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Concentration of the mobile telecommunications markets and countries' competitiveness☆

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ABSTRACT

This study examines how the level of concentration of a country's mobile telecommunications market affects its competitiveness. We created a unique database with information on 59 countries, which we used to perform several estimations including an instrumental variable approach to explain the degree of concentration in mobile phone markets. Our first and direct estimation shows that the higher the concentration in this industry, the lower the countries' competitiveness. In order to understand this positive correlation, we provide two additional estimations. First, using an instrumental variable, we find that the concentration in mobile telecommunications market explains the use of information and communications technology (ICT). Moreover, we also find that the use of ICT is positively correlated with countries' competitiveness. Thus, our results confirm that the mobile phone industry has positive spillover effects on countries' competitiveness and demonstrate the benefits of policies designed to reduce concentration and market power in the industry.

1. Introduction

Several studies have examined how information and communications technology (ICT) enhances firm-level productivity and countries' competitiveness and have pointed out the utility of public policies designed to promote the digitisation of the economy. Digitisation requires access to infrastructure; such access entails investing in the deployment of networks and facilities supplied by the telecommunication sector. These investments from telecommunication firms in turn indirectly depend on the intensity of competition in this sector. On the one hand, when the competition is not intense enough, firms are not incentivised to invest. On the other hand, too much competition erodes the profits that are necessary to invest in this industry, which is characterised by high sunk costs.

This paper investigates how the level of concentration of a country's mobile telecommunications market affects its competitiveness. Digital transformation is a multifaceted phenomenon that impacts innovation in all sectors of the economy (OECD, 2019). Since innovation is strongly linked to countries' level of competitiveness, we also explore how digitisation influences the relationship between the intensity of competition in a country's mobile telecommunications sector and its competitiveness.

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We merge two databases with information on 59 countries to determine whether the concentration of a country's mobile market affects its competitiveness. First, we use the database of the Global Competitiveness Index of the World Economic Forum to extract measures of the degree of countries' competitiveness. Second, the database of the mobile market provided by the Global System for Mobile Communications (GSMA) contains information on the degree of concentration in mobile phone markets, which serves as a good proxy for the level of competition.

Our first (and direct) regression highlights the statistical relationship between the level of concentration of a country's mobile phone market (which we use to proxy for the sector's competition intensity) and its degree of competitiveness. Using panel data, allowing for fixed effects and introducing the usual control variables for this kind of cross-country study, our results indicate that a higher degree of concentration in the mobile phone industry is associated with a lower level of competitiveness. Since this first regression does not allow us to infer the causal relationship between these two variables, we cannot rule out the possibility that countries' competitiveness also explains the degree of concentration in their mobile phone markets. We therefore decompose this statistical relationship in two stages to more clearly establish the causal relationship between these two variables.

In the first stage, we perform a fixed effect (linear) regression in which the dependent variable is ICT use, which seeks to capture the degree of digitisation. The independent variables measure the degree of competition of mobile phone markets and contain a battery of control variables. We also use an instrumental variable (IV) that captures the degree of strictness of each country's antitrust policy. We hypothesise that the strictness of such policies may directly influence the level of competition in a country's mobile phone market without directly affecting its degree of digitisation. We find that a higher degree of concentration in the mobile phone market causes, on average, a reduction of 0.45 points (on a scale of 1 to 7) in the level of digitisation of a country's economy.

In the second stage, we analyse the statistical relationship between multiple digitisation indicators and the countries' competitiveness indicators for the same set of countries using an OLS regression with fixed effects. Our results show that, on average, higher levels of digitisation are positively correlated with greater economic competitiveness. Thus, our decomposition reveals a negative and significant causal relationship between the concentration of mobile phone markets and countries' competitiveness, explained by the channel of ICT use.

Section 2 briefly reviews the literature. Section 3 describes the data and variables used in the study. Section 4 explains our empirical strategy. Section 5 reports the results, and Section 6 concludes.

2. Literature review

Numerous empirical studies have addressed the relationship between certain features of a country's telecommunication sector and its competitiveness/productivity. We highlight the most relevant articles for our analysis, both for directly estimating the concentration ratio in mobile phone markets with the countries' competitiveness indicators, as well as those related to our two estimations.

Gruber and Koutroumpis (2011) estimate the impact of mobile telecommunications on economic growth. They find that the penetration of this technology increases economic growth and productivity and establish a causal relationship between these variables. They identify two drivers of the impact of mobile telecommunications on economic growth: (1) the direct effect of infrastructure investment and (2) the spillover effects that result from the use of these networks, which facilitate interactions between individuals by shortening distances, facilitating remote working, and avoiding unnecessary travel, all of which improve productivity and the quality of life. Similarly, Grimes, Ren, and Stevens (2012) confirm that broadband adoption increased the productivity of firms in New Zealand by 7%–10%. More recently, Edquist, Goodrige, Haskel, Li, and Lindquist (2018) corroborate the significant effect of mobile broadband introduction and diffusion on GDP. Using a two-stage model, they find that a 10% increase in mobile broadband adoption increases GDP by 0.8%. This economic effect decreases over time. These results point in the same direction: mobile telecommunications penetration improves countries' growth and productivity. In Section 6, we show that competitiveness and productivity yield similar results in a subset of Organisation for Economic Co-operation and Development (OECD) countries. We contribute to this literature by demonstrating that a country's degree of digitisation is one channel that yields this outcome.

Several articles are also related to our first-stage estimation. For the two forces mentioned in the introduction, the relationship between the telecommunications market structure and digitisation as part of understanding the determinants of Internet diffusion and liberalisation policy impacts on ICT adoption remains unclear. Friesenbichler (2007), as well as in Frontier Economics report published in 2017, suggested that there is an inverted-U relationship between market concentration and investment for Latin American mobile markets. Genakos, Valletti, and y Verboven (2015) analysed the relationship between market structure and prices and investments in the mobile telecommunications industry. They find that a four-to-three merger between smaller firms in European countries would increase end users' bill by about 4%–7% while increasing capital expenditure per operator by 7.5%–14%. Although we cannot rule out the possibility that there is a non-linear relationship between mobile phone market concentration and investment, in our first estimation we find no linear effect of mobile phone market concentration on ICT use.

Even though the market structure of the mobile phone industry is important, Hargittai's (1999) empirical study points out that economic wealth and telecommunications policy are also relevant predictors of countries' Internet connectivity, while a monopoly in the telecommunications sector seems to have a negative impact on connectivity. Kiiski and Pohjola (2002) show that market liberalisation itself does not guarantee greater Internet diffusion unless it coincides with a reduction in market prices for those services. Using data on Internet hosts per capita for a sample of OECD countries during 1995–2000, they find that competition in telecommunications markets has no direct effect on Internet penetration. Finally, Billon, Marco, and Lera-Lopez (2009) provide a canonical correlation analysis for 142 countries in 2004 to explain differences in ICT diffusion for different groups of countries. Their explanatory variable set includes dummy variables for the level of competition for digital cellular mobile services. Based on

their results, they anticipate that deregulation, liberalisation, and competition measures in telecommunication infrastructures and services might boost Internet use in less-developed economies. The results of our first-stage estimation corroborate their findings. Moreover, unlike their correlation approach, our IV approach allows us to establish the causal effect of the mobile phone industry's market structure on ICT use.

Regarding the relevant to our second-stage estimation, Gal et al. (2019) found a robust statistical relationship between digitisation and firm-level productivity in EU countries. Their results indicate that digitisation is more beneficial for manufacturing firms than service firms, which confirms previous results from Akerman, Gaarder, and Mogstad (2013) and Dhyne, Konings, Konings, and Vanormelingen (2018). Gal et al. (2019) also concluded that digitisation has a greater impact in industries that rely on repetitive processes, which aligns with the results of Chevalier and Luciani (2018). The results of the second stage of our decomposition corroborate these empirical findings, even though we do not include details of the firms' sectors and our dependent variables are measures of competitiveness that are closely related to productivity.

3. Data

To construct our empirical estimations, we use data from two sources for the period 2007–2017: the database of the Global Competitiveness Index of the World Economic Forum and the GSMA database of the mobile market.

3.1. Global Competitive Index

The World Economic Forum (WEF) defines competitiveness as "the set of institutions, policies and factors that determine the level of productivity of a country". The WEF calculates the annual Global Competitive Index (GCI) based on weighted performances of each country in 12 aspects that, according to the WEF, reflect the quality of institutions, policies, and all factors that promote productivity and competitiveness. Each of these pillars is composed of sub-pillars and indicators that are evaluated qualitatively (*e.g.*, by administering surveys to businessmen in each country) or quantitatively (*e.g.*, based on official statistics) (see Appendix for details of the pillars). Instead of using the GCI directly, we use its decomposition into pillars; in some cases, indicators that feed a pillar are also used directly (described in more detail below).

To measure competitiveness, we use pillars 8 (Financial market development), 10 (Market size), 11 (Business sophistication) and 12 (Innovation), which the WEF defines as follows:

- Pillar 8 — Financial market development: qualifies the extent to which a country's financial market is reliable, transparent, adequately regulated to protect investors and other economic actors, efficient enough to meet companies' needs, affordable (credits and financial services), whether it is financed through the local stock market and if it has risk capital.
- Pillar 10 — Market size: based on the assumption that increasing the size of the market available for a country's firms allows them to take advantage of scale economies.
- Pillar 11 — Business sophistication: evaluates the quality of a country's business networks, and the operational and strategic quality of individual firms.
- Pillar 12 — Innovation: assesses private sector investment in research and development, the presence of high-quality scientific research institutions, the level of university–industry collaboration in research and technological development, and intellectual property protection.

We use pillar 9 (Technological readiness and its decomposition) to measure each country's level of digitisation. It considers the level of technological adoption and the penetration of voice and internet services through fixed and mobile networks in the population (see the Appendix for more details). This pillar captures the agility with which a country adopts existing technologies, especially ICT, to enhance its industries' productivity. Through this pillar, the WEF recognises how ICT increases competitiveness.

We employ pillars 1 (Institutions), 2 (Infrastructure), 3 (Macroeconomic environment), 4 (Health and primary education), 5 (Higher education and training), and 7 (Labour market efficiency) as control variables. We build a new variable from pillar 2, eliminating the telecommunications dimension incorporated by the WEF to avoid obvious endogeneity concerns. Finally, the decomposition of pillar 6 (Efficiency of the goods market) – specifically the indicator that evaluates the effectiveness of the antitrust policy – is used as an instrumental variable in the two-stage model.

3.2. Global system for mobile communications

This organisation maintains a quarterly database, directly collecting information from more than 1,250 mobile telecommunications service providers around the world.[1] We used the Hirschman–Herfindhal Index (HHI) of the telecommunications market reported for the last quarter of each year between 2007 and 2017 to measure the concentration of the mobile market in 59 developed and developing countries. Figs. 7–8 show the levels and variability in mobile HHI for some of these countries.[2]

[1] This database is commercially available and has been provided to us for research purposes.

[2] The HHI calculation takes into account each active mobile user in these countries, defined as persons with an active sim card.

Table 1
Correlation matrix.

		HHI	ICT use	P9	P8	P10	P11	P12
Concentration	HHI	1						
Digitisation	ICT Use	−0,05	1					
	P9	−0,15	0,81	1				
Competitiveness	P8	0,02	0,65	0,53	1			
	P10	−0,33	0,12	0,14	0,00	1		
	P11	−0,09	0,80	0,79	0,69	0,30	1	
	P12	−0,15	0,85	0,82	0,65	0,24	0,92	1

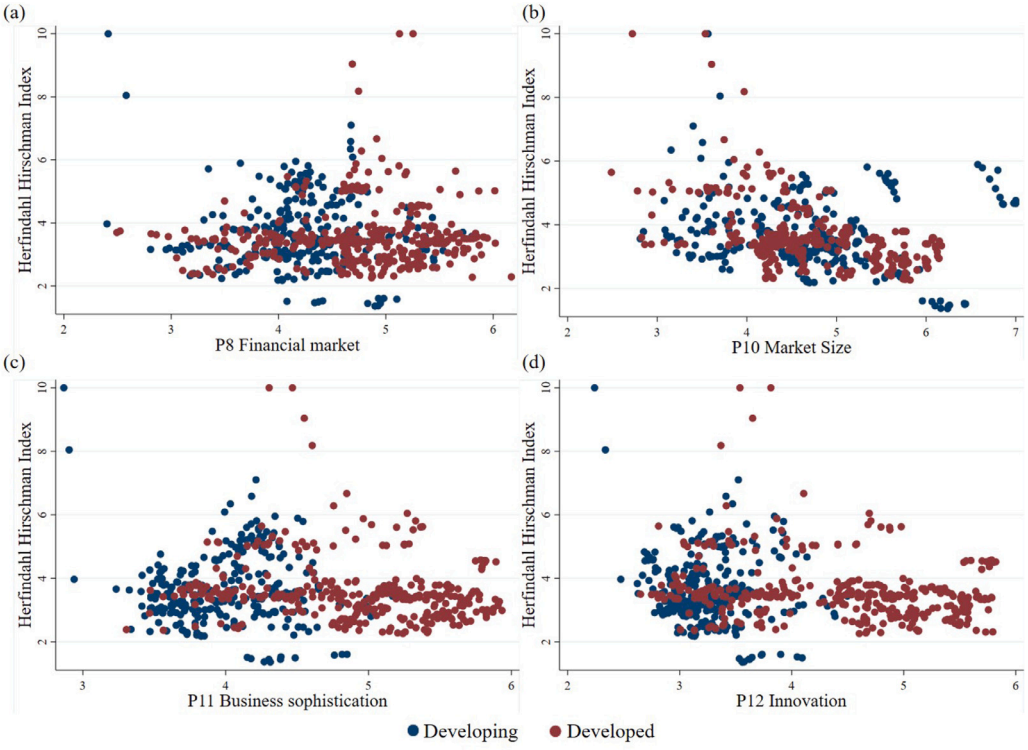

Fig. 1. HHI vs. Competitiveness.
Source: Author's calculations.

3.3. Exploratory analysis

As Table 1 shows, our concentration variable is negatively correlated with the digitisation and competitiveness variables, except the development of the financial market (for which the correlation is close to zero). Likewise, the two digitisation variables are positively correlated with the four competitiveness indicators. These findings suggest that the level of concentration of a country's mobile phone market negatively affects digitisation, which in turn affects its competitiveness.

Fig. 1 displays these relationships disaggregated by developed vs. developing countries. It demonstrates a strong negative relationship between concentration in the mobile phone market and the market size of the economy for both developed and developing countries. Additionally, we observe that the relationship between concentration and competitiveness is more pronounced for less developed countries than for developed countries. Similarly, Fig. 2 shows the scatter plot between HHI and our digitisation variables, ICT use and technological readiness. There is a negative relationship between market concentration and digitisation, and it is stronger for developing countries; this relationship remains unclear for developed countries.

Finally, Fig. 3 illustrates the relationship between digitisation and competitiveness. For the sake of simplicity, only the ICT use variable is plotted. Panels (a), (c) and (d) reveal a positive correlation between digitisation and the pillars of financial market development, business sophistication and innovation. This correlation is high for both developed and developing countries. Panel (b) shows a positive relationship between ICT use and market size of the economy for developing countries, while for developed countries it is unclear.

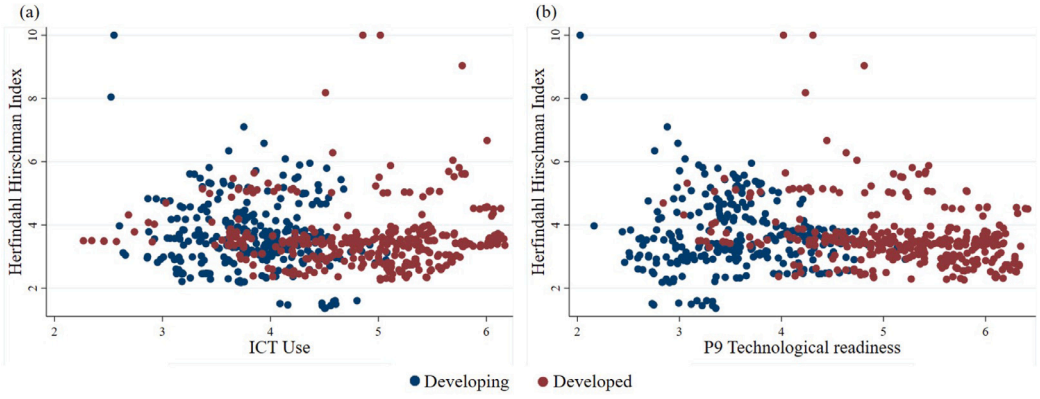

Fig. 2. HHI vs. Digitisation.
Source: Author's calculations.

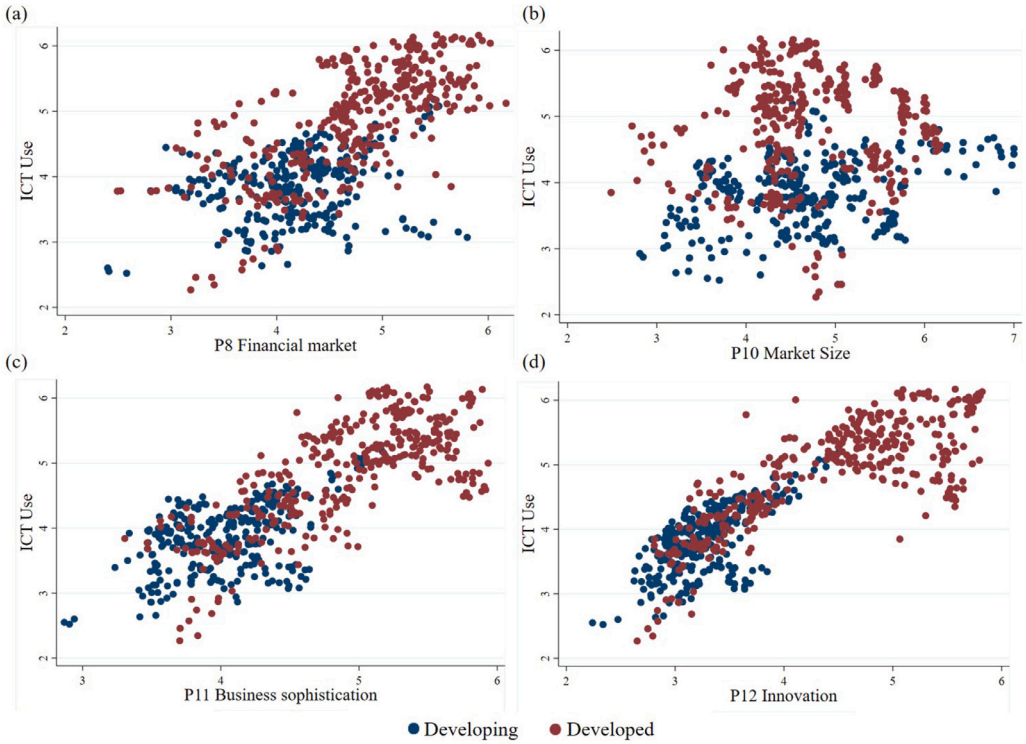

Fig. 3. Digitisation vs. Competitiveness.
Source: Author's calculations.

4. Empirical strategy

We have balanced panel data for 59 developed and developing countries (see Table 3). Our empirical approach uses fixed effects (FE) estimation to exploit the variability between and within countries. We include time fixed effects and country fixed effects to control for macroeconomic shocks that could have occurred during the period of analysis and to control for country characteristics that remain constant over time. Additionally, we use pillars 1 to 7 from the GSMA database as controls.

We use this panel data to measure the correlation between a country's mobile phone market concentration and its competitiveness. First, we calculate the following equation:

$$Y_{it} = \beta_0 + \alpha_t + \beta_1 HHI_{it} + \beta_2 Inst_{it} + \beta_3 Infra_{it} + \beta_4 MaEnv_{it} + \beta_5 Health_{it} + \beta_6 Edu_{it} + \beta_6 Efilabor_{it} + \epsilon_{im}, \quad (1)$$

where:

- Y_{it} measures the competitiveness of country i, year t;
- HHI_{it}: Hirschman–Herfindhal index of the telecommunications sector in country i, year t;
- $Inst_{it}$: Score of pillar 1 of GCI: Institutions, country i, year t;
- $Infra_{it}$: Score of pillar 2 of GCI: Infrastructure, country i, year t;
- $MaEnv_{it}$: Score of pillar 3 of GCI: Macroeconomic environment, country i, year t;
- $Health_{it}$: Score of pillar 4 of GCI: Health service, country i, year t;
- Edu_{it}: Score of pillar 5 of GCI: Education, country i, year t;
- $Efilabor_{it}$: Score of pillar 7 of GCI: Labour market efficiency, country i, year t.

We use four measures of competitiveness from the GCI: development of the financial sector, size of the market, business sophistication and innovation. It is worth to note that many variables can be correlated with our competitiveness measures. For example, a country with stronger institutions and better infrastructure may have more productive companies (according to the business sophistication and innovation measures). Additionally, countries that have better health services and good education systems are likely to have a more qualified labour force and thus be more competitive than those that do not. Finally, labour market efficiency and the macroeconomic environment may affect competitiveness.

In a second exercise, in order to understand this correlation result, we estimate the relationship between the level of concentration in mobile phone markets and countries' degree of competitiveness in two stages. First, we estimate the relationship between HHI and digitisation. Second, we study the correlation between the digitisation and competitiveness variables described above.

The first-stage equation is:

$$D_{it} = \gamma_0 + \alpha_t + \gamma_1 HHI_{it} + \gamma_2 Inst_{it} + \gamma_3 Edu_{it} + \gamma_4 SM_{it} + \varepsilon_{im}. \tag{2}$$

Here, D_{it} is a measure of ICT use in country i, year t, and SM_{it} is the size of the market (exports and imports) of economy i in year t. We implement an IV strategy to identify the causal relationship between the concentration of mobile phone markets and competitiveness. We use the strictness of a country's antitrust policy as an instrumental variable for HHI. We expect antitrust policy strictness to directly affect the level of competition in mobile phone markets without directly affecting the degree of digitisation.

The equation associated with our second stage is:

$$\begin{aligned} Y_{it} = \ & \beta_0 + \alpha_t + \beta_1 \hat{D}_{it} + \beta_2 Inst_{it} + \beta_3 Infra_{it} + \beta_4 MaEnv_{it} + \beta_5 Health_{it} + \\ & \beta_6 Edu_{it} + \beta_6 Efilabor_{it} + \epsilon_{im}. \end{aligned} \tag{3}$$

This equation allows us to estimate the statistical relationship between countries ICT use and their competitiveness.

5. Results

Our results, presented in Fig. 8, reveal a statistically significant and negative relationship between the concentration of the mobile market and competitiveness in the 59 countries in our sample from 2007 to 2017 on the four indicators of competitiveness variables. The figure highlights the HHI's impact on financial market development and innovation. A 1,000-unit increase in a country's HHI score (scale of 1–7) decreases the value of the first variable by 0.05 and the value of the second by 0.08, which is significant. Likewise, institutions and the macro environment explain part of the good performance of the financial market, while institutions and the efficiency of the labour market significantly affect the other variables of competitiveness examined here (see Table 4) (see Fig. 4).

In a second exercise, we estimate the impact of ICT on competitiveness using a two-stage approach. In the first stage, we aim to explain the relationship between HHI and the variable ICT use. In the second stage, we focus on the relationship between the use of ICTs and the competitiveness variables described above. To determine whether the concentration of the mobile market has a causal relationship with the use of ICT, the first equation of this two-stage procedure is estimated with and without our instrumental variable, which comes from the decomposition of the GCI. Pillar 6 (Goods market efficiency) rates the performance of competition in each country, when evaluating the effectiveness of anti-monopoly policy. This instrumental variable is considered suitable insofar as it explains the HHI without directly explaining the chosen digitisation variables. It is the case as long as the competition intensity strictness impacts much more the price of ICT, due to the fact that it affects competition in telecommunication sector, than the demand of ICT in other sectors.[3]

[3] Our assumption related to our instrumental variable is reasonable if the supply-side effect is much larger in magnitude than the demand-side one. Four arguments support our assumption. First, the supply-side effect is more direct since the strictness of a country's competition policy directly affects the price of its ICT through the concentration of its mobile telecommunication sector. Second, our variable ICT use measures the number of people who access the internet, subscriptions to fixed and mobile broadband, international bandwidth, and the number of fixed and mobile telephone users, not only firm-level Internet connections. In other words, it seems realistic to assume that in the construction of this variable, the weight of households is much more important than the number of Internet connections bought by firms. Third, even though one might think that it is better to focus on firms' demand (rather than all the demand that includes households), the strictness of competition intensity is likely to affect a small subset of sectors characterised by high levels of concentration (*i.e.* few firms are concerned) rather than all firms. In other words, only few sectors are concerned by competition policy strictness, and their weight in the total demand of ICT is likely to be small. Finally, since firms tend to be more price inelastic than households for this kind of service, their demand for ICT should vary less than household demand, which is much more price elastic.

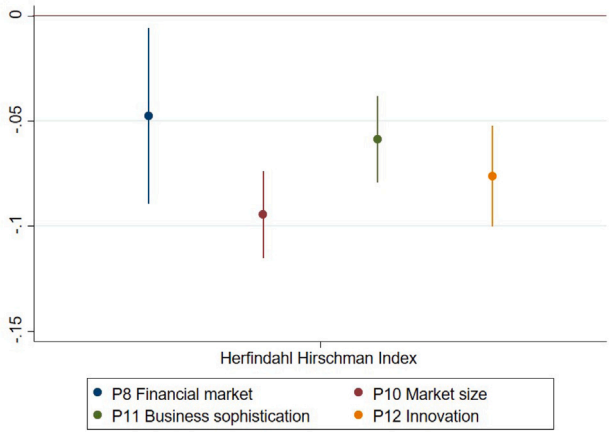

Fig. 4. Coefficients Associated with HHI *vs.* Competitiveness Variables. Note: Confidence intervals with *p*-value of 0.05.

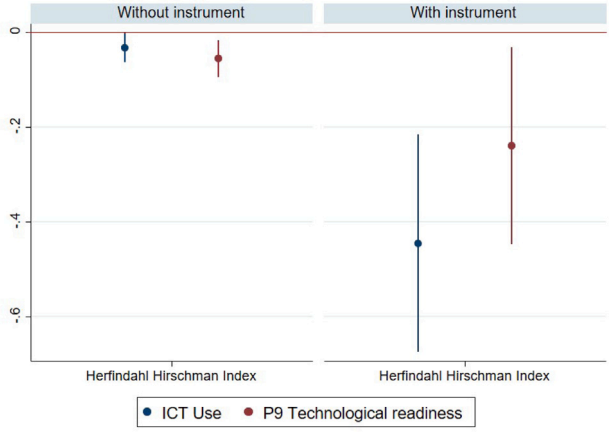

Fig. 5. Coefficients Associated with HHI *vs.* Digitisation variables. Note: Confidence intervals with *p*-value of 0.05.

The results of the second regression (Fig. 5) reveal a negative and significant relationship between competence (HHI) and digitisation; the latter is measured by the variables Technological Readiness and ICT use. After including the effectiveness of anti-monopoly policy as the instrumental variable, this relationship is maintained and the r-squared increases for the ICT use variable (Table 5).[4]

Finally, the results shown in Fig. 6 illustrate that digitisation, measured using the GCI's overall Pillar 9 rating, has a positive and statistically significant relationship with business sophistication. Digitisation measured as the use of ICT (Pillar 9 component) has a positive and significant relationship with the variables Market size, Business sophistication and Innovation (see Tables 6–8).

6. Robustness checks: productivity vs. competitiveness variables

The WEF data comes from surveys administered to business leaders. Even though this information is relevant for business leaders and may motivate some of their economic decisions, we cannot be sure that the variables built from WEF surveys constitute a good measure of countries' competitiveness and reflect their true productivity. Therefore as a robustness check, we use competitiveness variables for productivity indicators from the OECD database: annual growth of (1) multi-factorial productivity (2) capital productivity and (3) labour productivity.[5]

Table 2 reports the results of the OLS estimation adding time and country fixed effects. These results demonstrate that higher ICT adoption is correlated with three different productivity measures — higher capital, labour and multi-factor productivity. Although

[4] In our first regressions, we included the squared HHI as an additional control but found no statistical evidence to suggest that this inverted-U relationship is linked to ICT use. Moreover, by including the variable Squared HHI, the coefficient is not significant, and multicollinearity problems appear that affect the estimation of standard errors. For this reason, we prefer to fit a parsimonious model including only the HHI.

[5] The subset of OECD countries reduces the sample size to 19.

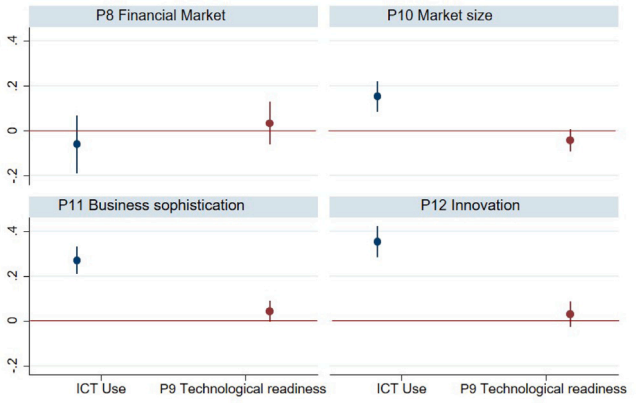

Fig. 6. Coefficients Associated with Digitisation Variables *vs.* Competitiveness Variables. Note: Confidence intervals with *p*-value of 0.05.

Table 2
Relationship between ICT use and productivity.

Variables	(1) Multifactor productivity	(2) Capital productivity	(3) Labour productivity
ICT_use	1.73**	2.48**	1.47*
	(0.83)	(1.10)	(0.85)
P1 Institutions	0.83	−0.16	1.21*
	(0.60)	(0.80)	(0.62)
P2 Infrastructure	−1.98***	−1.03	−2.33***
	(0.60)	(0.79)	(0.62)
P3 Macroeconomic	−0.07	−1.09***	0.32
environment	(0.29)	(0.39)	(0.30)
P4 Health and	−3.35**	−4.47**	−2.95*
primary education	(1.57)	(2.09)	(1.62)
P5 Higher education	−0.64	−0.02	−0.86
and training	(1.01)	(1.34)	(1.04)
P7 Labour	0.03	1.45	−0.61
market efficiency	(0.69)	(0.91)	(0.71)
Constant	24.35***	20.15*	26.10***
	(9.15)	(12.18)	(9.46)
Observations	209	209	209
R-squared	0.478	0.626	0.380
Number of countries	19	19	19

Standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.

the sample is reduced to 19 OECD countries, these coefficients corroborate the results using the WEF database, which highlights a robust statistical relationship between ICT use and countries' competitiveness.

7. Conclusions

Our first estimation shows the higher the concentration in this industry, the lower the countries' competitiveness. In order to better understand this result, we perform two other estimations. We find that the degree of concentration in a country's mobile phone explains its level of digitisation and that this relationship is stronger for developing countries, but is less clear in developed economies. Finally, we find a negative correlation between ICT use and countries competitiveness.

These results suggest that the level of concentration of a country's mobile market negatively impacts the digitisation process, and in this way could affect its competitiveness. These results corroborate previous analysis that highlights that the mobile phone industry is part of an ecosystem that generates spillover effects on the rest of the economy. Based on our findings and those of previous analyses, we conclude that regulations designed to promote competition in mobile phone markets are likely to generate positive externalities in other sectors of the economy, especially in developing countries.

We used the HHI to approximate the degree of competition in mobile telephony markets. Future studies could use a more direct measure of the degree of competition to identify how specific changes in the market structure generate differentiated effects depending on the characteristics of the economy, and to see whether for a given level of concentration, other factors shape the positive indirect effects generated by this industry.

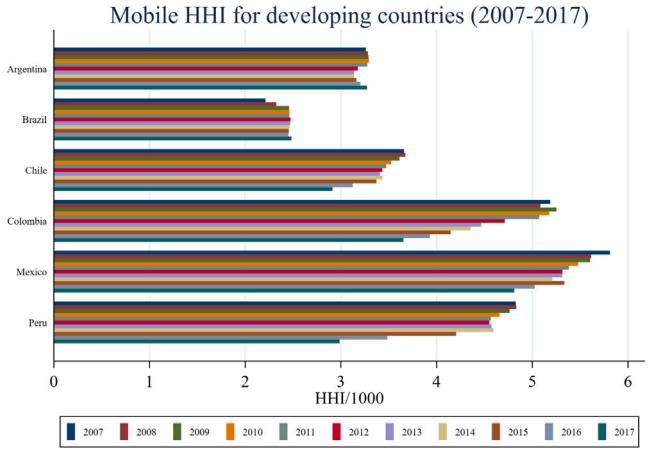

Fig. 7. Evolution of Mobile HHI for Selected Developing Countries in our Sample, 2007–2017. *Source:* GSMA.

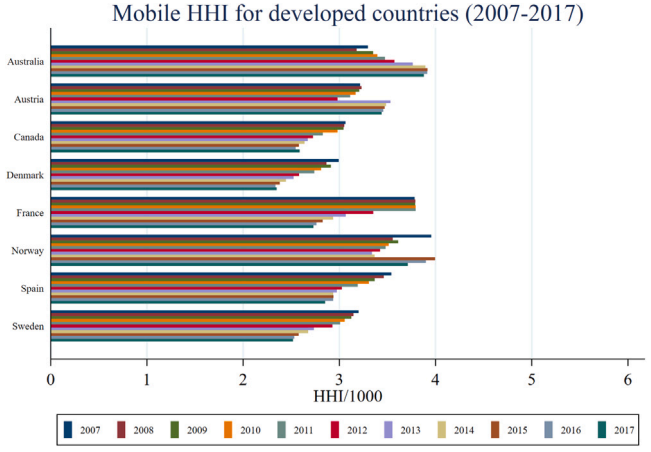

Fig. 8. Evolution of Mobile HHI for Selected Developed Countries in our Sample, 2007–2017. *Source:* GSMA.

Appendix

The Global Competitive Index is built upon the 12 pillars described below and is based on what affects competitiveness according to the World Economic Forum, in addition to the "ICT use" variable. We summarise the pillars as follows:

- Pillar 1 — Institutions: assesses the suitability of the legal and administrative framework in which individuals, firms and governments interact. It assumes that this institutional framework influences investment decisions and the organisation of production, and shapes how societies distribute benefits and face the costs of developing policies and strategies.
- Pillar 2 — Infrastructure: evaluates the quality, coverage and efficiency of the transport, electricity and telecommunications infrastructure, considering that they are fundamental components that allow businesses to acquire goods and services, affect workplace displacement, the operation of production plants and information flows.
- Pillar 3 — Macroeconomic environment: reflects the stability of a country's macroeconomic variables, as they create a favourable environment in which to increase productivity and facilitate economic growth.
- Pillar 4 — Health and primary education: reflects the health of a country's workforce and the quantity and quality of the basic education of the population, both of which are essential to workforce productivity.
- Pillar 5 — Higher education and training: measures the enrolment rates of the population in secondary and tertiary education programmes, as well as the quality of the education provided as assessed by business leaders. It also evaluates workforce training opportunities, with the aim of improving workers' skills.
- Pillar 6 — Efficiency of the goods market: assesses the performance of competition in the local market vs. the international market, as well as the level of demand among a market's consumers vs. suppliers.

Table 3
Most representative countries.

Countries in the sample	
Argentina	Malaysia
Australia	Mexico
Austria	Myanmar
Bahrain	Netherlands
Belgium	New Zealand
Brazil	Nigeria
Bulgaria	Norway
Canada	Oman
Chile	Pakistan
China	Peru
Colombia	Philippines
Croatia	Poland
Czech Republic	Portugal
Denmark	Qatar
Egypt	Romania
Finland	Russian
France	Saudi
Germany	Singapore
Ghana	Slovakia
Greece	South Africa
Hong Kong, SAR China	Spain
Hungary	Sweden
India	Switzerland
Indonesia	Taiwan
Iran	Tanzania
Iraq	Thailand
Ireland	Turkey
Israel	Uganda
Italy	Ukraine
Japan	United Arab Emirates
Kazakhstan	United Kingdom
Kenya	United States of America
Korea, South	Vietnam
Kuwait	

Table 4
Relationship between HHI and competitiveness.

	(1) P8 Financial market	(2) P10 Market size	(3) P11 Business sophistication	(4) P12 Innovation
HHI	−0.05**	−0.09***	−0.06***	−0.08***
	(0.02)	(0.01)	(0.01)	(0.01)
P1 Institutions	0.47***	0.11***	0.28***	0.16***
	(0.06)	(0.03)	(0.03)	(0.04)
P2 Infrastructure	0.05	0.06***	0.00	0.02
	(0.03)	(0.02)	(0.02)	(0.02)
P3 Macroeconomic environment	0.19***	0.01	0.02	0.02
	(0.02)	(0.01)	(0.01)	(0.01)
P4 Health and primary education	0.09	−0.03	0.02	−0.01
	(0.07)	(0.04)	(0.03)	(0.04)
P5 Higher education and training	−0.03	−0.05	0.15***	0.32***
	(0.07)	(0.03)	(0.03)	(0.04)
P7 Labour market efficiency	−0.07	−0.09***	0.22***	0.25***
	(0.06)	(0.03)	(0.03)	(0.03)
Constant	1.59***	4.81***	1.72***	0.70***
	(0.46)	(0.23)	(0.23)	(0.26)
Observations	640	640	640	640
R-squared	0.474	0.537	0.497	0.545
Number of countries	59	59	59	59

Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

- Pillar 7 — Labour market efficiency: assesses the efficiency and flexibility of the labour market, to assign areas where workers should be located and the incentives for their optimal performance in the workplace.
- Pillar 8 — Financial market development: rates the degree to which a country's financial market is reliable, transparent, adequately regulated to protect investors and other economic actors, efficient enough to meet companies' needs, affordable (credit and financial services), whether it is financed through the local stock market and if it has risk capital.

Table 5
Impact of Concentration in the Mobile Market on Digitisation.

	(1) ICT_use	(2) P9 Technological readiness
HHI	−0.45***	−0.24**
	(0.12)	(0.11)
P5 Higher education and training	0.58***	0.38***
	(0.07)	(0.06)
P1 Institutions	0.29***	0.07
	(0.06)	(0.05)
P10 Market size	−0.37**	−0.42***
	(0.17)	(0.16)
Constant	3.92***	4.79***
	(1.29)	(1.17)
Observations	640	640
Number of countries	59	59

Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 6
Relationship between HHI and Digitisation.

	(2) ICT_use	(3) P9 Technological readiness
HHI	−0.03**	−0.06***
	(0.02)	(0.02)
P5 Higher education and training	0.60***	0.38***
	(0.04)	(0.06)
P1 Institutions	0.31***	0.08
	(0.04)	(0.05)
P10 Market size	0.17***	−0.18**
	(0.06)	(0.07)
Constant	−0.37	2.89***
	(0.34)	(0.43)
Observations	640	640
R-squared	0.479	0.731
Number of countries	59	59

Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 7
Relationship between technological readiness and competitiveness.

	(1) P8 Financial market	(2) P10 Market size	(3) P11 Business sophistication	(4) P12 Innovation
P9 Technological readiness	0.03	−0.04	0.04*	0.03
	(0.05)	(0.03)	(0.02)	(0.03)
P1 Institutions	0.48***	0.13***	0.29***	0.17***
	(0.06)	(0.03)	(0.03)	(0.04)
P2 Infrastructure	0.05*	0.07***	0.01	0.03
	(0.03)	(0.02)	(0.02)	(0.02)
P3 Macroeconomic environment	0.20***	0.00	0.02*	0.02
	(0.02)	(0.01)	(0.01)	(0.01)
P4 Health and primary education	0.07	−0.06	−0.00	−0.03
	(0.07)	(0.04)	(0.04)	(0.04)
P5 Higher education and training	−0.04	−0.03	0.13***	0.31***
	(0.07)	(0.04)	(0.04)	(0.04)
P7 Labour market efficiency	−0.06	−0.08**	0.22***	0.26***
	(0.06)	(0.03)	(0.03)	(0.04)
Constant	1.32***	4.51***	1.39***	0.32
	(0.47)	(0.25)	(0.23)	(0.27)
Observations	640	640	640	640
R-squared	0.469	0.473	0.472	0.515
Number of countries	59	59	59	59

Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

- Pillar 9 — Technological readiness: measures the agility with which an economy adopts existing technologies, especially ICT, to promote the productivity of its industries.

Table 8
Relationship between ICT use and competitiveness.

	(1) P8 Financial market	(2) P10 Market size	(3) P11 Business sophistication	(4) P12 Innovation
ICT_use	−0.06	0.15***	0.27***	0.35***
	(0.07)	(0.03)	(0.03)	(0.04)
P1 Institutions	0.49***	0.10***	0.24***	0.11***
	(0.06)	(0.03)	(0.03)	(0.03)
P2 Infrastructure	0.06*	0.05***	−0.02	−0.01
	(0.03)	(0.02)	(0.02)	(0.02)
P3 Macroeconomic environment	0.19***	0.01	0.02**	0.03**
	(0.02)	(0.01)	(0.01)	(0.01)
P4 Health and primary education	0.08	−0.09**	−0.05	−0.10**
	(0.07)	(0.04)	(0.03)	(0.04)
P5 Higher education and training	0.00	−0.13***	0.00	0.13***
	(0.08)	(0.04)	(0.04)	(0.04)
P7 Labour market efficiency	−0.05	−0.12***	0.16***	0.18***
	(0.06)	(0.03)	(0.03)	(0.03)
Constant	1.30***	4.65***	1.89***	0.92***
	(0.46)	(0.24)	(0.22)	(0.25)
Observations	640	640	640	640
R-squared	0.470	0.489	0.532	0.585
Number of countries	59	59	59	59

Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

- Pillar 10 — Market size: based on the assumption that increasing the size of the market available for a country's firms allows them to take advantage of scale economies.
- Pillar 11 — Business sophistication: assesses the quality of a country's business networks, and the operational and strategic quality of individual firms.
- Pillar 12 — Innovation: assesses private sector investment in research and development, the presence of high-quality scientific research institutions, the level of university–industry collaboration in research and technological development, and intellectual property protection.
- ICT use — variable scaled from 1 to 7 based on six indicators: (1) Internet users, (2) Broadband Internet subscriptions, (3) Internet bandwidth, (4) Mobile broadband subscriptions, (5) Mobile telephone subscriptions and (6) Fixed telephone lines.

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