Concentration of the Mobile Phone Markets and Countries' Competitiveness

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Abstract

The present study aims to shed light on the role of mobile phone markets' concentration on countries' competitiveness using a database that includes 59 countries and performing several estimations to find a causal relationship. Using an instrumental variable that aims to explain the degree of concentration in mobile phone markets, we find that the higher is the concentration in this industry, the lower is the use of the information technology and communication (ITC). On the other hand, we also find that the use of ITC is positively associated to countries' competitiveness. Thus, our results reveal pretty strong positive spillover effects of the mobile phone industry on countries' competitiveness. These results suggest that all policies that aim to reduce concentration and market power in the mobile phone industry may increase competitiveness.

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1 Introduction

Several researches have revealed the role of Information Technology and Communications (ICT hereafter) on the productivity of firms and countries, showing the usefulness of a public policy that focuses on the promotion of the economy digitisation. According to that digitisation it has as a prerequisite access to infrastructure, and on the other hand, this access depends fundamentally on the investment in the deployment of networks and facilities supplied by the telecommunication sector. Our aim is to shed light on the role of the competition intensity in the mobile telecommunications on the countries' competitiveness.

In this study we use two databases that collect information from 59 countries to measure whether the concentration of the mobile market has an impact on countries' competitiveness. More precisely, we use the database of the Global Competitiveness Index of the World Economic Forum to extract information that measures the degree of countries' competitiveness. On the other hand, the database of the mobile market provided by the Global System for Mobile Communications shares information related to the degree of concentration in mobile phone markets that works as a good proxy of the competition degree.

We perform a first regression to highlight the statistical relationship between the level of concentration in mobile phone markets and the degree of countries' competitiveness. Using a panel data, allowing for fixed effects and introducing usual control variables for this kind of study, our results indicate that a higher concentration in the mobile phone industry is related to a lower level of competitiveness. Nevertheless, this first regression does not allow us to infer the causality relationship between these two variables and we cannot rule out that countries' competitiveness also explain the degree of concentration in mobile phone markets.

Thus, we propose a decomposition of this statistical relationship to establish more clearly the causal relationship between these two variables. More precisely, our decomposition contains two stages. In the first stage, we perform a linear regression where the dependent variable is the ICT use that aims to capture the degree of digitisation, while the independent variables contain the degree of competition of mobile phone markets and a battery of control variables. Additionally, we use an instrumental variable that captures the degree of strictness of antitrust policy in different countries. Our claim is that antitrust policy strictness may directly affect the degree of competition in mobile phone markets without affecting the countries' degree of digitisation directly. We find that a higher degree of concentration in the mobile phone markets causes, on average, a reduction of 0.45 points (it is a scale of 1 to 7) at the level of digitisation of the countries' economies.

In a second stage, we analyse for these same countries the statistical relationship between some digitisation indicators and the countries' competitiveness indicators. Yet, we perform an OLS regression with fixed effects. Our results show that, on average, higher levels of digitisation correlate positively with greater competitiveness. This decomposition allows us to point out a negative and significant causal relationship between the concentration of mobile phone markets and countries' competitiveness.

In section 2 we provide a brief review of literature. In section 3 we present the sources of information used in this study and some descriptive statistics of the variables we constructed. In section 4 we explain the empirical strategy adopted. Our results are given in section 5 and we conclude in section 6.

2 Literature Review

There are numerous empirical studies that have addressed the relationship between telecommunications features and the competitiveness of countries' economies. We highlight the most relevant articles for our analysis, both for the direct estimation of the concentration ratio in mobile phone markets with the competitiveness indicators of the countries, as well as those related to our two stages procedure.

Regarding the direct impact of the mobile phone industry and countries' competitiveness, Gruber and Koutroumpis (2011) estimate the impact of mobile telecommunications on economic growth, finding that the penetration of this technology has positive effects on economic growth and productivity, and that a causal relationship between these variables can be established. In addition, their results reveal that the impact of mobile telecommunications on economic growth is due to the direct effect of infrastructure investment, but also to all spillover effects that result from the use of these networks and that facilitate interaction between individuals by shortening distances, facilitating remote work, avoiding unnecessary travel, all for the benefit of quality of life and productivity. Similarly, Grims *et al.* (2012) results confirm that the adoption of broadband increased the productivity of firms in New Zealand by 7 to 10%. Both studies find results that point into the same direction: digitisation improves competitiveness. Our direct estimation gives similar results albeit we do not have established a causal relationship between mobile phone competition and countries' competitiveness.

Several articles are related to our first-stage estimation. It must be said that there is not a clear relationship between telecommunications market structure and digitisation as part of understanding determinants of Internet diffusion and liberalisation policy impacts on ICT adoption. First, Friesenbichler (2007) as well as Frontier Economics report published in 2017 suggested that there is an inverted-U relationship between market concentration and investment for Latin American mobile markets. Second, Hargittai (1999) empirical study points out that economic wealth and telecommunications policy are the most relevant predictors of countries' Internet connectivity, while monopoly in telecommunication sector seems to have a negative impact on connectivity. Conversely, Kiiski and Pohjola (2002) show that market liberalization itself does not guarantee greater Internet diffusion, unless it is done with a reduction in market prices on those services. Using data on Internet hosts per capita for a sample of the OECD countries during 1995-2000, they find that competition in telecommunications markets does not have any direct effect on Internet penetration. Finally, Billon *et al.* (2009) makes a canonical correlation analysis for 142 countries in 2004 to explain the differences in ICT diffusion for different groups of countries. The explanatory variable set includes dummy variables for the level of competition for digital cellular mobile services. From their results, they recommend that deregulation, liberalisation and competition measures in telecommunication infrastructures and services might boost Internet use in less-developed economies.

Regarding the literature dealing with our second stage, in a report prepared for the OECD, Gal *et al.* (2019) found a robust statistical relationship between digitisation and productivity of firms using data from countries belonging to the European Union. Their results indicate that digitisation is more beneficial in manufacturing firms than in service firms, confirming previous results from Akerman, Gaarder and Mogstad (2013) and Dhyne *et al.* (2018). Gal *et al.* (2019) also concluded that the impact of digitization is higher in industries with repetitive processes; result aligned with Chevalier and Luciani (2018). The results we obtained in the second stage of our decomposition come to corroborate these empirical findings, even though we do not enter into the details of firms' sectors. The OECD Economic Policy Papers report (2019) also confirms the positive relationship

between digitization and competitiveness.

3 Data

For the construction of our empirical estimations we use data at the annual level of the country from two sources of information for the period 2007-2017: the database of the Global Competitiveness Index of the World Economic Forum and the database of the mobile market from the Global System for Mobile Communications.

3.1 Global Competitive Index (GCI)

The World Economic Forum (WEF) defines competitiveness as "the set of institutions, policies and factors that determine the level of productivity of a country." In this sense, the GCI calculated annually by the WEF is the result of 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 evaluated qualitatively, through surveys aimed at businessmen in each country, or quantitatively by going to statistics provided by official sources recognized in each subject. In Appendix 1 we summarise the decomposition of the pillars realised by the WEF. In this study, instead of using the ICG directly we rather use its decomposition into pillars, and in specific cases that will be pointed out later, some indicators that feed a pillar are also used directly.

More precisely, to measure competitiveness, we use pillars 8 (Financial market development), 10 (Market size), 11 (Business sophistication) and 12 (Innovation), defined by the WEF as follows:

- Pillar 8 - Financial market development: qualifies to what extent the financial market of a country is reliable, transparent, adequately regulated to protect investors and other economic actors, efficient to meet the needs of companies, affordable (credits and services financial), can be financed through the local stock market and if it has risk capital.
- Pillar 10 - Market Size: believes that increasing the market available for a country's firms allows them to take advantage of economies of scale.
- 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 investment in Research and Development by the private sector, the presence of high quality scientific research institutions, the level of university-industry collaboration in research and technological development and property protection intellectual.

The Pillar 9 - Technological readiness and its decomposition is used as a digitisation measure. This pillar captures the agility with which a country adopts existing technologies, especially ICT, to promote the productivity of its industries. Through this pillar the WEF recognises the importance of ICT in competitiveness. More precisely, the pillar considers the level of technological adoption and the penetration of voice and internet services through fixed and mobile networks in the population (Appendix).

Pillars 1 (Institutions), 2 (Infrastructure), 3 (Macroeconomic environment), 4 (Health and primary education), 5 (Higher education and training), and 7 (Labor market efficiency) are used as

control variables. For the proper use of pillar 2 (Infrastructure), we build a new variable from it eliminating the telecommunications dimension incorporated by the WEF in order to avoid obvious problems of endogeneity. Finally, the decomposition of pillar 6 - Efficiency of the goods market, and 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 (GSMA)

This organisation builds a quarterly database that contains information on the mobile market of 60 countries. For the present study of this database, the Hirschman-Herfindhal Index of the telecommunications market reported for the last quarter of each year between 2007 and 2017 was taken to measure the concentration of the mobile market.

3.3 Exploratory analysis

As Table 1 shows, our concentration variable is negatively correlated with digitisation and competitiveness variables, except with the development of financial market (the correlation is close to zero). Likewise, the two digitisation variables are positively correlated with the four competitiveness indicators. This information gives us indications in favor of a possible negative effect of the level of concentration of the mobile phone market on digitization, thus affecting the competitiveness of countries.

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

In Figure 1 we show these relationships disaggregated by income classification (*i.e.*, developed and developing countries). We observe a strong negative relationship between concentration in the mobile phone market and market size of the economy for both developed and developing countries. Additionally, we observe that for less developed countries the relationship between concentration and competitiveness is more pronounced than for developed countries. Similarly, Figure 2 shows the scatter plot between HHI and our digitisation variables. There is a negative relationship between market concentration and digitisation, and it is stronger for developing countries, while for developed countries this relationship is not clear.

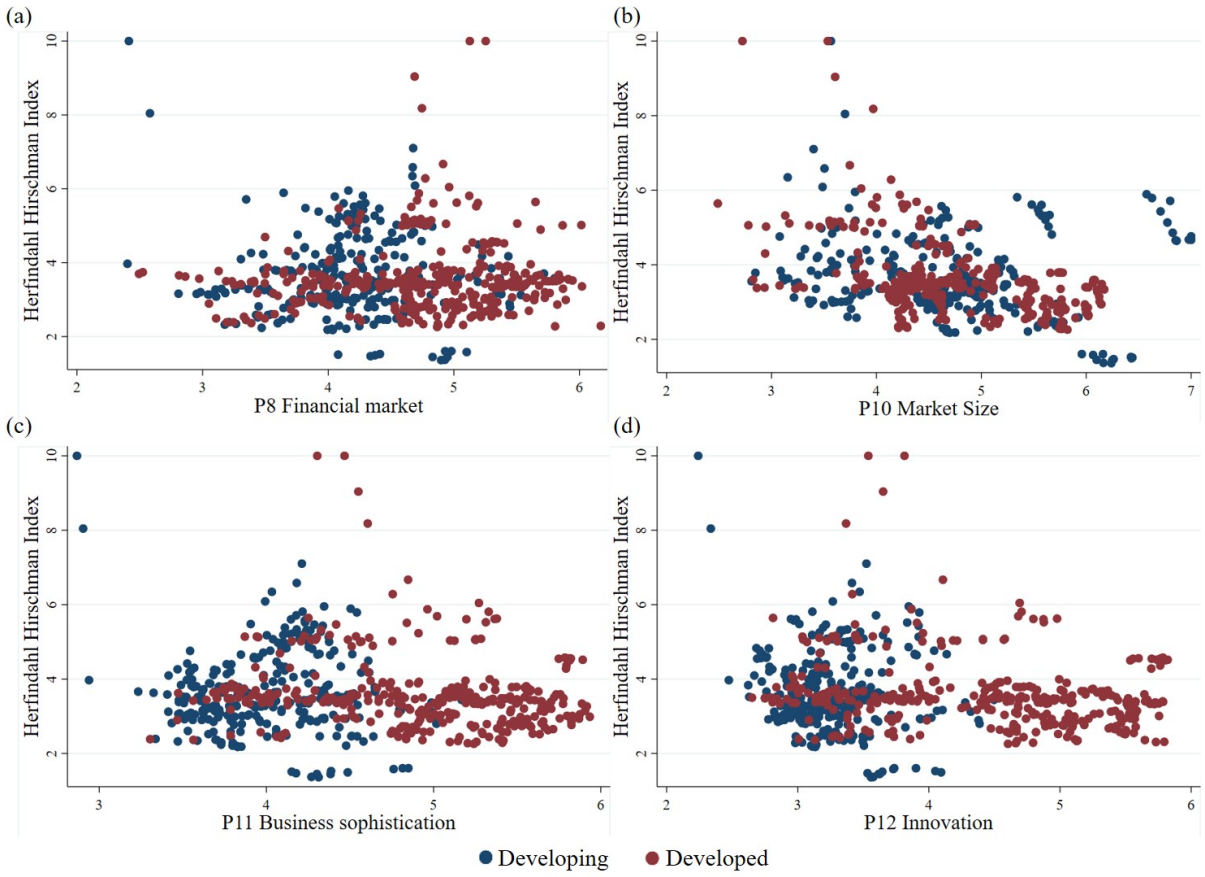

Figure 1: HHI vs Competitiveness
Source: Author's calculations.

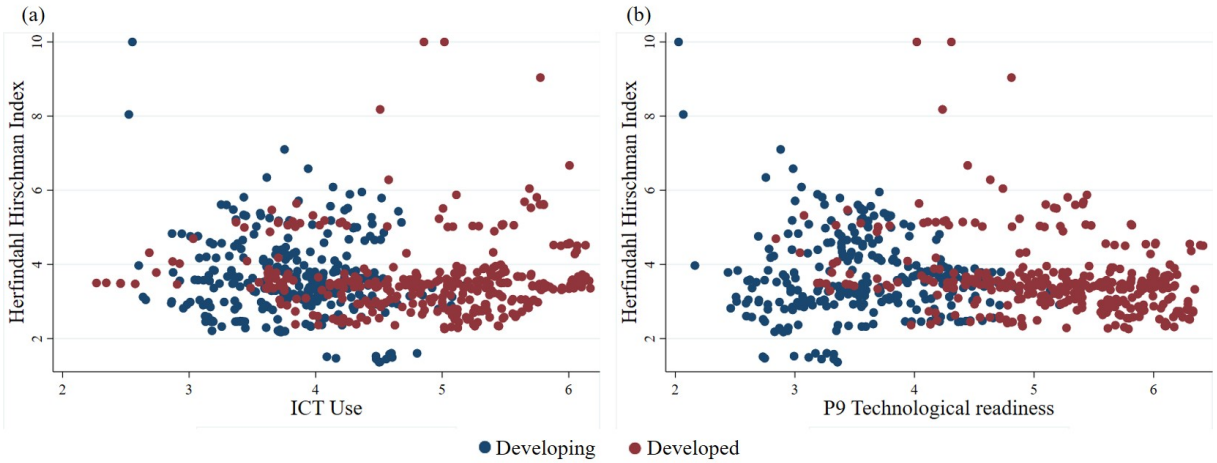

Figure 2: HHI vs Digitisation
Source: Author's calculations.

Finally, Figure 3 shows 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. The 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.

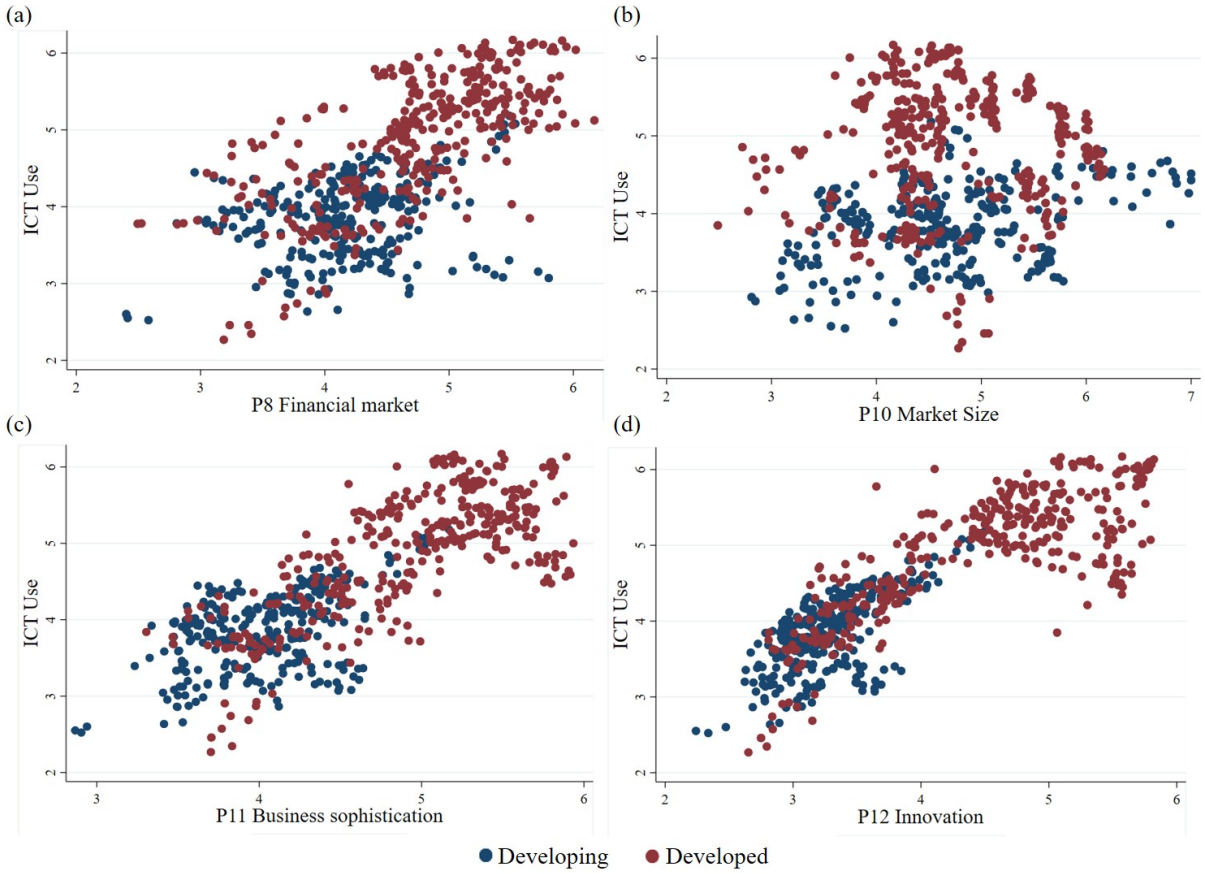

Figure 3: Digitisation vs Competitiveness
Source: Author's calculations.

4 Empirical Strategy

Using the panel data of 59 countries from databases described above we want to capture the correlation between concentration of the mobile phone market and competitiveness for countries in the sample. First, we perform the following equation:

$$\begin{aligned} Y_{it} =& \beta_0 + \alpha_t + \beta_1 HHI_{it} + \beta_2 Inst_{it} + \beta_3 Infra_{it} + \beta_4 AmbMa_{it} + \beta_5 SaludPri_{it} + \\ & \beta_6 Edu_{it} + \beta_6 Efilabor_{it} + \varepsilon_{im}, \end{aligned} \tag{1}$$

where:

- One measure of competitiveness of country i, year t;
- HHI_{it}: Hirschman-Herfindhal index of telecommunication sector in country i, year t;
- $Inst_{it}$: Score of Pilar 1 of GCI: Institutions, country i, year t;
- $Inst_{it}$: Score of Pilar 2 of GCI: Infrastructure, country i, year t;
- $AmbMa_{it}$: Score of Pilar 3 of GCI: Macroeconomic environment, country i, year t;
- $SaludPri_{it}$: Score of Pilar 4 of GCI: Macroeconomic environment, country i, year t;
- Edu_{it}: Score of Pilar 5 of GCI: Education, country i, year t;
- $Efilabor_{it}$: Score of Pilar 6 of GCI: Labor market efficiency, country i, year t.

We use four measures of competitiveness contained in the Global Competitive Index: development of the financial sector, size of the market, business sophistication and innovation.

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

In the following specification we have the first stage of our model:

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

Here D_{it} is a measure of ICT use in country i, year t, and TM_{it} is the size of the market (exports and imports) of economy i in year t.

The equation associated to our second stage is the following:

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

Finally, we implement an instrumental variables strategy to verify the causal relationship between concentration of mobile phone markets and competitiveness. We use degree of strictness of antitrust policy as an instrumental variable for HHI. Our claim is that the antitrust policy strictness may directly affect the degree of competition in mobile phone markets without affecting directly the countries' degree of digitisation.

5 Results

Our results are presented in Figure 4 and reveal that there is a statistically significant and negative relationship between the concentration of the mobile market and competitiveness for the four indicators. The impact of the HHI on financial market development and innovation is highlighted. An increase of 1000 units in the HHI decreases the value of the first variable by 0.05 and the value of the second one by 0.08, which is significant considering that the scale of these variables is from

1 to 7. Likewise, institutions and the macro environment explain part of the good performance of the financial market, while institutions and the efficiency of the labor market significantly affect the other variables of competitiveness contemplated in this study (see Table 2).

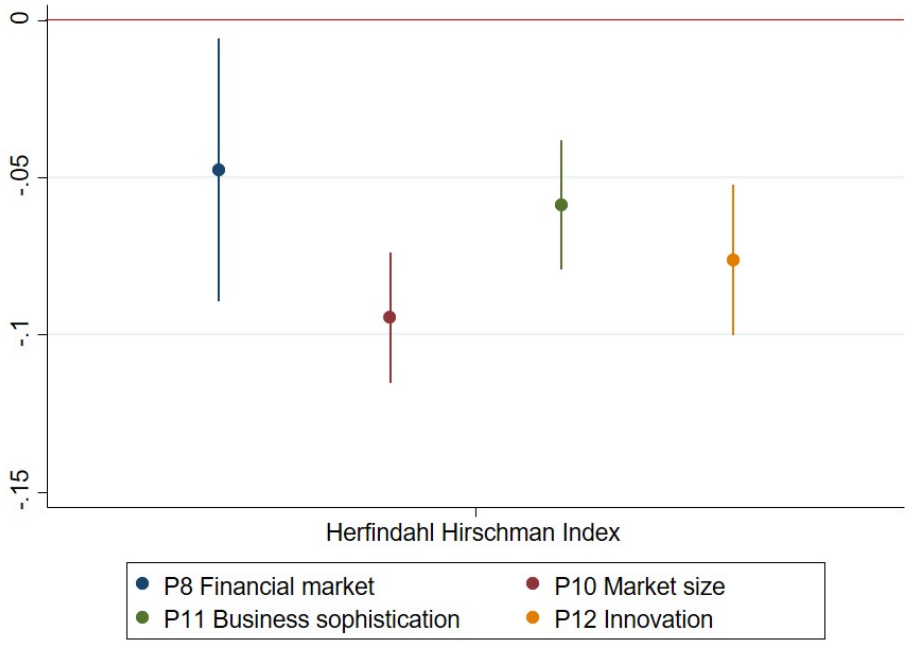

Figure 4: Coefficients associated with HHI vs Competitiveness Variables
Note: Confidence intervals with p-value of 0.05

In a second exercise, we estimate the impact of ICT on competitiveness using a two-stage approach. In the first, the purpose is to explain the relationship between HHI and the use of ICTs and, in second step, the relationship between the use of ICTs and the competitiveness variables described above. Furthermore, the first equation of this two-stage exercise was estimated with and without the use of instrumental variables. This was done in order to corroborate if the concentration of the mobile market has a causal relationship on the use of ICT, and in this way on competitiveness.

The instrumental variable that was chosen also 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.

The results of the second regression (Figure 5) reveal that there is a negative and significant relationship between competence (HHI) and digitisation, the latter measured by the variables Technological Readiness and ICT use. After the inclusion of effectiveness of anti-monopoly policy as instrumental variable, this relationship is maintained and the r-squared increases for the ICT use variable (Table 3).

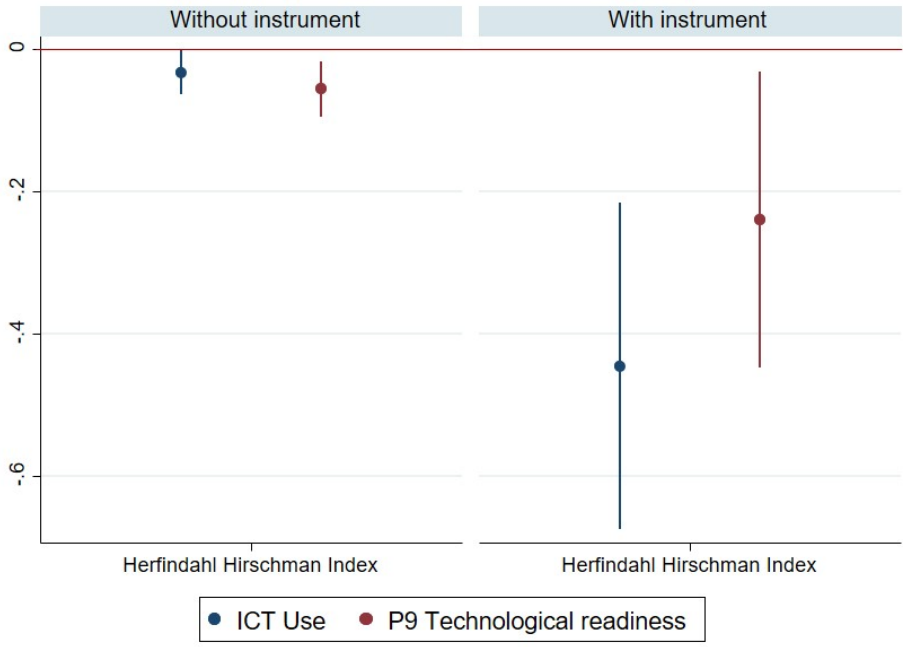

Figure 5: Coefficients associated with HHI vs Digitization variables
Note: Confidence intervals with p-value of 0.05

Finally, results shown in Figure 6 reveal that digitisation, measured through the Pillar 9 rating of the GCI, has a positive and significant statistical relationship with business sophistication, while when we measure digitisation through the use of ICT (component of the Pillar 9), the positive and significant relationship occurs with the variables Market size, Business sophistication and Innovation.

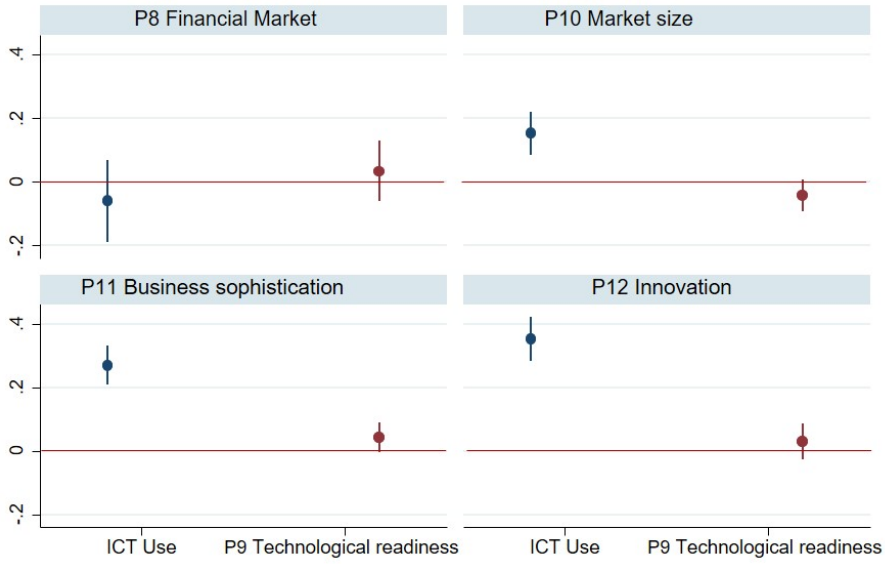

Figure 6: Coefficients associated with Digitisation variables vs Competitiveness variables
Note: Confidence intervals with p-value of 0.05

6 Conclusions

From a database that includes 59 countries, our results reveal that there exists a negative relationship between the concentration in mobile phone markets and countries' competitiveness. Beyond the identification of the causality relationship, our two-stages estimation allows us to shed light on the channel of ICT use that explains why the higher is the concentration the lower is the competitiveness. By this, it becomes clear that the mobile phone industry is part of an ecosystem that generates spillover effects on the rest of the economy. The most straightforward policy recommendation that one can derive from these results is that all regulations that aim to promote competition in mobile phone markets may generate positive externalities on other sectors of the economy. In this study we focus on the HHI to approximate the degree of competition of mobile phone markets. An interesting extension would be to consider a more direct variable to measure this competition degree in order to see if for a level of concentration given, there exist other factors that are important to modify to increase these positive spillover effects generated by this industry.

7 References

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8 Appendix

Table 2: 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 Labor 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

Table 3: 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 4: 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 5: 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 Labor 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

Table 6: 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 Labor 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