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

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Abstract

In this paper we empirically investigate the effect of more intensive use and wider adoption of telecommunication technologies on the intensity of competition in services and goods markets. Our results suggest that the wider adoption and more intensive use of these technologies significantly increase the level of product market competition. We also find that this effect is somewhat stronger in countries which have better telecommunications infrastructure. This is consistent with the view that these technologies can lower the costs of entry. Our findings are 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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1 Introduction

"...[I]n most of the economy [the information technologies] IT 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 [can] increase competition."
The Economist, September 21, 2000

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

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

This research empirically investigates the relation between the country wide diffusion of telecommunication technologies and the competition in services and goods markets. In order to alleviate the endogeneity concerns we use difference-in-difference 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 disproportionately different in the industries which depend more on these technologies.

Our results indicate that the diffusion of telecommunication technologies has a strong positive effect on the intensity of competition in services and goods markets. This supports the conjectures such as in the issue of *The Economist*. Our results also imply slightly stronger effect in countries with higher quality of communications infrastructure. We also find that once we control for the diffusion of telecommunication technologies the conventional measures of entry costs, such as the bureaucratic costs of registering a firm (Klapper, Laeven, & Rajan, 2006), tend to lose their significance. This suggests that telecommunication technologies, perhaps through information acquisition costs, play a significant role in the mechanisms which govern those conventional measures.

According to the standard theoretical inference our results imply higher allocative efficiency in the economy. Moreover, according to empirical papers such as Nickell, Wadhwani, & Wall (1992), Nickell (1996), and Disney, Haskel, & Heden (2003) they imply significant productivity gains (for a theory behind such results see Hart, 1983). Starting from the low levels of competition our results can be also mapped to higher innovative activity in line with Aghion, Bloom, Blundell, Griffith, & Howitt (2005).[3,4]

These results contribute to the ongoing debate about the impact of telecommunication technologies, as well as of general information and communication technologies (ICT), on economic performance. The macro-level empirical studies suggest that the diffusion of these technologies has a positive impact on development level and growth (e.g., Madden & Savage, 1998; Roller & Waverman, 2001; Datta & Agarwal, 2004; Czernich *et al.*, 2011). In turn, the micro-level empirical studies suggest that the use of telecommunication technologies and ICT can reduce the price dispersion and average prices in online markets (e.g., Jensen, 2007; Lee, 1998; Strader & Shaw, 1999; Brynjolfsson & Smith, 2000). There can be various drivers behind these results. For instance, the literature on general ICT emphasizes the productivity improvements/cost reductions which stem from the immediate use of ICT (Jorgenson, Ho, & Stiroh, 2005; Vourvachaki, 2010). The literature on telecommunications, in addition, argues that the use of these technologies can improve the access to information. In line with Stigler (1961), it further conjectures that that would reduce distortions and frictions in the markets (e.g., Leff, 1984; Jensen, 2007; Brynjolfsson & Smith, 2000). Our empirical findings offer a support for these conjectures. They imply that the diffusion of the telecommunication technologies intensifies the competition in services and goods markets (i.e., reduces the 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. The results indicate that the economic benefits from a particular type of ICT, the telecommunications, may come not only from its immediate use

[3] 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 product market competition. However, according to Tingvall & Poldahl (2006) this finding seems to be not very robust.

[4] See also Geroski (1995b) and Blundell, Griffith, & van Reenen (1999).

(e.g., switch from mail to e-mail) but also from the intensified competition.

The results of this study can be interesting also for the policy makers. They imply that the policies which encourage diffusion of telecommunication technologies can complement the competition/antitrust policies.

Having mentioned what we identify in this study, it is worth also to mention what we do not intend to identify. The diffusion of the 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 how exactly those changes would happen.

In addition to the ICT and particularly the telecommunications literature, this paper is related to the studies which try to identify the determinants of product market competition. Although the competition seems to be an important engine of economic activity, to our best knowledge, there are very few such studies. There is an evidence, for example, that the railroad networks have intensified competition in the US shipping industry in the 19th century (Holmes & Schmitz, 2001). There is also some evidence that the 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; Feldkircher, Martin, & Worz, 2010). Our study is related to these studies to the extent that the telecommunication technologies, similar to the railroad, are general purpose technologies. Moreover, according to our results the policies which promote telecommunication technologies diffusion should affect the intensity of competition in services and goods markets.

There is also vast amount of theoretical studies which analyze the effect of search frictions on price dispersion (see, for instance, Salop & Stiglitz, 1977; Reinganum, 1979; Varian, 1980). The typical model here assumes that consumers know only the distribution of prices and have search costs. These costs are argued to be lower in electronic market places compared to the regular ones (e.g., Bakos, 1991). This motivates many empirical studies which try to find whether there is significant difference in terms of price dispersion, as well as average prices, in electronic and regular market places (e.g., Lee, 1998; Strader & Shaw, 1999; Brynjolfsson & Smith, 2000; Brown & Goolsbee, 2002). Our study is related to these papers to the extent that the diffusion of telecommunication technologies also can lower the 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, life insurance) and market places, our inference is for (virtually) 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 offers its sources. The fourth section summarizes the results. The last section concludes. The tables of basic statistics, correlations, and regression results are presented in the end of the paper.

2 Theoretical background and methodology

2.1 How the telecommunications can matter

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

It is largely argued that the information acquisition costs matter for the firms' decision of entry into a market (see, for instance, Demsetz, 1982; Hausch & Li, 1993; Geroski, 1995b). Meanwhile, this decision can be affected as well by the transaction and initial investment costs. For instance, a firm which considers entry into a market would need to gather information about that market and wire 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; Czernich, Falck, Kretschmer, & Woesmann, 2011). Some of the relatively contemporary observations which can support these arguments are that these technologies enable internet and internet banking. The former in many cases can serve as a very cheap source of information, whereas the latter 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 former 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 the telecommunication technologies can help the firms in gaining market power. An example of such actions can be the (extensive) advertisement of products over the internet and other types of telecommunication networks. The advertisement may help to increase the product differentiation and, thus, it may help to gain market power (see, for instance, Comanor & Wilson, 1974). Another, though related, example would be that the lower information acquisition costs would help in learning the demand and the general market environment. Therefore, they can help in increasing the product differentiation. A quite contemporary example is that, currently, many online firms are able to track, for instance, via search keywords, visited web site, and IP address the preferences and the approximate location of the users. They tend to use that information for targeting their marketing appeals, for instance. In Appendix T.1 we offer a very stylized and simplistic model that delivers predictions in line with our inference.

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.[5] Doing so is not straight forward, however. According to many theoretical models, the level of competition in services and goods markets matters for the resource allocation in the economy (see, for instance, van de Klundert & Smulders, 1997; Jerbashian, 2011).[6] This, in its turn, can matter for the country wide diffusion of the telecommunication technologies which is largely a market outcome. Therefore, according to the theory there can be reverse causality between the diffusion and competition in the services and goods markets.

Nevertheless, there is 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 the industries which depend more heavily on those technologies. Such variation can arise at least due to one reason. Those that depend more *ceteris paribus* would increase their demand more due to that diffusion. In such case, in line with the arguments offered in Leff (1984) or Jensen (2007) this can result in more information about the industry. A motivation for that can be the observation that these technologies are used exactly for transmitting and disclosing information. A further supporting observation is that in these days, for instance, the computer producers and retailers seem to be more widely known than the core manufacturers, when the first set uses significantly more of these technologies.[7] The diffusion, in such case, will alter the information

[5] In a related study we analyze the impact of telecommunication technologies diffusion on industry growth.

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

[7] Jensen (2007), in addition, 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.

acquisition costs disproportionately as long as that information has an idiosyncratic component.

Our test looks exactly for such disparity. Such test permits also country and industry fixed effects. These can be important for capturing, for instance, the regulatory differences and the variation in the fixed costs of entry into different industries. Moreover, with such 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 varying effects of those variables across industries which are expected to be the most responsive to them. The country level variables can create ambiguities with the interpretation of the results, when included in regressions 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 the telecommunication technologies. A naive measure of an industry's dependence would be its share of expenditures on telecommunications out of total expenditures on intermediates. The problem of 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 the telecommunication technologies from the US data. This involves three important assumptions, where the first and second are that in the United States the supply of telecommunication technologies is perfectly elastic and frictionless. The first assumption can be supported by an argument that the marginal cost of production in the telecommunications industry is very low (see for similar argument, for instance, Noam, 1992; 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 the exemplary regulations/reforms for 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 relatively frictionless environment in the US markets. The third assumption is that the dependence identified from the US data holds in other countries as well. 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.[8] This would mean that, for example, retail trade industry would depend more on telecommunication technologies than the mining of metal ores in all 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 the telecommunication technologies.[9] An example of such 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 robustness check we employ also the shares of expenditures on telecommunications in Japan and United Kingdom. These countries tend to have relatively well developed ICT sector 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 different industrial composition than the United States, which would be another type of robustness check.

For the same purpose, we employ also the share of expenditures on the 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.[10]

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 disproportionately different in the industries which depend more on these technologies.

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

[9] Clearly, the shocks also can generate varaition out of the steady state equilibrium.

[10] 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 indeed from the technological lag between the European Union countries and the United States.

One of the advantages of trying to test exactly this hypotheses is that we need not to explain the drivers behind the diffusion of telecommunication technologies - economic/market or regulatory. In order the diffusion to matter in such a setup, we need only to have a "world" where the diffusion cannot happen instantaneously or it 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 time/sample period). Assuming that we were able to measure the level of competition, the industry i's dependence on the telecommunication technologies, and the diffusion of those technologies in the 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 which vary with industry and country. These are the interaction between the initial/*ex ante* level of diffusion of telecommunication technologies in country c and 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).[11] 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 *et al.* 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).

[11] 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 somewhat coherent sample. We need these databases in order to construct the measures of competition, for instance. Particularly, the Amadeus database we need for constructing competition measures such as Herfindahl index and 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 till 2008. We do not do so since we want to avoid incorporating data from the recent financial crisis.[12]

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 and mobile telephone subscribers per capita (hereafter, telecom subscribers).[13] This variable may also measure the availability of the telecommunication infrastructure and is extensively applied in that context (see, for instance, Roller & Waverman, 2001). However, it may not fully reflect the quality of the telecommunication technologies which can matter for the costs associated with information transmission. Therefore, for robustness check of our main results, we also use as a measure the revenue of the telecommunications industry per capita (hereafter, telecom revenue), which can better reflect the quality. Nevertheless, from the between countries comparison perspective the latter measure may fail to correctly reflect the amount of telecommunication goods produced since it could be higher, for instance, simply because prices are higher.[14]

[12] 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.

[13] Adding also the internet subscribers can lead to significant double counting since, for example, fixed lines are used extensively for dial-up and DSL internet.

[14] This problem could be alleviated with a purchasing power parity index for telecommunications industry. We are not aware of any source for 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 3 minutes (local) mobile phone call.

Talk that we control also for digitalization and international internet bandwidth...

These measures can indicate the adoption and use of telecommunication technologies in the entire economy. This is important for us since the potential entrants could use their personal/private telecommunications for acquiring information. 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 the cheat-chat over the phone. From this perspective, therefore, using these measures plays against us since it would 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 descriptive statistics of the country level variables and their correlations.

3.2 Industry level variables

Measures for the dependence on the telecommunication technologies

In order 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 2-digit industry level. We obtain these data from the square input-output tables of the Bureau of Economic Analysis (BEA). The original data are in NAICS 2007 and have 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).[15] Further, we average it over the period 1997–2006 and use the average as a measure for the dependence.[16]

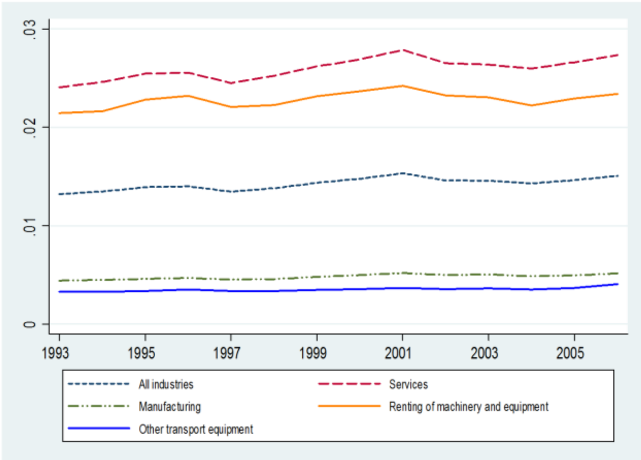
Figure 1 provides further support to the validity of this measure. It suggests that the share of expenditures on telecommunications in the United States virtually has not changed. A simple ANOVA exercise on our sample confirms this observation and shows that the industry level variation accounts for 99.48% of the total, while time variation accounts for only 0.52%.[17]

[15] Our results are robust to their inclusion.

[16] 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 which we were able to obtain.

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

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



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

For robustness check we also obtain data for Japan and United Kingdom. The data is from the OECD STAN database. It has a similar to 2-digit ISIC structure, 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 OECD STAN database for the United States industries.

Table 3 offers the industry level variation of these measures. It also offers the average share of expenditures on telecommunications in industries in the European Union countries in our sample (see also Table C in Appendix D.3 for industry-time variation in the US). We have derived it from industry-country-time level data 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 to our telecom dependence measures.

Measures for competition and the share of sales

We use - the time averages of - five measures of product market competition. 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.[18,19]

Our second (inverse) measure for the intensity of competition is the profit elasticity (PE) introduced in Boone, Ours, & Wiel (2007) and Boone (2008). The profit elasticity captures the relation between profits and efficiency. This relation can be argued to become steeper as competition intensifies since in more competitive environment the same percentage increase in costs reduces the profits more. In a given pair of industry and country PE for all time periods 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 the industry i, country c, and time t is the estimated coefficient $\hat{\beta}_{3,i,c,t}$.[20]

The third and fourth (inverse) measures which we use are concentration measures. The third one is the Herfindahl index (HI), which is defined as the sum of 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 four

[18] According to Carlin, Schaffer, & Seabright (2004) this measure 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 accroding to, for instance, Collins & Preston (1969).

[19] We follow, for instance, 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.

[20] 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.

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, 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 arguable at the same time. It would relatively firmly approximate the competition intensity 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 situation 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 four largest firms when, for instance, one or several of the largest firms leave the market.[21] Meanwhile, the price cost margin may fail in such case when, for instance, the 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; 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 somewhat different nature (i.e., can reflect different forces behind the competition intensity) it seems reasonable to use them for robustness checks of our results. It is worth to note also that averaging over time would alleviate some of these concerns since in such case we focus on 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 Herfindahl index, the market share of four largest firms, and for 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 industries financial intermediation and insurance and pension funding. Therefore, our analysis for competition measures from Amadeus does not contain those industries.[22] Second, the industry

[21] Another possible criticism that applies to consentration 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).

[22] 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

classifications vary over time and across countries. In order to align them with the rest of our data, we have transformed them to 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 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].[23]

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 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

database are excluded from the sample. We are able to tackle that problem in the Amadeus database by combining several releases.

[23] Table B in Appendix D.3 offers of the frequency of having higher than 0.06 absolute difference between PCM and PCMa for the industries in our sample. The highest frequency is in the services industries and industries associated with mining.

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, respectively.

The estimate of the coefficient on the interaction term is negative and significant at the 1% level, [-2.72 (SE 0.37)].[24] Given that smaller values of PCM correspond to higher competition intensity, this indicates that competition in industries that dependent more on telecommunication technologies is disproportionately more intensive in countries with higher telecom diffusion. The telecom diffusion, therefore, has positive effect on the intensity of competition in the services and goods markets.

Since we have a difference-in-difference 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 and France in our sample, correspondingly. 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 and renting of machinery and equipment, respectively. Finally, we compute

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

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 compared to Estonia. This difference is relatively large number 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.

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, everything else the same, the dependent variables are profit elasticity, Herfindahl index, market share of

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

four largest firms, and total number of firm in an industry, correspondingly [-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 price cost margin which is derived from the Amadeus database [-0.59 (SE 0.26)].

All the estimates of the coefficients on the interaction terms are negative and significant at the 1% level, except the estimates of the coefficients in the specifications for (the logarithm of the) number of firms and PCMa. The former we treat as a direct measure of competition; therefore, the sign of the estimated coefficient we expected to be positive. We have also checked that this result holds when we take the number of firms from the Amadeus database, which in comparison with the OECD STAN database does not have a full coverage. Meanwhile, the estimated coefficient in the specification for PCMa is significant, though, at the 5% level. Moreover, it is considerably smaller 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 number, 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, and for the subsample which was employed in Klapper *et al.* (2006). In both cases the results remain qualitatively the same, not reported.

We further report the estimation results exclusively for PCM. We have checked, however, that all our results stay qualitatively the same for these measures of competition.[25,26]

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

We further report exclusively the results for telecom subscribers. We have, nev-

[25] 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, not reported. The positive coefficient is consistent with the rest of our estimates. Meanwhile, the estimate is not significant, perhaps, because we have few data for that measure.

[26] The results from all robustness checks are avaialble upon request.

ertheless, checked that all our results are qualitatively the same for telecom revenue measure.

Alternative measures for telecom dependence

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

Given that the EU countries tend to be behind in terms of the application of telecommunication technologies 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, though 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 these technologies in the US already by 1994, which is consistent with the observation of virtually no time variability in our measure of dependence.[27]

We retrieve the data for Japan and 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, not substantially though [-1.18 (SE 0.23)]. The result for the measure identified from the data for 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 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 different (higher) industry aggregation.[28] The magnitudes of effects also vary, though not considerably.

A reason behind such variation can be the 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 the Table 10 reports the results when we use as a measure for 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

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

[28] We have also estimated the 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.

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 the column (I) of the 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 which excludes the first and the last percentiles of the dependent variable, PCM. The results are reported in the columns (II) and (III) of the Table 11 [-2.20 (SE 0.40) and -2.63 (SE 0.36), respectively].

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

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

which captures the average effect only. The effect which we compute with such nonparametric estimator is -0.018. This result reassures that the effect which 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)].[29] Its magnitude has increased in comparison with the main results, however, not considerably. This suggests that the integration processes are not likely to be the drivers behind our results.

Country level - Are the results sensitive to different country groups?

A. New and old EU member countries and UK

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 emergence of 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 distinguishable neither from our main results nor from each other, though the estimate for the new members tends to be somewhat bigger in absolute value.[30]

In this respect, UK also can be expected to be different from the remaining countries, in terms of the use of telecommunication technologies and its development level. Columns (IV) in Table 12 excludes from the sample UK. The result is the same as our main result [-2.72 (SE 0.37)].

B. The most and the least developed EU countries

Our telecom diffusion measure may proxy the level of development, which, in its turn, may proxy the availability of general infrastructure, for instance. In case the industries which depend more on the telecommunication technologies, or their (potential) entrants, are generally more hungry of infrastructure, our results may not be driven by the diffusion of telecommunications.[31] In order to rule out this possibility, we check whether our results hold in the samples of the most and the least developed EU countries. The most developed countries are those that have

[29] 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.

[30] For a formal test we would need, for example, to add to the 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 so in all the appropriate cases.

[31] It is reasonable to expect that, for instance, the construction industry, which has higher than median telecom dependence, would also depend largely on general infrastructure.

higher than median real GDP per capita, the least developed are the remaining countries.

The results are reported in columns (I) and (II) of the Table 13, respectively [-3.50 (SE 0.95); -2.18 (SE 0.74)]. The estimated coefficient for the most developed countries is bigger in absolute value, though not significantly. These estimates are also qualitatively close to our main result. This suggests that there may be such drivers behind our result, though these drivers are not so significant.

C. The most and the least corrupt EU countries

In the same spirit we have checked also that our results are robust for varying corruption levels, which we measure by the corruption perception index of the Transparency International. The level of corruption may matter if the telecom diffusion is correlated with it and the industries which have higher telecom dependence are more affected by it. For example, it could be that in more corrupt countries the diffusion is lower since the (informal) costs/barriers for entry into the telecommunications industry are higher. Meanwhile, the costs of entry are higher also for high telecom dependence industries (e.g., services). The results are reported in columns (III) and (IV) of the Table 13, respectively [-4.96 (SE 1.17); -3.44 (SE 0.67)]. Similar to the previous case, the estimated coefficient is somewhat bigger in absolute value for less corrupt countries, not significantly though. Moreover, the estimates are qualitatively not so different from our main result. This suggests that such explanation of our results is also virtually absent.

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 goods sector. This is because given their nature the services products can be marketed and delivered over the telecommunication networks easier. In such case, first, in line with the literature on electronic versus regular market places, it seems reasonable to expect that the role of the 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; Brown & Goolsbee, 2002). Second, if the 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 a room for entry). The entry then would intensify the competition.

Column (I) and (II) of the Table 14 report the results when we restrict the sample to services and goods sectors, respectively. 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.[32]

Sector/Industry level - Are the least users of telecommunications different?

We have also checked that our results are qualitatively not different from the main result for the industries which, 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 take those industries in a country that have a value lower than the median of that interaction term in the country. Second, we take those industries in a country which have below than the median expenditures on telecommunications in 1995 in the country. The data for this measure we obtain from 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 slightly different aggregation.

Columns (III) and (IV) of the Table 14 report the results. The coefficient for the industries which have lower than the median interaction between the telecom dependence and industry share is essentially the same as our main result [-2.93 (SE 1.97)]. Meanwhile, the coefficient for the industries which 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 exploring such possibility.

Alternative explanations: Reverse casualty

Instrumental variables

Our inference would be incorrect in case some third factors are responsible for the intensity of competition and are correlated with the interaction between telecom dependence and diffusion. In this section we attempt to rule out such explanation of our results.

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

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 which 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; ITU, 2002). Meanwhile, France and Germany had the best access to mobile technologies the 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 15 reports the results [-2.76 (SE 0.40)]. These are no different from our main results.[33]

Our country group level instrumental variables may not solve the endogeneity problem, however. It might be that they are correlated with some omitted variables - 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 which matter for entry (and potential entry) and size distribution of firms and, thus, for the intensity of competition. Following that paper 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 for basic statistics and correlations Tables 1 and 2). 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 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

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

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

We use the measure and the data of Klapper *et al.* (2006) for identifying 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 the 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 number of employees and sales in the US industries.[34] We take these data from the OECD STAN database and average it over the period 1997–2006. Tables 7 and 8 offer the basic statistics and correlations.

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.[35] 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. Its higher values stand for higher product market regulation. Financial development level we mea-

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

[35] 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.

sure as stock market capitalization over GDP.[36] The data for it we take from the WDI database. The measure for strictness of the employment law, and its data, we obtain from Botero, Djankov, La Porta, Lopez-de-Silanes, & Shleifer (2004). This is an index which takes into account job security, the conditions of employment, and the provisions in laws regarding alternative employment contracts. Its 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. Its higher values stand for higher private property protection. As a measure of human capital development we use the average years of schooling of population of age over 25. The data are for 1995, and we obtain it from Barro-Lee tables, World Bank.[37] Given their availability the data for these measure are for 1999, 1997, 1997, 1998, 1997, and 1995, respectively.[38]

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

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

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

C. Answering the question

Columns (II)–(VII) of the Table 15 report the results. Clearly, 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 in case we use data for competition, dependence, and diffusion measures from the period 2000–2006, for instance.[39]

The coefficient on the interaction term between telecom dependence and diffusion remains virtually the same in all cases. It somewhat, though, reduces in 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 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 the labor intensive industries. Therefore, it may hinder the entry (and the 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. This is somewhat surprising since we would expect the entrants to benefit, for instance, from looser liquidity constraints and better patent protection, in terms of future margins on possible innovation. However, such positive effect may be offset by the incumbents which would equally benefit and, perhaps, use finance and patent protection for deterring entry and/or escaping competition. Perhaps the latter effect slightly dominates in our data. We do not explore these conjectures further since these additional variables are merely for robustness check of the main result.

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 country average intensity of competition. Our main result is not affected by such inclusion; it also stays unaffected if we include all these interaction terms at once, not reported.

It may be also argued that the ranking of the industries according to their depen-

[39] 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.

dence on telecommunication technologies corresponds to the ranking of industries according to the effect these variables have on them. In columns (I)–(VI) of the Table 16 we one-by-one include the interactions of the telecom dependence measure with the respective variable together with our main interaction term. Our main result, again, stays basically unchanged. The estimates of the coefficients on interactions with bureaucratic costs of entry, market regulations, 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 disproportionately lower in industries which 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 the (potential) entrants and/or the intensity of competition may indeed benefit from financial development and availability of human capital. It would do so more in industries that depend more on telecommunication technologies. Meanwhile the estimate for the 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 be also that the measure of dependence on telecommunication technologies identifies the industries which 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 the 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. We, therefore, also use the growth rates of industries in three most developed (measured by GDP per capita) EU countries in our sample averaged over the period 1998–2007.[40]

We interact the measures of growth potential with telecom diffusion variable and include those in the baseline specification. Columns (I) and (II) of the Table 17 report the results. The estimate of the coefficient on the interaction between telecom

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

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 correlation between the measure of telecom dependence and growth potential).

Omitted variables - Does the shadow economy matter?

Finally, we are concerned that the countries with bigger shadow economy could have lower reporting of output and lower competition due to adherence to rather informal agreements, for instance.[41] Meanwhile, it could be that the industries that depend more on telecommunication technologies have disproportionately 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 the Table 17 includes the interaction of this variable with 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 higher 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 17]. The main result is, again, virtually unaffected. In case of CPI it is slightly, though not significantly, higher. The change in the value, however, is not due to inclusion of the new interaction term since it is virtually the same for the subsample where we have observations for CPI.[42]

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, not

[41] 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.

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

reported.

5 Conclusion

Talk about the other entry costs variables, quality differences, and perhaps mention Etro (2009) and say that we have similar inference. Moreover, in the ned mention that it would be goods to extend this study to other countries, perhaps using data from UNIDO.

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

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

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

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Tables - Data and results

Basic statistics and correlations

Table 1: Country-level variables

Country	Telecom subscribers	Telecom revenue	GDP	CPI	B.Entry cost	Market regulation	Market capitalization	Employment 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. Both measures are in 1997. The remaining columns offer the values of country-level variables which 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	GDP	0.88*	0.93*								
4	CPI	0.75*	0.83*	0.78*							
5	B.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*	0.35	-0.34		
10	Human capital	-0.05	0.09	0.08	0.32	-0.37	-0.42	0.01	-0.28	0.14	
11	Shadow economy	-0.47*	-0.60*	-0.59*	-0.63*	0.43	0.62*	-0.4	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 comp.	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 cl.	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 veh.	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 fin. int.	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, equip.	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 memb. org.	0.0191	0.0187					
92	Recreational, cultural and sp.	0.0152	0.0176					
93	Other service activities	0.0293	0.0345					

Note: This table offers the measures of telecom dependence for 2-digit industries (ISIC rev. 3.1. classification). In the first two columns this measure is computed from the US data using square input-output tables obtained from the Bureau of Economic Analysis, for 1994 and averaged over 1997–2006 period correspondingly. The last four columns present this measure for Japan, United Kingdom, US and the average within EU countries from our sample. These are computed using square 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, 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 differences between Telecom dependence US, Telecom dependence US94, Telecom dependence USOECD and definition for Telecom dependence EU. That table also offers the data sources. All correlation coefficients are significant at 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 shows 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 shows 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 5% level of significance.

Table 7: Industry-level variables - descriptive statistics

						Percentiles		
	Nobs.	Mean	S.D.	Min	Max	25th	50th	75th
Telecom dependence US	987	0.014	0.015	0.000	0.066	0.004	0.007	0.023
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 shows 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 shows 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 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 adjusted	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, not reported. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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 adjusted	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) telecom dependence measure is identified from the data for Japan and United Kingdom. These data are from OECD STAN. In column (IV) the dependence measure is identified from OECD STAN data for the US. In column (V) 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, not reported. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Alternative estimators

	(I) Tobit	(II) Quantile	(III) OLS w/o 1 & 100 pct
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 adjusted	-	0.50	0.68

Note: This table reports the results from the of 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, not reported. Pseudo R2 is reported for quantile regression. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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 adjusted	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, not reported. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13: Restrictions on development and corruption level

	(I) More developed	(II) Less developed	(III) Less corrupt	(IV) More corrupt
Telecom dependence US	-3.50***	-2.18***	-4.96***	-3.44***
× Telecom subscribers	(0.95)	(0.74)	(1.17)	(0.67)
Industry share	0.39	0.72**	0.41	0.94***
	(0.30)	(0.38)	(0.29)	(0.39)
Observations	453	449	367	402
R2 adjusted	0.75	0.72	0.74	0.73

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) and (II) countries are divided into two groups - above and below the median real GDP per capita in 1997. In column (III) and (IV) countries are divided into two groups - above and below the median CPI in 1997. See Table A in Appendix D.1 for complete definitions and sources of variables. All regressions include industry and country dummies, not reported. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 14: Restrictions on sectors and telecom dependence level

	(I) Services	(II) Goods/ 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 adjusted	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 (III) the sample includes exclusively the services industries and in column (IV) the sample includes exclusively the goods/manufacturing industries. Column (III) excludes the industries in a country which have higher than median telecom dependence times industry share in the country. Column (IV) excludes the industries in a country which 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, not reported. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 15: Specification check - new variables

	(I) IV	(II) B.Entry cost	(III) Market regulation	(IV) Market. capitalization	(V) Employment 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 adjusted	0.74	0.75	0.74	0.75	0.81	0.75	0.75

Note: This table reports the results from specifications which 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, not reported. Robust standard errors are in parentheses. p<0.01, ** p<0.05, * p<0.1.

Table 16: Specification check - new variables

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

Note: This table reports the results from specifications which 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, not reported. Robust standard errors are in parentheses. p<0.01, ** p<0.05, * p<0.1.

Table 17: Specification check - new variables

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

Note: This table reports the results from specifications which 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, not reported. Robust standard errors are in parentheses. p<0.01, ** p<0.05, * p<0.1.

7 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, 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.

Assuming that the consumption good is the numeraire and the aggregate demand is normalized to 1, (7) implies 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 good the firms require $\frac{1}{\lambda_V}x$ amount of consumption good, where λ_V is their 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.[43]

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

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

[43] This assumption is necessary for having non-neglidgible strategic interactions between the firms.

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

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 the fixed costs decline, or equivalently λ_F increases, the competition intensifies. Moreover, the Lerner index declines with the elasticity of substitution,

$$sgn\left(\frac{\partial LI}{\partial \varepsilon}\right) = sgn\left[-\frac{1}{\varepsilon - 1}\sqrt{\left(\frac{1}{\varepsilon}\right)^2 + 4\frac{1}{\lambda_F}\frac{\varepsilon - 1}{\varepsilon}} - \frac{\varepsilon}{\varepsilon - 1}\left(\frac{1}{\varepsilon}\right)^2 - 2\frac{1}{\lambda_F}\right] < 0.$$

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

According to, for example, Geroski (1995) and Leff (1984) the information acquisition costs are a significant part of the entry costs $\frac{1}{\lambda_F}$ and the diffusion of telecommunication technologies reduces those costs. Therefore, according to this model the competition should intensify with the diffusion. However, instead if the diffusion of the telecommunication technologies would help the firms to increase the product differentiation (notice that $\frac{\partial \pi}{\partial \varepsilon} < 0$) than 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 case, assuming free entry, the sum of streams of revenues minus 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 the diffusion would intensify the competition. The diffusion can lower these costs for example for software producing firms while lowering their transportation costs.

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

Appendix D.1 - Variable definitions

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 2000 prices. The data are for 1997. Source: GMID and ITU databases.
GDP	GDP per capita in 2000 prices. 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**

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. 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). We average it over the period 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. Source: Authors' calculations using data from Amadeus.
MS	Market share of four largest firms in an industry. Source: Authors' calculations using data from Amadeus.
logN	Logarithm of the total number of firms in an industry. 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. 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 the period 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 the period 1995–2005. Source: OECD STAN, I-O tables.
Telecom dependence UK	The share of telecommunication inputs in UK industries, averaged over the period 1995–2005. Source: OECD STAN, I-O tables.
Telecom dependence JP	The share of telecommunication inputs in Japanese industries, averaged over the period 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**

Name	Definition and source
Industry-level variables	
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 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

We use the Amadeus database (Analyse Major Databases from European Sources) in order to obtain firm level data. These data we use for calculation of HI and MS, as well as, alternative measures of PCM and number of firms. This database 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 industry codes (NACE) of European firms. However, it has a specific feature regarding 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. It means that, for example, in the 2010 edition of Amadeus the data from 2006 does not include firms that exited in 2006 or before. For our analysis we need to have as full dataset as possible in order to obtain competition measures that better approximate the real intensity of competition. Therefore, in order to mitigate this problem, 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 Herfindahl index and market share of four largest firms), operational profit/losses (for computing the PCM), and industry codes of the firms. We transform all industry codes into ISIC rev. 3.1, in order to have coherence across countries and other databases which we use. We perform basic data cleaning in order to reduce potential selection bias and measurement errors. First of all, we drop "empty" firms that do not report operational revenue or total assets at all. Similar to Klapper, Laeven, & Rajan (2006), we drop the firms that report their data in consolidated statements in order to avoid double counting of firms and/or subsidiaries. We impute missing values of key variables using linear interpolation across years. This helps to restore possibly erroneously missing values, although we perform a robustness check with the data without the imputation. After interpolation we exclude all observations with missing data in operational revenue and total assets. Then, we drop industries which have less than four firms in a given year. Further, we define severe outliers – the first and the last percentiles of relative yearly changes in operational revenue and total assets for each country and two-digit industry code. If an outlier is at the beginning or at the end of the time period for a firm, then only first or last observation is dropped, if an outlier is in the middle of the time period, the whole firm is dropped. Finally, for computation of PCM we exclude observations with negative operational profit/losses, because negative Learner index does not have theoretical interpretation, and observations where profit/losses bigger than operational revenue in order to have PCM that varies from zero to one.

Appendix D.3

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

ISIC	Industry	Freq.
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 sport	0.52
93	Other service activities	0.87

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

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

ISIC	Industry	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	1997-2006
		Year													
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 organ.	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 activity	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 telecom dependence measure for 2-digit industries (ISIC rev. 3.1. classification). This measure is computed for the US using square input-output tables obtained from the Bureau of Economic Analysis. See Table *A* for complete definitions and sources of variable.

Table D: Correlations between interaction terms

	Telecom dependence US ×Telecom subscribers	Telecom dependence US ×Telecom revenue
Telecom dependence US × Telecom revenue	-0.60*	
Telecom dependence US × B.Entry cost	-0.63*	0.52*
Telecom dependence US × Market regulation	-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 rights	-0.60*	0.99*
Telecom dependence US × Human capital	-0.71*	0.98*
Growth potential US × Telecom subscribers	0.55*	-0.37*
Growth potential EU × Telecom subscribers	0.38*	-0.14*
Telecom dependence US × Shadow economy	-0.76*	0.90*
Telecom dependence US × GDP	-0.64*	0.99*
Telecom dependence US × CPI	-0.47*	0.97*
Entry rate US × B.Entry cost	-0.14*	-0.20*
Entry rate US × Market regulation	-0.43*	0.17*
Ext. fin. dependence US × Market capitalization	0.01	0.12*
Labor intensity US × Employment law	-0.34*	0.52*
R&D intensity US × Property rights	-0.07*	0.15*
R&D intensity US × Human capital development	-0.11*	0.15*

Note: This table shows the pairwise correlations between our main interaction terms and the interaction terms which include telecom diffusion or dependence variables and 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 5% level of significance.

Appendix R.1

Table E: Additional interaction terms only

	(I) Growth potential US	(II) Growth potential EU	(III) Shadow economy	(IV) GDP	(V) CPI
Growth potential US	-0.90***				
× Telecom subscribers	(0.17)				
Growth potential EU		-0.48**			
× Telecom subscribers		(0.19)			
Telecom dependence US			10.37***		
× Shadow economy			(3.53)		
Telecom dependence US				-1.40***	
× GDP				(0.22)	
Telecom dependence US					-0.55***
× CPI					(0.10)
Industry share	0.63**	0.62**	0.67**	0.71***	0.76***
	(0.27)	(0.28)	(0.27)	(0.27)	(0.28)
Observations	902	902	857	902	769
R2 adjusted	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, not reported. Robust standard errors are in parentheses. p<0.01, ** p<0.05, * p<0.1.

Table F: Additional interaction terms only

	(II) B.Entry cost	(III) Market regulation	(IV) Market. capitalization	(V) Employment law	(VI) Property rights	(VII) Human capital
Entry US	0.004***					
× B.Entry cost	(0.002)					
Entry US		0.01***				
× Market regulation		(0.00)				
Ext. fin. dependence US			0.01			
× Market Capitalization			(0.02)			
Employment intensity US				-0.30		
× Employment law				(5.64)		
R&D intensity US					-0.000	
× Property rights					(0.000)	
R&D intensity US						-0.02
× Human capital						(0.02)
Industry share	0.68**	0.79***	0.62**	0.45*	0.63**	0.65**
	(0.27)	(0.28)	(0.28)	(0.24)	(0.28)	(0.28)
Observations	803	721	882	616	882	882
R2 adjusted	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, not reported. Robust standard errors are in parentheses. p<0.01, ** p<0.05, * p<0.1.

Table G: Additional interaction terms only

	(I) B.Entry cost	(II) Market regulation	(III) Market capitalization	(IV) Employment law	(V) Property rights	(VI) Human capital
Telecom dependence US	3.08***					
× B.Entry cost	(1.04)					
Telecom dependence US		1.70***				
× Market regulation		(0.30)				
Telecom dependence US			-2.45***			
× Market capitalization			(0.77)			
Telecom dependence US				-1.42		
× Employment law				(1.43)		
Telecom dependence US					-2.81**	
× Property rights					(1.18)	
Telecom dependence US						-1.94
× Human capital						(1.32)
Industry share	0.66**	0.79***	0.64**	0.64**	0.64**	0.61**
	(0.27)	(0.28)	(0.27)	(0.27)	(0.27)	(0.27)
Observations	857	769	902	857	902	902
R2 adjusted	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, not reported. Robust standard errors are in parentheses. p<0.01, ** p<0.05, * p<0.1.