries that rank in the 25th and 75th percentiles of the level of dependence on telecommunication technologies and compute the difference between dependence levels. In our sample these industries are other transport equipment (25th) and renting of machinery and equipment (75th). Finally, we compute

$$\hat{\alpha}_3 * \Delta\text{telecom dependence} * \Delta \log\left(\text{telecom diffusion}\right), \tag{6}$$

where Δ stands for the difference operator between the 75th and 25th percentiles. The computed number is -0.023. This means that the difference in PCM (the intensity of competition) between renting of machinery and equipment and other transport equipment is lower (higher) by 0.023 in France as compared to Estonia. This difference is relatively large compared to the mean of PCM, 0.190 (12%).

In an attempt to rule out other explanations of our main result we conduct a range of robustness checks.

[19] The major part of the high R-squared is attributable to industry and country dummy variables.

4.1 Robustness checks

Alternative measures for competition

In order to check whether our results are robust in terms of the competition measure we estimate our baseline specification (1) for the remaining four competition measures. Columns (II)-(V) in Table 9 report the results where, all else equal, the dependent variable is correspondingly the profit elasticity, the Herfindahl index, the market share of the four largest firms, and the total number of firms in an industry [-28.23 (SE 12.85); -1.56 (SE 0.56); -1.82 (SE 0.62); and 16.94 (SE 3.86)]. Column (VI) reports the results for the price cost margin, which is derived from the Amadeus database [-0.59 (SE 0.26)].[20]

All the estimates of the coefficients on the interaction terms have the expected signs and are significant at least at the 5% level. The estimated coefficient in the specification for PCMa is considerably smaller, though, than our main result. The predicted magnitude of the effect according to this estimate is also smaller, -0.005. However, relative to the mean of this measure, 0.094, the predicted magnitude is still comparably large, 5%.

We have also estimated the baseline specification (1) for all competition measures for a subsample where the square of the percentage difference between PCM and PCMa is smaller than its median. Our results remain qualitatively the same, but are not reported.[21]

We further report the estimation results exclusively for PCM. We have checked, however, that all our results stay qualitatively the same for other measures of competition.[22]

Alternative measure for telecom diffusion

Column (I) in Table 10 offers the results where we use the (logarithm of) telecom revenue in 1997 for measuring telecom diffusion, while for competition and telecom dependence we use our main measures. The estimated coefficient is negative and significant at the 1% level, which complements the result reported in column (I) of Table 9. Although the coefficient is somewhat smaller [-1.49 (SE 0.24)] the predicted magnitude of the effect is very close, 0.035 (Hungary is at the 25th percentile and

[20] We have also checked that this result holds when we take the number of firms from the Amadeus database, which, in contrast to the OECD STAN database, does not have a full coverage.

[21] The results from all robustness checks are available upon request.

[22] We have also used import penetration (imports over sales) as a competition measure. The estimated coefficient is positive, though not significant at the 10% level and is not reported. The positive coefficient is consistent with the rest of our estimates. Meanwhile, the estimate is not significant, perhaps because we have little data for that measure.

Finland is at the 75th percentile in terms of telecom revenue).

We report the results only for telecom subscribers. We have, nevertheless, checked that all our results are qualitatively the same for the telecom revenue measure.

Alternative measures for telecom dependence

Thus far we have reported the results for our main measure of telecom dependence. In columns (II)-(IV) of Table 10 we check whether identifying the dependence measure from 1994 data for the US and from data for Japan and the UK improves or alters our results.

Given that EU countries tend to be behind in terms of the application of ICT, we could expect that in the regression where the dependence measure is from the US data for 1994, the coefficient on the interaction term is higher. It is, although very marginally [-.2.74, (SE 0.37)]. The magnitude of the effect does not change, either. An explanation for this can be the maturity of telecommunication technologies in the US already by 1994, which is consistent with the observation of virtually no time variability in our measure of dependence.[23]

We retrieve the data for Japan and the UK from the OECD STAN database. All the estimates are again negative, which reaffirms our main result. The estimate for the measure identified from the data for Japan is somewhat smaller than the main result, although not substantially [-1.18 (SE 0.23)]. The result for the measure identified from the data for the UK is smaller [-0.65 (SE 0.30)]. However, it is not substantially smaller from the result for the measure identified from the OECD STAN database for the US [-1.69 (SE 0.24)], column (V). The former, in its turn, is quite close to the main result. It is different, however, since the OECD STAN database has slightly higher industry aggregation.[24] The magnitudes of the effects also vary, though not considerably.

A reason behind such variation can be higher noise in the UK and Japanese data. For instance, the dependence measures identified from the data for these countries have lower rank correlations with the share of telecommunications expenditures in the industries in the European Union countries compared to the measures identified from the data for the US (see Table 4).

The last column of Table 10 reports the results when we use as a measure for

[23]One way to explore further our conjecture is to use sufficiently dated data. We do not have such data.

[24]We also estimated baseline specification (1) for the overlapping sample of industries of BEA and OECD STAN for the US measures. The estimates are very close: -1.8 (SE 0.30) and -1.1 (SE 0.20), respectively.

dependence the country-time average of the expenditure share on telecommunications in industries in the EU countries in our sample. The estimate of the coefficient on the interaction term is not qualitatively different from the main one [-1.54 (SE 0.35)]. We further report exclusively the results for our main measure of telecom dependence. We have, nevertheless, checked that all our results are qualitatively the same for the remaining measures.

Alternative estimators and robustness to outliers

The competition measure PCM varies from 0 to 1. We estimate the baseline specification (1) with Tobit and report the results in column (I) of Table 11 [-2.72 (SE 0.35)]. Further, in order to alleviate the influence of outliers, if any, we estimate the baseline specification using quantile regression. We estimate it also on a sample that excludes the first and the last percentiles of the dependent variable, PCM. The results are reported in columns (II) and (III) of Table 11 [-2.20 (SE 0.40) and -2.63 (SE 0.36), respectively].

In our difference-in-differences estimation we essentially divide the countries into high diffusion (HDIFF) and low diffusion (LDIFF) and the industries into high dependence (HDEP) and low dependence (LDEP). Abstracting from the control variables, our estimate is

[HDEP(HDIFF)-LDEP(HDIFF)]-[HDEP(LDIFF)-LDEP(LDIFF)],

which captures the average effect only. The effect that we compute with this non-parametric estimator is -0.018. This result reassures that the effect that we have identified previously is generally present in all countries and industries.

When appropriate we have checked that all our results are qualitatively the same with these alternative estimators. In the remaining reported regressions we have used OLS.

Alternative explanations: Varying sample restrictions

Time period - Do we capture integration processes?

We also test whether our results are robust to various sample restrictions. First, we restrict our sample to 2000–2006 in order to check whether the integration processes in the European Union affect our results. Column (I) in Table 12 reports the results from the baseline specification. The dependent variable is PCM and, together with the measure of telecom dependence, it is averaged over the period 2000–2006. The measure of telecom diffusion and the industry share variable are in 2000. The estimate of the coefficient on the interaction term is negative and highly significant [-3.34 (SE 0.56)].[25] Its magnitude has increased in comparison with the main results, but not considerably. This suggests that the integration processes are not likely to be the drivers behind our results.

Country level - Are new and old EU member countries and the UK different?

The former transition countries Czech Republic, Slovakia, Estonia, Slovenia, Poland, and Hungary, which joined the EU in 2004, can be different from the remaining countries in our sample. In these countries the privatization process has resulted in the emergence of a large number of private firms (Klapper *et al.*, 2006). Moreover, these countries have gone through large structural/industry changes. The latter can affect the intensity of competition, whereas the former can affect the patterns of the use of telecommunication technologies. We want to make sure that our results are not driven by this. Column (II) in Table 12 reports the results when we exclude these countries from the sample [-3.67 (SE 0.82)]. Column (III) reports the estimates exclusively for these countries [-4.11 (SE 0.92)]. Both estimates are statistically indistinguishable from our main results and from each other, though the estimate for the new members tends to be somewhat bigger in absolute value.[26]

In this respect, the UK also can be expected to be different from the remaining countries, in terms of the use of telecommunication technologies and its development level. Column (IV) in Table 12 excludes the UK from the sample. The result is the same as our main result [-2.72 (SE 0.37)]. We have also estimated our baseline specification (1) for the subsample of countries (and industries) that was employed in Klapper *et al.* (2006). Our results remain qualitatively the same, but are not reported.

We further check whether sectorial or industry differences drive or affect our results.

Sector/Industry level - Are the services industries different?

The processes behind our results may be different in the services sector compared to the goods/manufacturing sector. This is because, given their nature, services products can be more easily marketed and delivered over telecommunication networks. In such a case, first, in line with the literature on electronic versus regular

[25]Our results are virtually the same if we consider the period 1997–1999. Our results also do not change when we add to our specification the interaction of telecom dependence and the ratio of imports and/or exports to GDP. Similarly, they do not change when we add the interaction of telecom diffusion with the ratio of imports and/or exports to sales at the industry level.

[26]For a formal test we add to baseline specification (1) the interaction term multiplied by a dummy for the new member countries and check if that additional term is significant. We have done this in all the appropriate cases.

market places, it seems reasonable to expect that the role of consumers' search costs is different for these industries. These costs can be important since they can affect the intensity of competition (e.g., Bakos, 1991). Although theory does not have a clear-cut inference, the empirical studies seem to point out that the relationship is likely to be negative (Brynjolfsson & Smith, 2000; and Brown & Goolsbee, 2002). Second, if transportation costs are a significant part of the fixed costs that the services firms incur in their operations, then the diffusion could motivate entry while reducing those costs (i.e., it would create room for entry). The entry then would intensify the competition.

Columns (I) and (II) of Table 13 report the results when we restrict the sample to the services or goods sectors. The estimate of the coefficient for the goods sector is basically the same as our main estimate [-2.79 (SE 1.71)]. Meanwhile, the estimate of the coefficient in the services sector is slightly lower [-3.24 (SE 0.65)], which is in line with the suggested effect of the search and transportation costs. However, this estimate is not significantly different from the main one either.[27]

Sector/Industry level - Are those that use telecommunications the least different?

We have also checked that our results are qualitatively not different from the main result for the industries that, most likely, affect telecom diffusion the least. We try to identify such industries in two ways. First, we take the interaction between the variables industry share and telecom dependence and for a country take those industries that have a value lower than the median in the country. Second, in a country we take those industries that have below than the median expenditures on telecommunications in 1995 in the country. The data for this measure we obtain from the input-output tables from the OECD STAN database. We use the dependence measure identified from that database in the estimation for this group of industries since the OECD STAN database has a slightly different aggregation.

Columns (III) and (IV) of Table 13 report the results. The coefficient for the industries that have lower-than-median interaction between telecom dependence and industry share is essentially the same as our main result [-2.93 (SE 1.97)]. Meanwhile, the coefficient for the industries that have lower than the median expenditures on telecommunications in 1995 is very close to the result which we have obtained using OECD STAN data for the dependence measure [-1.38 (SE 0.51)]. This exercise suggests that our results are not likely to be driven by reverse causality. Nevertheless, we continue to explore such a possibility.

[27] The result for services industries is essentially the same if we exclude the transport industries, ISIC 60-62.

Alternative explanations: Reverse casuality

Instrumental variables

Our inference would be incorrect if a third factor is responsible for the intensity of competition and is correlated with the interaction between telecom dependence and diffusion. In this section we attempt to rule out such an explanation of our results.

First, we try to further alleviate the reverse causality concerns and instrument the predetermined level of the diffusion of telecommunication technologies. The set of instruments that we use consists of dummy variables for country groups: New members of the EU (post-transition countries), Scandinavian countries, and France and Germany. The first set of countries inherited its (antiquated) telecommunications infrastructure from the socialist regime. Scandinavian countries, in turn, were very effective in promoting universal access via state control and subsidies after deregulation (Gruber & Verboven, 2000; and ITU, 2002). Meanwhile, France and Germany had the best access to mobile technologies through industry leaders such as La Compagnie Generale d'Electricite and Siemens. These dummy variables explain approximately 70% of our diffusion measures. Column (I) in Table 14 reports the results [-2.76 (SE 0.40)]. They are no different from our main results.[28]

Our country-group-level instrumental variables may not solve the endogeneity problem, however. It might be that they are correlated with some omitted variables and therefore do not satisfy the exclusion restrictions.

Omitted variables - Do we identify other costs of entry?

According to, for example, Klapper *et al.* (2006), the countries identified with our instruments are quite different in terms of variables that matter for the entry (and potential entry) and size distribution of firms and, thus, for the intensity of competition. Following Klapper *et al.* (2006) and Scarpetta, Hemmings, Tressel, & Woo (2002), these variables are the bureaucratic costs of entry, human capital development (or the availability of qualified personnel), financial development, employment law, and property rights and market regulations (see Tables 1 and 2 for basic statistics and correlations). To the extent that the diffusion of telecommunications is correlated with these variables (e.g., because it reflects the business environment) and the rank of telecom dependence is correlated with the rank of the industries that are mostly affected by these variables, our inference would be incorrect.

One way to check whether these variables matter in our setup is the following. First, we find a measure that identifies the ranking of industries according to

[28] Our results remain qualitatively the same if we do not use the dummy for the new members of the EU.

the effect these variables should have on them (i.e., on the competition in those industries). Next, we interact this measure with a proxy of a variable and add it to the baseline specification (1). In case these variables drive our results, the coefficient of the interaction between telecom dependence and diffusion should become insignificant.

A. Identifying the ranking of the industries according to the effect

The bureaucratic costs of entry, according to Klapper *et al.* (2006), have a higher impact on entry in "naturally" high-entry industries. It would be reasonable to expect that market regulation matters in these industries in a similar way. Meanwhile, financial development, according to Rajan & Zingales (1998), has a higher impact on the creation of new establishments in industries that depend more on external finance. Further, property rights regulation and human capital development would have a disproportionate impact on the industries that have high R&D intensity. In turn, the strictness of employment law could be expected to have a disproportionate impact on the industries that have high labor intensity.

We use the measure and the data of Klapper *et al.* (2006) to identify the "naturally" high-entry industries. In an industry in the US, it is defined as the percentage of new corporations (firms that are not more than one year old). It is averaged over the period 1998–1999 in that paper. We take the measures and the data for dependence on external finance and R&D intensity from Bena & Ondko (2012). The first is defined as the industry median of the average of the ratio of capital expenditures minus cash flows from operations to capital expenditures over the period 1996–2005. Meanwhile, R&D intensity is defined as the industry median of the ratio of averages of R&D expenditures to capital expenditures over the period 1996–2005. As a measure for labor intensity we use the ratio of the number of employees to sales in US industries.[29] We take these data from the OECD STAN database and average them over the period 1997–2006. Tables 7 and 8 offer the basic statistics and correlations.

[29]The results are essentially the same when we use labor income share instead of the number of employees over sales.

B. Measuring the costs

The measure and the data for bureaucratic costs of entry we obtain from Djankov, Porta, Lopez-de-Silanes, & Shleifer (2002). According to the authors, these costs include all identifiable official expenses in a country.[30] In turn, in order to measure the country-wide market regulation we use the product market regulation indicator from OECD Stat. This indicator takes into account the public control of business, bureaucratic barriers to entrepreneurship, trade, and investment. Higher values stand for higher product market regulation. The level of financial development we measure as stock market capitalization over GDP.[31] We take the data from the WDI database. The measure for the strictness of the employment law, and its data, we obtain from Botero, Djankov, La Porta, Lopez-de-Silanes, & Shleifer (2004). This is an index that takes into account job security, the conditions of employment, and the provisions in laws regarding alternative employment contracts. Higher values mean higher protection for a worker. Further, in order to proxy the property rights regulation we use the property rights index constructed by the Heritage Foundation. It measures the protection of private property in a country. Higher values stand for higher private property protection. As a measure of human capital development we use the average years of schooling for the population older than 25. The data are for 1995, and we obtain it from the Barro-Lee tables, the World Bank.[32] Given availability, the data for these measures are for 1999, 1997, 1997, 1998, 1997, and 1995 respectively.[33]

C. Answering the question

Columns (II)–(VII) of Table 14 report the results. Clearly, the fact that we use data for the years 1999 and 1998 for entry costs and market regulation can raise further endogeneity concerns. However, as we have already reported, our results are no different when we use data for competition, dependence, and diffusion measures from the period 2000–2006, for instance.[34]

The coefficient on the interaction term between telecom dependence and diffusion remains virtually the same in all cases. It somewhat, though, reduces in

[30] We have also tried adding the interactions of entry rate and labor intensity variables with the overall economic freedom index (in 1997) from the Heritage Foundation. Our results remain virtually the same.

[31] Our results are the same when we use private credit over GDP and GDP per capita instead of market capitalization over GDP.

[32] We have experimented with various measures of human capital development. None of them affects our inference differently.

[33] See Table D in Appendix D.3 for correlations between the main interaction terms and the interaction terms that we use for specification/robustness checks.

[34] We have also tried to adjust our sample to the period 1996–2005 when using data from Bena & Ondko (2012). Our results remain qualitatively the same.

absolute value when we insert the interaction between employment law and labor intensity, column (V). However, this effect is neither significant nor driven by that interaction term. The estimate of the baseline regression on the subsample where we have values for the latter interaction term is virtually the same. Generally, the signs of the coefficients of these additional interaction terms are intuitive, although the estimates are not significant. For instance, higher entry costs and more strict market regulation are likely to hinder entry (and potential entry) in naturally high-entry industries. Therefore, they might reduce the intensity of competition in these industries. The strictness of the employment law can reduce the future expected value of the entrant more in labor-intensive industries. Therefore, it may hinder entry (and potential entry) and competition in such industries. The respective estimates are correspondingly positive. The estimates of the coefficients on interaction terms for financial development and property rights are also positive. A possible explanation for this is that the incumbents use, for example, patent protection and finance for deterring entry and/or escaping competition. Exploring these conjectures is well beyond the scope of this study.

All these additional interaction terms, as well as our main interaction term, may proxy for the business environment in the country. Another rough way to proxy for that, together with the entrepreneurial culture in the country, is to include an interaction term of telecom dependence with the average intensity of competition for the country. Our main result is not affected by such an inclusion; it also stays unaffected if we include all these interaction terms at once, but these results are not reported.

It may also be argued that the ranking of the industries according to their dependence on telecommunication technologies corresponds to the ranking of industries according to the effect these variables have on them. In columns (I)–(VI) of Table 15 we include the interactions of the telecom dependence measure with the respective variable together with our main interaction term one-by-one. Our main result, again, stays basically unchanged. The estimates of the coefficients on interactions with bureaucratic costs of entry, market regulations, and employment law are positive, though insignificant. This result suggests that in countries where either the entry costs are higher or market regulation or employment law are tougher the competition is lower in industries that depend more on telecommunication technologies. The coefficients on the interactions with financial development/market capitalization and human capital availability are negative, although only the former is significant. This suggests that (potential) entrants and/or the intensity of competition may indeed benefit from financial development and the availability of human capital. It would do so more in industries that depend more on telecommunication technologies. Meanwhile, the estimate for property rights is positive and highly significant. This is in line with our previous conjecture that the incumbents may enforce their patents and loosen the competition.

Omitted variables - Does our measure of dependence simply identify the growth potential of the industries?

It could also be that the measure of dependence on telecommunication technologies identifies the industries that have high growth potential/opportunities. Meanwhile, such industries could depend on the availability of modern technologies, which can be proxied by the telecom diffusion variable, and face tougher competition due to attractiveness.

In order to measure the growth potential of the respective industries, following Fisman & Love (2007), we use the growth rate of US industries averaged over the period 1998–2007. We obtain this data from the sales figures from the Bureau of Economic Analysis. This measure seems to be the most appropriate given the relatively low market imperfections in the United States. However, it could fail if there are important taste differences in the US compared to our sample countries. Therefore, we also use the growth rates of industries in the three most developed (measured by GDP per capita) EU countries in our sample averaged over the period 1998–2007.[35]

We interact the measures of growth potential with the telecom diffusion variable and include those in the baseline specification. Columns (I) and (II) of Table 16 report the results. The estimate of the coefficient on the interaction between telecom dependence and diffusion stays virtually unaffected. The estimated coefficients on the interactions between telecom diffusion and the measure of growth potential are negative. This suggests that in countries where the diffusion of telecommunication technologies is higher the competition is more intensive in industries with higher growth potential. An explanation for this can be exactly that these industries depend more on such (modern) technologies (see Table 8 for the correlation between the measure of telecom dependence and growth potential).[36]

Omitted variables - Does the shadow economy matter?

Finally, we are concerned that countries with bigger shadow economies could have lower reporting of output and lower competition due to adherence to rather informal

[35] The countries are Denmark, Norway, and Sweden.

[36] Tables E, F, and G in Appendix R.1 report the results for the additional interaction terms when we do not include our main interaction term.

agreements.[37] Meanwhile, it could be that the industries that depend more on telecommunication technologies have a higher share in the shadow economy (e.g., services).

We take the measure of the size of the shadow economy and the data for it from Schneider (2002). This variable is in percentage of GNP and is averaged over the period 1999–2000. Column (III) of Table 16 includes the interaction of this variable with the telecom dependence measure and reports the results. The estimate of the coefficient on the interaction between telecom diffusion and dependence is virtually not affected. Meanwhile, the estimate of the coefficient on the interaction between the measure of the size of shadow economy and telecom dependence is positive, although not significant. This suggests that the economies with a larger shadow economy tend to have lower competition in the industries that are more dependent on telecommunication technologies.

In the same vein, in the baseline specification (1) we have also included the interactions between GDP per capita and telecom dependence and CPI and telecom dependence [see columns (IV) and (V) in Table 16]. The main result is, again, virtually unaffected. In the case of CPI it is slightly, though not significantly, higher. The change in the value, however, is not due to the inclusion of the new interaction term since it is virtually the same for the subsample where we have observations for CPI.[38]

For a further robustness check, we included in the baseline specification the principal components of the matrix of all additional interaction terms which explain 92% of the variation in the data. We have used principal components due to high collinearity between the variables. Our main result is virtually the same, but is not reported.

5 Conclusion

In this study we use industry-country-level data in order to identify the effect of the wider adoption and more intensive use (diffusion) of telecommunication technologies on the competition in services and goods markets. Taken together, our results offer a robust inference that the diffusion of telecommunication technologies significantly intensifies competition. It does so especially in the industries that depend more on

[37]For example, in our sample PCM is 6% higher in countries where the shadow economy is more than the median compared to the remaining countries.

[38]In line with Klapper *et al.* (2006) we have also checked if the coefficient on the interaction term in the baseline specification is different for countries with a higher development level and lower corruption level. We have found no systematic and significant differences.

these technologies.

According to the theory and empirical evidence the intensity of product market competition matters for allocative and productive efficiency. Therefore, our empirical results highlight a mechanism for how the use of telecommunication technologies can contribute to economic performance. This complements, for example, the cost reduction mechanism that tends to be extensively analyzed in the literature.

Our results also suggest that the policies intended to promote the diffusion of telecommunication technologies can complement competition policies.

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Tables

Summary statistics and correlations

Table 1: Country-level variables

Country	Telecom subscribers	Telecom revenue	GDPC	CPI	B.Entry cost	Market regulation	Market capital.	Empl. law	Property rights	Human capital	Shadow economy
Austria	0.64	389.13	21616.62	7.61	0.27	2.33	0.06	0.50	90	8.65	0.10
Belgium	0.56	377.41	20858.04	5.25	0.10	2.18	0.12	0.51	90	9.72	0.23
Czech Republic	0.37	147.74	5280.83	5.2	0.08	2.99	0.12	0.52	70	11.45	0.19
Denmark	0.91	573.82	27928.02	9.94	0.10	1.59	0.28	0.57	90	9.97	0.18
Estonia	0.44	116.75	3517.05	-	-	-	0.29	-	70	10.48	-
Finland	0.98	512.43	20601.65	9.48	0.01	2.08	0.30	0.74	90	9.17	0.18
France	0.68	389.85	19976.97	6.66	0.14	2.52	0.28	0.74	70	8.30	0.15
Germany	0.65	460.63	21553.48	8.23	0.16	2.06	0.25	0.70	90	9.42	0.16
Greece	0.59	290.06	10431.71	5.35	0.59	2.99	0.15	0.52	70	8.18	0.29
Hungary	0.37	156.29	3996.52	5.18	0.86	2.30	0.16	0.38	70	10.39	0.25
Ireland	0.57	562.44	20016.94	8.28	0.12	1.65	0.20	0.34	90	10.90	0.16
Italy	0.66	380.37	18078.85	5.03	0.2	2.59	0.17	0.65	70	8.43	0.27
Netherlands	0.68	453.77	21819.39	9.03	0.18	1.66	0.74	0.73	90	10.51	0.13
Norway	1.01	863.10	35325.19	8.92	0.05	1.85	0.29	0.69	90	11.14	0.19
Poland	0.22	85.44	3873.72	5.08	0.25	3.97	0.05	0.64	70	9.05	0.28
Portugal	0.55	351.83	10207.43	6.97	0.18	2.25	0.18	0.81	70	6.82	0.23
Slovakia	0.30	105.28	5038.39	-	0.15	-	0.08	0.66	50	11.17	0.19
Slovenia	0.40	135.86	8791.17	-	0.21	-	0.02	0.74	50	8.67	0.27
Spain	0.51	316.32	12761.84	5.9	0.17	2.55	0.79	0.74	70	7.73	0.23
Sweden	1.06	682.45	24527.46	9.35	0.03	1.93	0.70	0.74	70	10.51	0.19
UK	0.70	653.39	22743.77	8.22	0.01	1.07	0.61	0.28	90	8.47	0.13

Note: The first two columns of this table offer the telecom diffusion measures, telecom subscribers and telecom revenue, for every country from our sample. These measures are from 1997. The remaining columns offer the values of country-level variables that we use for robustness checks. See Table *A* in Appendix D.1 for complete definitions and sources of variables.

Table 2: Country-level variables - rank correlations

	Variable	1	2	3	4	5	6	7	8	9	10
1	Telecom subscribers										
2	Telecom revenue	0.92*									
3	GDPC	0.88*	0.93*								
4	CPI	0.75*	0.83*	0.78*							
5	Entry costs	-0.55*	-0.64*	-0.56*	-0.57*						
6	Market regulation	-0.62*	-0.85*	-0.79*	-0.80*	0.57*					
7	Market capitalization	0.63*	0.60*	0.47*	0.64*	-0.52*	-0.56*				
8	Employment law	0.17	0.002	-0.02	0.21	-0.08	0.14	0.37			
9	Property rights	0.59*	0.73*	0.75*	0.63*	-0.41	-0.74*	0.352	-0.34		
10	Human capital	-0.05	0.09	0.08	0.32	-0.37	-0.42	0.005	-0.28	0.14	
11	Shadow economy	-0.47*	-0.60*	-0.59*	-0.63*	0.43	0.62*	-0.43	0.09	-0.60*	-0.21

Note: This table shows the pairwise Spearman's rank correlation coefficients between all country-level variables. See Table A in Appendix D.1 for complete definitions and sources of variables. * indicates 5% significance.

Table 3: Telecom dependence measures

ISIC	Industry	US		ISIC	Japan	UK	US	EU
		1994	1997–2006					
10	Coal mining	0.0032	0.0032	10-14	0.0146	0.0104	0.0076	0.0112
11	Oil and gas extraction	0.0089	0.0085					
13	Mining of metal ores	0.0020	0.0022					
14	Other mining and quarrying	0.0061	0.0064					
15	Food products and beverages	0.0021	0.0022	15-16	0.0025	0.0103	0.0079	0.0060
16	Tobacco products	0.0006	0.0004					
17	Textiles	0.0030	0.0039	17-19	0.0072	0.0082	0.0066	0.0100
18	Wearing apparel	0.0041	0.0057					
19	Luggage, handbags, footwear	0.0020	0.0024					
20	Wood, except furniture	0.0037	0.0044	20	0.0028	0.0076	0.0058	0.0079
21	Pulp and paper	0.0026	0.0030	21-22	0.0104	0.0131	0.0245	0.0245
22	Publishing, printing	0.0143	0.0168					
23	Coke and petroleum products	0.0010	0.0010	23	0.0024	0.0037	0.0024	0.0031
24	Chemicals	0.0026	0.0028	24	0.0084	0.0142	0.0098	0.0099
25	Rubber and plastic products	0.0057	0.0066	25	0.0048	0.0099	0.0079	0.0102
26	Non-metallic mineral products	0.0050	0.0057	26	0.0047	0.0131	0.0093	0.0107
27	Basic metals	0.0024	0.0027	27	0.0025	0.0062	0.0039	0.0055
28	Fabricated metal products	0.0066	0.0072	28	0.0103	0.0096	0.0102	0.0107
29	Machinery and equipment n.e.c.	0.0057	0.0061	28	0.0063	0.0083	0.0145	0.0111
30	Office machinery and computers	0.0040	0.0039	30	0.0042	0.0065	0.0142	0.0137
31	Electrical machinery	0.0038	0.0040	31	0.0052	0.0091	0.0091	0.0095
32	Communication equipment	0.0060	0.0057	32	0.0046	0.0068	0.0160	0.0116
33	Instruments, watches and clocks	0.0087	0.0088	33	0.0072	0.0106	0.0182	0.0149
34	Motor vehicles and trailers	0.0013	0.0015	34	0.0018	0.0051	0.0066	0.0054
35	Other transport equipment	0.0033	0.0036	35	0.0037	0.0057	0.0086	0.0083
36	Furniture manufacturing n.e.c.	0.0078	0.0091	36-37	0.0061	0.0082	0.0164	0.0099
40	Electricity, gas, hot water	0.0023	0.0023	40-41	0.0090	0.0055	0.0074	0.0145
41	Distribution of water	0.0250	0.0290					
45	Construction	0.0138	0.0164	45	0.0178	0.0085	0.0225	0.0083
50	Sale and repair of motor vehicles	0.0283	0.0324	50-52	0.0660	0.0380	0.0480	0.0447
51	Wholesale trade	0.0245	0.0264					
52	Retail trade	0.0232	0.0251					
55	Hotels and restaurants	0.0175	0.0193	55	0.0248	0.0338	0.0305	0.0234
60	Land transport	0.0129	0.0140	60-63	0.0210	0.0246	0.0302	0.0238
61	Water transport	0.0105	0.0118					
62	Air transport	0.0321	0.0351					
63	Supporting transport activities	0.0250	0.0275					
64	Post and telecommunications	0.0177	0.0197					
65	Financial intermediation	0.0250	0.0262	65-67	0.0586	0.1548	0.0344	0.0803
66	Insurance and pension funding	0.0074	0.0071					
67	Activities auxiliary to financial intermediation	0.0602	0.0544					
70	Real estate activities	0.0175	0.0187	70	0.0088	0.0298	0.0267	0.0207
71	Renting of machinery, equipment	0.0216	0.0230	71	0.0115	0.0379	0.0405	0.0411
72	Computer and related activities	0.0642	0.0658	72	0.0421	0.0337	0.0960	0.0766
73	Research and development	0.0168	0.0185	73	0.0654	0.0214	0.0672	0.0431
74	Other business activities	0.0449	0.0485	74	0.0887	0.0488	0.0878	0.0512
80	Education	0.0271	0.0298	80	0.0289	0.0322	0.0467	0.0346
85	Health and social work	0.0244	0.0268	85	0.0107	0.0172	0.0475	0.0258
90	Sewage, disposal, sanitation	0.0129	0.0141	90-93	0.0415	0.0293	0.0426	0.0515
91	Activities of membership organizations n.e.c.	0.0191	0.0187					
92	Recreational, cultural and sporting activities	0.0152	0.0176					
93	Other service activities	0.0293	0.0345					

Note: This table offers the measures of telecom dependence for 2-digit ISIC industries. In the first two columns this measure is computed from the US data using input-output tables obtained from the Bureau of Economic Analysis for 1994 and averaged over the period 1997–2006. The last four columns present this measure for Japan, the United Kingdom, the US and the average within the EU countries from our sample. These are computed using input-output tables obtained from the OECD STAN database and are averaged over the period 1995–2005. See Table A in Appendix D.1 for complete definitions and sources of variables.

Table 4: Telecom dependence measures - rank correlations

Telecom dependence	US	US94	USOECD	EU	Japan	UK
US94	0.99					
USOECD	0.89	0.91				
EU	0.88	0.90	0.87			
Japan	0.88	0.88	0.84	0.87		
UK	0.80	0.80	0.82	0.83	0.84	
Austria	0.74	0.77	0.81	0.87	0.78	0.76
Belgium	0.81	0.84	0.85	0.93	0.80	0.68
Czech Republic	0.92	0.92	0.89	0.92	0.87	0.87
Denmark	0.84	0.83	0.84	0.88	0.83	0.81
Estonia	0.80	0.80	0.82	0.83	0.76	0.71
Finland	0.82	0.82	0.74	0.87	0.80	0.77
France	0.89	0.88	0.84	0.88	0.86	0.81
Germany	0.71	0.74	0.73	0.87	0.74	0.69
Greece	0.87	0.88	0.83	0.94	0.80	0.77
Hungary	0.90	0.89	0.84	0.87	0.89	0.81
Ireland	0.58	0.54	0.45	0.65	0.63	0.62
Italy	0.78	0.81	0.77	0.84	0.79	0.68
Netherlands	0.85	0.85	0.84	0.87	0.78	0.81
Norway	0.67	0.67	0.66	0.78	0.66	0.55
Poland	0.82	0.83	0.86	0.87	0.81	0.78
Portugal	0.89	0.88	0.82	0.91	0.90	0.87
Slovakia	0.86	0.89	0.88	0.93	0.84	0.78
Slovenia	0.85	0.88	0.85	0.93	0.82	0.77
Spain	0.77	0.80	0.79	0.91	0.81	0.82
Sweden	0.73	0.76	0.79	0.88	0.69	0.73

Note: This table offers the pairwise Spearman's rank correlation coefficients between the telecom dependence measures identified from the data for the US, the UK, and Japan and the share of telecommunications expenditures in industries in the European Union countries. See Table A in Appendix D.1 for the definitions and the data sources of Telecom dependence US, Telecom dependence US94, Telecom dependence USOECD, and Telecom dependence EU. All correlation coefficients are significant at the 1% level.

Table 5: Competition measures - descriptive statistics

						Percentiles		
	Nobs	Mean	S.D.	Min	Max	25th	50th	75th
PCM	902	0.190	0.135	0.010	0.889	0.101	0.151	0.234
PE	892	-5.289	3.465	-20.558	-0.032	-7.126	-4.415	-2.653
HI	928	0.138	0.171	0.001	1	0.021	0.070	0.188
MS	928	0.447	0.270	0.021	1	0.216	0.392	0.650
logN	863	7.239	2.634	1.386	13.488	5.439	7.307	9.165
PCMa	928	0.094	0.061	0.019	0.519	0.059	0.078	0.110

Note: This table offers the descriptive statistics of competition measures, where Nobs is the number of country-industry observations in the sample. All measures are averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables.

Table 6: Competition measures - correlations

	PCM	PE	HI	MS	logN
PE	0.27*				
HI	-0.01	-0.24*			
MS	-0.06	-0.29*	0.88*		
logN	0.16*	0.29*	-0.66*	-0.74*	
PCMa	0.49*	0.31*	0.15*	0.16*	-0.19*

Note: This table offers the pairwise correlation coefficients between competition measures. All measures are averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. * indicates the 5% level of significance.

Table 7: Industry-level variables - descriptive statistics

	Nobs	Mean	S.D.	Min	Max	Percentiles 25th	50th	75th
Telecom dependence US	987	0.014	0.015	0.000	0.066	0.004	0.007	0.023
Telecom dependence US94	987	0.013	0.014	0.001	0.064	0.003	0.007	0.022
Telecom dependence USOECD	630	0.023	0.023	0.002	0.096	0.008	0.014	0.030
Telecom dependence JP	630	0.017	0.022	0.002	0.089	0.005	0.008	0.018
Telecom dependence UK	630	0.020	0.028	0.004	0.155	0.008	0.010	0.025
Telecom dependence EU	630	0.021	0.020	0.003	0.080	0.010	0.011	0.024
Industry share	926	0.021	0.025	0.000	0.244	0.005	0.013	0.027
Entry US	924	6.155	1.740	1.740	10.730	5.250	5.935	7.055
Ext. fin. dependence US	966	0.325	0.710	-1.548	2.949	-0.117	0.228	0.665
R&D intensity US	966	0.695	1.150	0.000	4.171	0.018	0.163	0.755
Labor intensity US	672	0.006	0.004	0.001	0.020	0.003	0.005	0.007
Growth potential US	987	0.011	0.033	-0.086	0.087	0.003	0.012	0.023
Growth potential EU	987	0.026	0.040	-0.074	0.215	0.010	0.025	0.039

Note: This table offers the descriptive statistics of industry-level variables, excluding the competition measures. Nobs is the number of country-industry observations. See Table A in Appendix D.1 for complete definitions and sources of variables.

Table 8: Industry-level variables - correlations

		1	2	3	4	5	6	7
1	Telecom dependence US							
2	Industry share	0.08*						
3	Entry US	0.33*	0.11*					
4	Ext. fin. dependence US	0.14*	-0.09*	0.05				
5	R&D intensity US	0.15*	-0.11*	0.42*	0.60*			
6	Labor intensity US	0.35*	0.07	0.21*	-0.13*	-0.15*		
7	Growth potential US	0.53*	0.19*	0.20*	0.43*	0.44*	0.44*	
8	Growth potential EU	0.25*	0.04	-0.26*	0.27*	-0.04	-0.04	0.32*

Note: This table offers the pairwise correlation coefficients between industry-level variables, excluding the competition measures. See Table A in Appendix D.1 for complete definitions and sources of variables. * indicates the 5% level of significance.

Regression results

Table 9: The main result and the results for alternative competition measures

	(I) PCM	(II) PE	(III) HI	(IV) MS	(V) logN	(VI) PCMa
Telecom dependence US	-2.72***	-28.23**	-1.56***	-1.82***	16.94***	-0.59**
× Telecom subscribers	(0.37)	(12.85)	(0.56)	(0.62)	(3.86)	(0.26)
Industry share	0.69***	17.27***	-0.25	-0.59*	10.57***	0.37***
	(0.27)	(4.81)	(0.22)	(0.34)	(2.15)	(0.09)
Observations	902	844	876	876	818	876
R2	0.72	0.56	0.62	0.75	0.93	0.53

Note: This table reports the results from the of baseline specification (1) for all our measures of product market competition. All measures are averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 10: Alternative measures of diffusion and dependence

	(I) Revenue	(II) US94	(III) JP	(IV) UK	(V) USOECD	(VI) EU
Telecom dependence US	-1.49***					
× Telecom revenue	(0.24)					
Telecom dependence [ ]		-2.74***	-1.18***	-0.65**	-1.69***	-1.54***
× Telecom subscribers		(0.37)	(0.23)	(0.30)	(0.24)	(0.35)
Industry share	0.70***	0.69***	0.87***	0.90***	0.93***	0.93***
	(0.29)	(0.271)	(0.34)	(0.34)	(0.33)	(0.33)
Observations	902	902	618	618	618	618
R2	0.71	0.72	0.73	0.73	0.74	0.73

Note: This table reports the results from the baseline specification (1) for various measures of telecom diffusion and dependence. The dependent variable is the competition measure PCM averaged over the period 1997–2006. In column (I) the diffusion measure is the (logarithm of) telecom revenue in 1997. In columns (II)-(VI) we vary the dependence measure. In column (II) the dependence measure is identified from BEA data for 1994 for the US. In columns (III)-(IV) the telecom dependence measure is identified from the data for Japan and the United Kingdom. These data are from OECD STAN. In column (V) the dependence measure is identified from OECD STAN data for the US. In column (VI) the dependence measure is constructed as the average of the industry's share of expenditures on telecommunications in all EU countries from our sample. The data are from the OECD STAN database. All measures from this database are averaged over the period 1995–2005. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 11: Alternative estimators

	(I) Tobit	(II) Quantile	(III) OLS w/o 1 & 100%
Telecom dependence US	-2.72***	-2.20***	-2.63***
× Telecom subscribers	(0.35)	(0.40)	(0.36)
Industry share	0.76***	0.42	0.46**
	(0.27)	(0.26)	(0.22)
Observations	902	902	884
R2	-	0.50	0.68

Note: This table reports the results from the baseline specification for alternative estimators. The dependent variable is the competition measure PCM, which is averaged over the period 1997–2006. Column (I) reports the estimates from Tobit regression with censoring at 0 and 1, column (II) reports the estimates from quantile regression, and column (III) reports the results from OLS regression for the sample that excludes the first and last percentiles of PCM. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Pseudo R2 is reported for quantile regression. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 12: Various restrictions on the time period and sample of countries

	(I) 2000-2006 sample	(II) W/o new EU members	(III) New EU members	(IV) W/o UK
Telecom dependence US	-3.34***	-3.67***	-4.11***	-2.72***
× Telecom subscribers	(0.56)	(0.82)	(0.92)	(0.37)
Industry share	0.81**	0.67**	0.29	0.69**
	(0.33)	(0.29)	(0.39)	(0.28)
Observations	900	637	265	861
R2	0.71	0.70	0.80	0.72

Note: This table reports the results from the baseline specification for various sample restrictions. The dependent variable is the competition measure PCM. In column (I) PCM and telecom dependence are averaged over the period 2000–2006, and telecom subscribers and industry share are for 2000. In column (II) new EU members (Czech Republic, Estonia, Hungary, Poland, Slovakia, and Slovenia) are excluded from the sample. In column (III) only new EU members are included. In column (IV) the United Kingdom is excluded from the sample. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 13: Restrictions on sectors and telecom dependence level

	(I) Services	(II) Manufacturing	(III) Less telecom dependent (interaction)	(IV) Less telecom dependent (expenditure)
Telecom dependence US	-3.24***	-2.79*	-2.93**	
× Telecom subscribers	(0.65)	(1.71)	(1.97)	
Telecom dependence USOECD				-1.38***
× Telecom subscribers				(0.51)
Industry share	0.68**	0.74**	-0.43	0.35
	(0.36)	(0.35)	(0.41)	(0.61)
Observations	411	491	445	307
R2	0.68	0.55	0.634	0.678

Note: This table reports the results from the baseline specification for various sample restrictions. The dependent variable is the competition measure PCM averaged over the period 1997–2006. In column (I) the sample includes exclusively the services industries and in column (II) the sample includes exclusively the goods/manufacturing industries. Column (III) excludes the industries in a country that have a higher-than-median telecom dependence times industry share in the country. Column (IV) excludes the industries in a country that have higher-than-median expenditures on telecommunications in the country in 1995. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 14: Specification check - new variables

	(I) IV	(II) B.Entry cost	(III) Market regulation	(IV) Market capital.	(V) Empl. law	(VI) Property rights	(VII) Human capital
Telecom dependence US	-2.76***	-2.68***	-3.18***	-3.01***	-2.12***	-2.97***	-2.98***
× Telecom subscribers	(0.40)	(0.43)	(0.53)	(0.37)	(0.33)	(0.37)	(0.36)
Entry US		0.01					
× B.Entry cost		(0.01)					
Entry US			0.01				
× Market regulation			(0.01)				
Ext. fin. dependence US				0.02			
× Market Capitalization				(0.02)			
Employment intensity US					0.76		
× Employment law					(5.42)		
R&D intensity US						0.00	
× Property rights						(0.01)	
R&D intensity US							-0.02
× Human capital							(0.02)
Industry share	0.69***	0.74***	0.83***	0.69***	0.52**	0.70***	0.73***
	(0.26)	(0.26)	(0.27)	(0.27)	(0.24)	(0.27)	(0.27)
Observations	902	803	721	882	616	882	882
R2	0.74	0.75	0.74	0.75	0.81	0.75	0.75

Note: This table reports the results from specifications that augment the baseline with additional interaction terms. The dependent variable is the competition measure PCM averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 15: Specification check - new variables

	(I) B.Entry cost	(II) Market regulation	(III) Market capital.	(IV) Empl. law	(V) Property rights	(VI) Human capital
Telecom dependence US × Telecom subscribers	-2.56*** (0.40)	-3.10*** (0.71)	-2.64*** (0.40)	-2.76*** (0.38)	-3.50*** (0.47)	-2.76*** (0.36)
Telecom dependence US × B.Entry cost	1.04 (1.07)					
Telecom dependence US × Market regulation		0.24 (0.47)				
Telecom dependence US × Market capitalization			-0.32 (0.73)			
Telecom dependence US × Employment law				0.11 (1.31)		
Telecom dependence US × Property rights					4.05*** (1.46)	
Telecom dependence US × Human capital						-2.32* (1.22)
Industry share	0.72*** (0.26)	0.79*** (0.27)	0.69*** (0.27)	0.72*** (0.28)	0.67*** (0.28)	0.69*** (0.28)
Observations	857	769	902	857	902	902
R2	0.72	0.71	0.71	0.71	0.72	0.72

Note: This table reports the results from specifications that augment the baseline with additional interaction terms. The dependent variable is the competition measure PCM averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 16: Specification check - new variables

	(I) Growth potential US	(II) Growth potential EU	(III) Shadow economy	(IV) GDPC	(V) CPI
Telecom dependence US × Telecom subscribers	-2.33*** (0.43)	-2.60*** (0.40)	-2.68*** (0.43)	-2.53*** (0.77)	-3.59*** (0.72)
Growth potential US × Telecom subscribers	-0.34** (0.16)				
Growth potential EU × Telecom subscribers		-0.16 (0.14)			
Telecom dependence US × Shadow economy			1.40 (3.66)		
Telecom dependence US × GDPC				-0.13 (0.43)	
Telecom dependence US × CPI					0.06 (0.16)
Industry share	0.68*** (0.27)	0.69*** (0.27)	0.80*** (0.28)	0.69*** (0.27)	0.79*** (0.28)
Observations	90	902	857	902	769
R2	0.72	0.72	0.71	0.72	0.71

Note: This table reports the results from specifications that augment the baseline with additional interaction terms. The dependent variable is the competition measure PCM averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Appendix

Appendix T.1 The model

A very stylized and simplistic model that can deliver predictions in line with our inference is as follows. For simplicity, assume that there is one industry. Let the consumption good (C) be a Dixit-Siglitz aggregate of the products (x) of the firms in that industry,

$$C = \left(\sum_{f=1}^{N} x_f^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{7}$$

where N stands for the number of firms, f indexes the firms, and ε is the (actual) elasticity of substitution between the products of the firms. Let $\varepsilon > 1$ in order to have imperfect competition in the market of x goods.

Normalizing the aggregate demand to 1 and taking the consumption good as the numeraire, from (7) it follows that the demand for the product of the j-th firm is

$$p_{x_j} x_j = \frac{x_j^{\frac{\varepsilon-1}{\varepsilon}}}{\sum_{f=1}^{N} x_f^{\frac{\varepsilon-1}{\varepsilon}}}, \tag{8}$$

where p_j is the price of x_j. Further, assume that in order to produce x amount of the good, the firms require $\frac{1}{\lambda_V} x$ of the consumption good, where λ_V is the productivity. For simplicity, let the firms live for one period. Meanwhile, the entrants pay a fixed cost $\frac{1}{\lambda_F}$ for entry and there is free entry into the industry (where $\lambda_F > 1$ since the aggregate demand is 1). In order to cover those fixed costs the firms are price setters. Moreover, they internalize their effect on the demand for the goods of the rest of the firms in the industry.[39]

The problem of the j-th firm in the industry is

$$\begin{aligned} &\max_{x_j} \pi_j = p_j x_j - \frac{1}{\lambda_V} x_j - \frac{1}{\lambda_F}, \\ &s.t. \ (8)\,. \end{aligned}$$

Assuming symmetricity it can be shown that the equilibrium price p and the profits are given by

$$p = \frac{1}{\lambda_V} \frac{\varepsilon}{\varepsilon - 1} \frac{N}{N-1},$$

$$\pi = \frac{1}{N} \left(1 - \frac{\varepsilon - 1}{\varepsilon} \frac{N-1}{N} \right) - \frac{1}{\lambda_F}.$$

[39] This assumption is necessary for having non-negligible strategic interactions between firms.

Meanwhile, since there is free entry the profits are zero,

$$\frac{1}{N}\left(1-\frac{\varepsilon-1}{\varepsilon}\frac{N-1}{N}\right)=\frac{1}{\lambda_F}.$$

From this condition the number of firms in the industry can be expressed in terms of the elasticity of substitution ε and the cost of entry $\frac{1}{\lambda_F}$,

$$N=\frac{\lambda_F}{2}\left[\frac{1}{\varepsilon}+\sqrt{\left(\frac{1}{\varepsilon}\right)^2+4\frac{1}{\lambda_F}\frac{\varepsilon-1}{\varepsilon}}\right].$$

It is easy to show that the number of firms N declines with the elasticity of substitution ε and fixed costs $\frac{1}{\lambda_F}$.

In this framework the intensity of competition in the industry can be expressed in terms of the (inverse measure) Lerner index,

$$LI=\frac{p_x-\frac{1}{\lambda_V}}{p_x}=\frac{\frac{\varepsilon}{\varepsilon-1}\frac{N}{N-1}-1}{\frac{\varepsilon}{\varepsilon-1}\frac{N}{N-1}}.$$

It is easy to show that LI declines with the number of firms N. This means that when fixed costs decline, or λ_F increases, the competition intensifies. Moreover, the Lerner index declines with the elasticity of substitution,

$$sgn\left(\frac{\partial LI}{\partial\varepsilon}\right)=sgn\left[-\frac{1}{\varepsilon-1}\sqrt{\left(\frac{1}{\varepsilon}\right)^2+4\frac{1}{\lambda_F}\frac{\varepsilon-1}{\varepsilon}}-\frac{\varepsilon}{\varepsilon-1}\left(\frac{1}{\varepsilon}\right)^2-2\frac{1}{\lambda_F}\right]=-1.$$

This implies that higher (by setup symmetric) product differentiation decreases the intensity of competition.

According to, for example, Geroski (1995a) and Leff (1984) information acquisition costs are a significant part of entry costs $\frac{1}{\lambda_F}$ and the diffusion of telecommunication technologies reduces those costs. Therefore, according to this model competition should intensify with diffusion. However, instead, if the diffusion of the telecommunication technologies would help firms to increase product differentiation (notice that $\frac{\partial\pi}{\partial\varepsilon}<0$), then the intensity of competition would decline with it. The combined effect depends on the functional forms of the relationships between ε and λ_F and the diffusion; therefore, it is ambiguous.

This model can be easily extended so that the firms live for more than one period and have fixed costs in their operation. In such a case, assuming free entry, the sum of the streams of revenues minus the variable costs of the firms will be equal to the sum of entry and operational fixed costs. The decline of any of these fixed costs will intensify the competition. Therefore, if the diffusion of telecommunication technologies lowers the operational fixed costs, then this would be another channel how diffusion would intensify competition. Diffusion can lower these costs, for example, for software producing firms while lowering their transportation costs.

It is worth noting also that diffusion may increase the productivity of firms λ_V. However, this wouldn't have an effect on LI in this model.

Appendix D.1 Definitions and sources of variables

Table A: Definitions and sources of variables

Name	Definition and source
	Country-level variables .
Telecom subscribers	The sum of fixed and mobile telephone subscribers per capita. The data are for 1997. Source: GMID and ITU databases.
Telecom revenue	The revenue of the telecommunications industry per capita in constant 2000 US$. The data are for 1997. Source: GMID and ITU databases.
GDPC	GDP per capita in constant 2000 US$. The data are for 1997. Source: WDI, World Bank.
CPI	Corruption perception index. The data are for 1997. Source: Transparency International.
B.Entry cost	The cost of obtaining legal status to operate a firm as the share of per capita GDP in 1999. Source: Djankov et al. (2002).
Market regulation	Product market regulation indicator in 1998. Source: OECD Stat.
Market capitalization	The ratio of stock market capitalization to GDP in 1997. Source: WDI, World Bank.
Employment law	Index of labor regulations in 1997. Source: Botero et al. (2004).
Property rights	Property rights index in 1997. Source: The Heritage Foundation.
Human capital	Average years of schooling of population of age over 25. The data are for 1995. Source: Barro-Lee, World Bank.
Shadow economy	Size of the informal economy as the share of GNP, averaged over the period 1999-2000. Source: Schneider (2002).

Table A: Definitions and sources of variables, continued

Name	Definition and source
	Industry-level variables/competition measures
PCM	Price cost margin is computed as sales (revenue) minus intermediate cost and labor costs divided by sales, averaged over 1997–2006. Source: Authors' calculations using data from OECD STAN.
PE	Profit elasticity in an industry-country pair is the estimate of the coefficient β_3 in the empirical specification (3), averaged over 1997–2006. Source: Authors' calculations using data from Amadeus.
HI	Herfindahl index is defined as the sum of squared market shares of firms within an industry, averaged over 1997–2006. Source: Authors' calculations using data from Amadeus.
MS	Market share of four largest firms in an industry, averaged over 1997–2006. Source: Authors' calculations using data from Amadeus.
logN	Logarithm of the total number of firms in an industry, averaged over 1997–2006. Source: OECD STAN.
PCMa	Price cost margin is defined as the weighted average of firm-level price-cost margins computed as operational profit over operational revenue within an industry, averaged over 1997–2006. Source: Authors' calculations using data from Amadeus.
	Industry-level variables/telecom dependence
Telecom dependence US	The share of telecommunication inputs in US industries, averaged over 1997–2006. Source: Bureau of Economic Analysis, I-O tables.
Telecom dependence US94	The share of telecommunication inputs in US industries, for 1994. Source: Bureau of Economic Analysis, I-O tables.
Telecom dependence USOECD	The share of telecommunication inputs in US industries, averaged over 1995–2005. Source: OECD STAN, I-O tables.
Telecom dependence UK	The share of telecommunication inputs in UK industries, averaged over 1995–2005. Source: OECD STAN, I-O tables.
Telecom dependence JP	The share of telecommunication inputs in Japanese industries, averaged over 1995–2005. Source: OECD STAN, I-O tables.
Telecom dependence EU	The share of telecommunication inputs in industries in the European Union countries from our sample, averaged over the countries and the period 1995–2005. Source: OECD STAN, I-O tables.

Table A: Definitions and sources of variables, continued

Name	Definition and source
	Industry-level variables/other
Industry share	The ratio of sales (revenue) in an industry in a country to the total sales in the country. Source: OECD STAN.
Entry US	Entry rates for US corporations, averaged over the period 1998–1999. Source: Klapper et al. (2006) using Dun & Bradstreet.
Ext. fin. dependence US	The median of the ratio of capital expenditures minus cash flow from operations over capital expenditures (where both are averaged over the period 1996–2005 for a firm). Source: Bena & Ondko (2012) using Compustat.
R&D intensity US	The ratio of median R&D expenditures over median capital expenditures. Both components are for the US and averaged over the period 1996–2005. Source: Bena & Ondko (2012) using Compustat.
Labor intensity US	The ratio of number of employees to production in an industry, in $1000. Source: Authors' calculations using data from OECD STAN.
Growth potential US	The annual growth rate of sales of US industries, averaged over the period 1998–2007. Source: Authors' calculations using data from BEA.
Growth potential EU	The annual growth rate of sales of industries from the three most developed European countries in terms of real GDP per capita in 1997 (Norway, Denmark, and Sweden), averaged over the countries and the period 1998–2007. Source: Authors' calculations using data from OECD STAN.

Appendix D.2 Description of Amadeus and data cleaning

The Amadeus database (Analyse Major Databases from European Sources) is a product of Bureau van Dijk. It consists of full and standardized information from balance sheets and profit-loss account items, identification information, and the industry codes (NACE) of European firms.

Amadeus has a specific feature regarding the exclusion of firms from the database. If a firm exits or stops reporting its financial data, Amadeus keeps this firm four years, and then excludes it from the database. For example, in the 2010 edition of Amadeus, the data for 2006 do not include firms that exited in 2006 or before. For our analysis, we need to have as full a dataset as possible in order to obtain competition measures that better approximate the real intensity of competition. Therefore, we combine and use several Amadeus editions: March 2011, May 2010, and June 2007 downloaded from WRDS, and August 2003 and October 2001 DVD updates from Bureau van Dijk.

From the Amadeus database we take operational revenues (for computing the Herfindahl index and the market share of the four largest firms), operational profit/losses (for computing the PCM), and the industry codes of the firms. We transform all industry codes into ISIC rev. 3.1, to have coherence across countries and other databases. We perform basic data cleaning in order to reduce potential selection bias and measurement errors:

- Drop "empty" firms that do not report operational revenue or total assets at all.
- Drop firms that report their data in consolidated statements in order to avoid double counting of firms and/or subsidiaries, similar to Klapper, Laeven, & Rajan (2006).
- Impute the missing values of key variables using linear interpolation across years. This helps to restore possibly erroneously missing values.
- Drop industries which have less than four firms in a given year.
- Define severe outliers: the first and the last percentiles of relative yearly changes in operational revenue and total assets for each country and the two-digit industry code. If an outlier is at the beginning or at the end of the time period for a firm, then only the first or last observation is dropped. If an outlier is in the middle of the time period, the whole firm is dropped.
- For the computation of PCM we also exclude observations with negative operational profit/losses, because a negative Learner index does not have a theoretical interpretation, and observations where profit/losses are bigger than operational revenue in order to have PCM that varies from zero to one.

Appendix D.3 Further statistics and correlations

Table B: Frequency of having a squared percentage difference between PCM and PCMa larger than the sample median

ISIC	Industry	Frequency
10	Coal mining	0.64
11	Oil and gas extraction	0.76
13	Mining of metal ores	0.64
14	Other mining and quarrying	0.60
15	Food products and beverages	0.36
16	Tobacco products	0.64
17	Textiles	0.20
18	Wearing apparel	0.40
19	Luggage, handbags, footwear	0.44
20	Wood, except furniture	0.36
21	Pulp and paper	0.16
22	Publishing, printing	0.24
23	Coke and petroleum products	0.44
24	Chemicals	0.20
25	Rubber and plastic products	0.20
26	Non-metallic mineral products	0.24
27	Basic metals	0.12
28	Fabricated metal products	0.24
29	Machinery and equipment n.e.c.	0.04
30	Office machinery and computers	0.48
31	Electrical machinery	0.08
32	Communication equipment	0.16
33	Instruments, watches and clocks	0.20
34	Motor vehicles and trailers	0.16
35	Other transport equipment	0.28
36	Furniture manufacturing n.e.c.	0.36
40	Electricity, gas, hot water	0.68
41	Distribution of water	0.68
45	Construction	0.64
50	Sale and repair of motor vehicle	0.84
51	Wholesale trade	0.84
52	Retail trade	0.80
55	Hotels and restaurants	0.48
60	Land transport	0.64
61	Water transport	0.32
62	Air transport	0.64
63	Supporting transport activities	0.72
67	Activities auxiliary to financial intermediation	0.52
70	Real estate activities	0.72
71	Renting of machinery, equipment	0.80
72	Computer and related activities	0.56
73	Research and development	0.52
74	Other business activities	0.48
92	Recreational, cultural and sporting activities	0.52
93	Other service activities	0.87

Note: This table offers the frequency of having a higher-than-median-squared percentage difference between PCM and PCMa for the industries in our sample. Industries ISIC 64, 80, 85, 90, 91 were excluded from the sample. We do not have data for industries ISIC 65 and 66 from the Amadeus database.

Table C: Telecom dependence, US - industry and time variation

ISIC	Industry	Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	1997-2006
10	Coal mining	0.0032	0.0032	0.0033	0.0032	0.0030	0.0031	0.0034	0.0035	0.0032	0.0033	0.0032	0.0029	0.0031	0.0032
11	Oil and gas extraction	0.0089	0.0091	0.0091	0.0087	0.0084	0.0086	0.0088	0.0092	0.0085	0.0085	0.0081	0.0081	0.0081	0.0085
13	Mining of metal ores	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0023	0.0024	0.0022	0.0025	0.0022
14	Other mining and quarrying	0.0061	0.0063	0.0064	0.0062	0.0062	0.0063	0.0067	0.0069	0.0064	0.0065	0.0062	0.0060	0.0063	0.0064
15	Food products and beverages	0.0021	0.0022	0.0022	0.0021	0.0021	0.0023	0.0023	0.0024	0.0022	0.0021	0.0021	0.0022	0.0023	0.0022
16	Tobacco products	0.0006	0.0005	0.0004	0.0004	0.0004	0.0003	0.0004	0.0003	0.0005	0.0004	0.0004	0.0003	0.0003	0.0004
17	Textiles	0.0030	0.0032	0.0034	0.0032	0.0034	0.0037	0.0040	0.0042	0.0040	0.0040	0.0039	0.0041	0.0044	0.0039
18	Wearing apparel	0.0041	0.0043	0.0047	0.0046	0.0047	0.0050	0.0053	0.0055	0.0057	0.0062	0.0063	0.0067	0.0069	0.0057
19	Luggage, handbags, footwear	0.0020	0.0021	0.0023	0.0020	0.0021	0.0023	0.0023	0.0023	0.0026	0.0026	0.0025	0.0026	0.0026	0.0024
20	Wood, except furniture	0.0037	0.0040	0.0041	0.0041	0.0043	0.0045	0.0046	0.0046	0.0043	0.0044	0.0042	0.0043	0.0044	0.0044
21	Pulp and paper	0.0026	0.0027	0.0029	0.0028	0.0029	0.0030	0.0031	0.0032	0.0030	0.0031	0.0029	0.0030	0.0032	0.0030
22	Publishing, printing	0.0143	0.0148	0.0153	0.0148	0.0153	0.0162	0.0169	0.0176	0.0170	0.0171	0.0169	0.0175	0.0183	0.0168
23	Coke and petroleum products	0.0010	0.0010	0.0011	0.0010	0.0012	0.0012	0.0012	0.0011	0.0009	0.0008	0.0007	0.0009	0.0006	0.0010
24	Chemicals	0.0026	0.0028	0.0029	0.0027	0.0028	0.0030	0.0030	0.0031	0.0028	0.0028	0.0026	0.0026	0.0029	0.0028
25	Rubber and plastic products	0.0057	0.0059	0.0063	0.0060	0.0062	0.0065	0.0068	0.0071	0.0067	0.0066	0.0064	0.0065	0.0069	0.0066
26	Non-metallic mineral products	0.0050	0.0052	0.0054	0.0053	0.0054	0.0057	0.0059	0.0061	0.0057	0.0058	0.0056	0.0056	0.0059	0.0057
27	Basic metals	0.0024	0.0025	0.0026	0.0025	0.0025	0.0027	0.0028	0.0029	0.0027	0.0028	0.0026	0.0026	0.0027	0.0027
28	Fabricated metal products	0.0066	0.0068	0.0069	0.0067	0.0068	0.0072	0.0074	0.0078	0.0074	0.0075	0.0070	0.0072	0.0073	0.0072
29	Machinery and equipment n.e.c.	0.0057	0.0058	0.0058	0.0056	0.0057	0.0059	0.0061	0.0064	0.0063	0.0063	0.0061	0.0062	0.0063	0.0061
30	Office machinery and computers	0.0040	0.0037	0.0032	0.0031	0.0032	0.0036	0.0037	0.0042	0.0043	0.0044	0.0041	0.0042	0.0045	0.0039
31	Electrical machinery	0.0038	0.0039	0.0039	0.0038	0.0038	0.0040	0.0041	0.0042	0.0041	0.0041	0.0039	0.0040	0.0042	0.0040
32	Communication equipment	0.0060	0.0059	0.0055	0.0052	0.0054	0.0055	0.0054	0.0057	0.0060	0.0061	0.0059	0.0058	0.0061	0.0057
33	Instruments, watches and clocks	0.0087	0.0088	0.0087	0.0085	0.0084	0.0088	0.0089	0.0094	0.0089	0.0088	0.0084	0.0086	0.0090	0.0088
34	Motor vehicles and trailers	0.0013	0.0012	0.0016	0.0014	0.0014	0.0011	0.0015	0.0014	0.0016	0.0017	0.0016	0.0016	0.0016	0.0015
35	Other transport equipment	0.0033	0.0034	0.0035	0.0034	0.0034	0.0035	0.0036	0.0037	0.0035	0.0036	0.0035	0.0037	0.0040	0.0036
36	Furniture manufacturing n.e.c.	0.0078	0.0082	0.0084	0.0081	0.0082	0.0088	0.0093	0.0099	0.0092	0.0092	0.0089	0.0092	0.0095	0.0091
40	Electricity, gas, hot water	0.0023	0.0023	0.0024	0.0023	0.0026	0.0026	0.0026	0.0025	0.0022	0.0020	0.0020	0.0023	0.0018	0.0023
41	Distribution of water	0.0250	0.0269	0.0263	0.0261	0.0272	0.0288	0.0296	0.0308	0.0287	0.0303	0.0297	0.0300	0.0290	0.0290
45	Construction	0.0138	0.0143	0.0147	0.0143	0.0150	0.0154	0.0163	0.0182	0.0170	0.0171	0.0167	0.0163	0.0175	0.0164
50	Sale and repair of motor vehicles	0.0283	0.0292	0.0300	0.0291	0.0302	0.0311	0.0327	0.0344	0.0332	0.0331	0.0324	0.0331	0.0344	0.0324
51	Wholesale trade	0.0245	0.0256	0.0259	0.0247	0.0253	0.0266	0.0274	0.0280	0.0267	0.0263	0.0256	0.0264	0.0272	0.0264
52	Retail trade	0.0232	0.0237	0.0242	0.0231	0.0235	0.0247	0.0256	0.0267	0.0257	0.0255	0.0250	0.0253	0.0260	0.0251
55	Hotels and restaurants	0.0175	0.0183	0.0186	0.0179	0.0182	0.0192	0.0199	0.0203	0.0192	0.0190	0.0188	0.0195	0.0205	0.0193
60	Land transport	0.0129	0.0134	0.0135	0.0131	0.0138	0.0143	0.0145	0.0149	0.0141	0.0140	0.0135	0.0137	0.0144	0.0140
61	Water transport	0.0105	0.0109	0.0111	0.0105	0.0110	0.0113	0.0116	0.0125	0.0119	0.0119	0.0120	0.0124	0.0128	0.0118
62	Air transport	0.0321	0.0332	0.0334	0.0319	0.0349	0.0357	0.0356	0.0361	0.0355	0.0348	0.0345	0.0343	0.0377	0.0351
63	Supporting transport activities	0.0250	0.0260	0.0262	0.0252	0.0261	0.0272	0.0283	0.0291	0.0277	0.0274	0.0270	0.0280	0.0287	0.0275
64	Post	0.0177	0.0184	0.0185	0.0179	0.0191	0.0197	0.0203	0.0210	0.0200	0.0196	0.0191	0.0194	0.0207	0.0197
65	Financial intermediation	0.0250	0.0261	0.0262	0.0252	0.0258	0.0265	0.0269	0.0277	0.0263	0.0260	0.0253	0.0262	0.0265	0.0262
66	Insurance and pension funding	0.0074	0.0077	0.0069	0.0068	0.0068	0.0071	0.0074	0.0075	0.0069	0.0068	0.0070	0.0074	0.0076	0.0071
67	Activities auxiliary to financial interm.	0.0602	0.0612	0.0588	0.0556	0.0553	0.0549	0.0544	0.0569	0.0533	0.0529	0.0523	0.0539	0.0541	0.0544
70	Real estate activities	0.0175	0.0180	0.0182	0.0175	0.0181	0.0190	0.0197	0.0199	0.0189	0.0187	0.0182	0.0185	0.0187	0.0187
71	Renting of machinery, equipment	0.0216	0.0228	0.0232	0.0221	0.0223	0.0232	0.0237	0.0242	0.0233	0.0231	0.0222	0.0229	0.0234	0.0230
72	Computer and related activities	0.0642	0.0648	0.0648	0.0620	0.0628	0.0653	0.0666	0.0690	0.0666	0.0660	0.0651	0.0668	0.0682	0.0658
73	Research and development	0.0168	0.0174	0.0174	0.0168	0.0174	0.0183	0.0192	0.0196	0.0186	0.0188	0.0183	0.0187	0.0190	0.0185
74	Other business activities	0.0449	0.0462	0.0466	0.0445	0.0460	0.0481	0.0495	0.0512	0.0490	0.0485	0.0478	0.0493	0.0511	0.0485
80	Education	0.0271	0.0282	0.0285	0.0274	0.0279	0.0293	0.0304	0.0313	0.0298	0.0297	0.0298	0.0308	0.0316	0.0298
85	Health and social work	0.0244	0.0255	0.0261	0.0250	0.0256	0.0270	0.0280	0.0284	0.0262	0.0261	0.0260	0.0270	0.0285	0.0268
90	Sewage, disposal, sanitation	0.0129	0.0130	0.0133	0.0128	0.0132	0.0140	0.0146	0.0149	0.0143	0.0145	0.0140	0.0141	0.0143	0.0141
91	Activities of membership organizations n.e.c.	0.0191	0.0198	0.0197	0.0186	0.0187	0.0188	0.0185	0.0196	0.0186	0.0186	0.0182	0.0188	0.0189	0.0187
92	Recreational, cultural and sporting activities	0.0152	0.0158	0.0162	0.0157	0.0166	0.0177	0.0187	0.0189	0.0176	0.0173	0.0173	0.0180	0.0184	0.0176
93	Other service activities	0.0293	0.0310	0.0321	0.0305	0.0314	0.0334	0.0349	0.0368	0.0347	0.0346	0.0351	0.0361	0.0374	0.0345

Note: This table shows the within-industry variation of the telecom dependence measure for the 2-digit ISIC rev. 3.1 industries. This measure is computed for the US using input-output tables obtained from the Bureau of Economic Analysis.

Table D: Correlations between interaction terms

	Telecom dependence US ×Telecom subscribers	Telecom dependence US ×Telecom revenue
Telecom dependence US×Telecom revenue	-0.60*	
Entry rates US×Entry cost	-0.14*	-0.20*
Entry rates US×Market regulations	-0.43*	0.17*
Ext. fin. dependence×Market capitalization	0.01	0.12*
Labor intensity US×Employment law	-0.34*	0.52*
R&D intensity US×Property right	-0.07*	0.15*
R&D intensity US×Human capital	-0.11*	0.15*
Telecom dependence US×Entry cost	-0.63*	0.52*
Telecom dependence US×Market regulations	-0.82*	0.88*
Telecom dependence US×Market capitalization	-0.23*	0.71*
Telecom dependence US×Employment law	-0.63*	0.94*
Telecom dependence US×Property right	-0.60*	0.99*
Telecom dependence US×Human capital	-0.71*	0.98*
Opportunity growth US×Telecom subscribers	0.55*	-0.37*
Opportunity growth EU×Telecom subscribers	0.38*	-0.14*
Telecom dependence US×Shadow economy	-0.76*	0.90*
Telecom dependence US×GDPC	-0.64*	0.99*
Telecom dependence US×CPI	-0.47*	0.97*

Note: This table offers the pairwise correlations between our main interaction terms and the interaction terms that we use for robustness checks. The diffusion measures are in logarithms. See Table A in Appendix D.1 for complete definitions and sources of variables. * indicates the 5% level of significance.

Appendix R.1 Further results

Table E: Additional interaction terms: Other entry costs and dependence measures

	(I) B.Entry cost	(II) Market regulation	(III) Market. capital.	(IV) Empl. law	(V) Property rights	(VI) Human capital
Entry US × B.Entry cost	0.004*** (0.002)					
Entry US × Market regulation		0.01*** (0.00)				
Ext. fin. dependence US × Market Capitalization			0.01 (0.02)			
Employment intensity US × Employment law				-0.30 (5.64)		
R&D intensity US × Property rights					-0.000 (0.000)	
R&D intensity US × Human capital						-0.02 (0.02)
Industry share	0.68** (0.27)	0.79*** (0.28)	0.62** (0.28)	0.45* (0.24)	0.63** (0.28)	0.65** (0.28)
Observations	803	721	882	616	882	882
R2	0.714	0.700	0.712	0.791	0.712	0.712

Note: This table reports the results for additional interaction terms. The dependent variable is the competition measure PCM averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table F: Additional interaction terms: Other entry costs and telecom dependence measure

	(I) B.Entry cost	(II) Market regulation	(III) Market capital.	(IV) Empl. law	(V) Property rights	(VI) Human capital
Telecom dependence US × B.Entry cost	3.08*** (1.04)					
Telecom dependence US × Market regulation		1.70*** (0.30)				
Telecom dependence US × Market capitalization			-2.45*** (0.77)			
Telecom dependence US × Employment law				-1.42 (1.43)		
Telecom dependence US × Property rights					-2.81** (1.18)	
Telecom dependence US × Human capital						-1.94 (1.32)
Industry share	0.66** (0.27)	0.79*** (0.28)	0.64** (0.27)	0.64** (0.27)	0.64** (0.27)	0.61** (0.27)
Observations	857	769	902	857	902	902
R2	0.703	0.697	0.705	0.698	0.703	0.702

Note: This table reports the results for additional interaction terms. The dependent variable is the competition measure PCM averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table G: Additional interaction terms: Growth potential, shadow economy, development and corruption levels and telecom dependence measure

	(I) Growth potential US	(II) Growth potential EU	(III) Shadow economy	(IV) GDP	(V) CPI
Growth potential US × Telecom subscribers	-0.90*** (0.17)				
Growth potential EU × Telecom subscribers		-0.48** (0.19)			
Telecom dependence US × Shadow economy			10.37*** (3.53)		
Telecom dependence US × GDP				-1.40*** (0.22)	
Telecom dependence US × CPI					-0.55*** (0.10)
Industry share	0.63** (0.27)	0.62** (0.28)	0.67** (0.27)	0.71*** (0.27)	0.76*** (0.28)
Observations	902	902	857	902	769
R2	0.710	0.704	0.702	0.714	0.695

Note: This table reports the results for additional interaction terms. The dependent variable is the competition measure PCM averaged over the period 1997–2006. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, which are not reported. Robust standard errors are in parentheses. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.