The Complementarity between ICT Use and Competition in Mexico*

ABCDE: "Productivity, Growth, and the Law"
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**This is a background research paper for the World Development Report 2016: "Internet for Development"*

1) Introduction

2) Data and descriptive Statistics

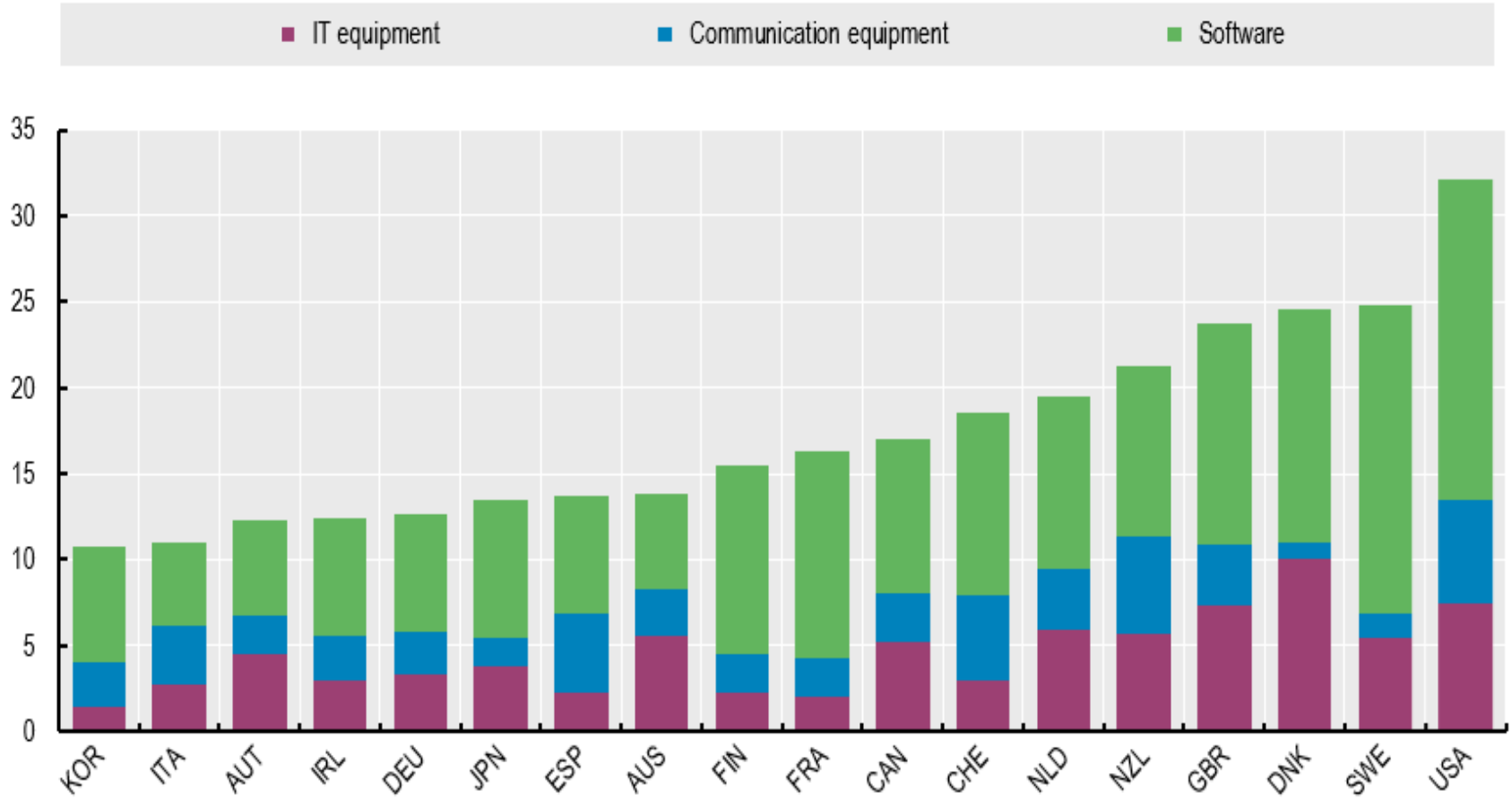
3) Empirical strategy

4) Results

5) Conclusions & Policy Implications

"Investment in ICT was the most dynamic component of investment in the late 1990s and early 2000s in OECD countries."

Figure 1. Shares of ICT investment in non-residential gross fixed capital formation



Source: OECD

July, 2014

BNamericas
Business Insight in Latin America

"This year's Prosoft 3.0 budget is more than 2bn pesos (US$155mn) and comes from federal and state governments and public entities, and officials said next year's budget would be similar or higher."

Motivation: Research

- ICT is one of the levers that can increase firm's productivity. (Syverson, 2011)
- There is limited evidence regarding the channels or the factors that could enhance these effects.
- Aghion et al. (2001) work suggests that firms invest in new technology to temporarily escape competition.
- Recent studies confirm how external competition shocks induce technical change, innovation and firm's productivity. (Iacovone et al.,2013; Bloom et al., 2015)

Research questions

- Does ICT increase firm's productivity?

- Does this effect depend on the competition context faced by the firms?

Contribution

- Contribute to the knowledge on the relation between ICT use and trade-induced technical change – focusing on a developing country.
- Novel firm-level data panel for Mexico.
- Test previous empirical results regarding ICT use and productivity for the case of a developing country.

Results Preview

- ICT increases productivity but only when companies have incentives to use it properly.

- Competition provides the right incentives.
  - Only firms that face higher competition from China are the ones showing positive effects of ICT on productivity.

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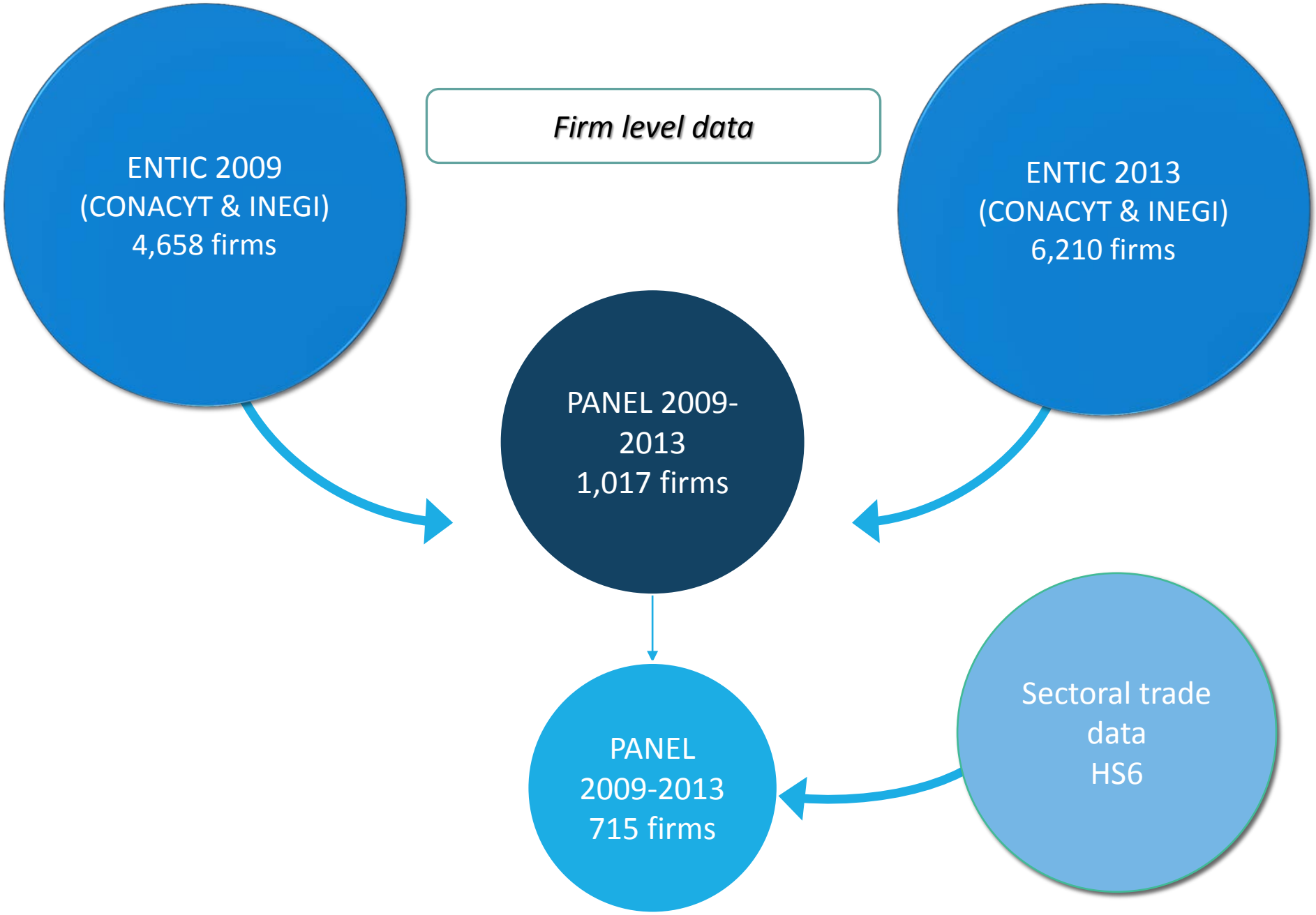

Firm level data
ENTIC 2009
(CONACYT & INEGI)
4,658 firms
ENTIC 2013
(CONACYT & INEGI)
6,210 firms
PANEL 2009-
2013
1,017 firms
PANEL
2009-2013
715 firms
Sectoral trade
data
HS6

Data

ICT-use measures

1) Computers per worker
2) *Share of labor with computer*
3) *Share of labor with internet*

Trade data

World Integrated Trade Statistics (WITS). HS 1996 6-digits

$$Compet_j = \frac{M_{j,China}}{\sum_{k=1}^{n} M_{j,k}}$$

Where:

$M_{j,China} = Imports\ of\ country\ j\ from\ country\ k$

$M_{j,k} = Imports\ of\ country\ j\ from\ country\ k$

Descriptive statistics

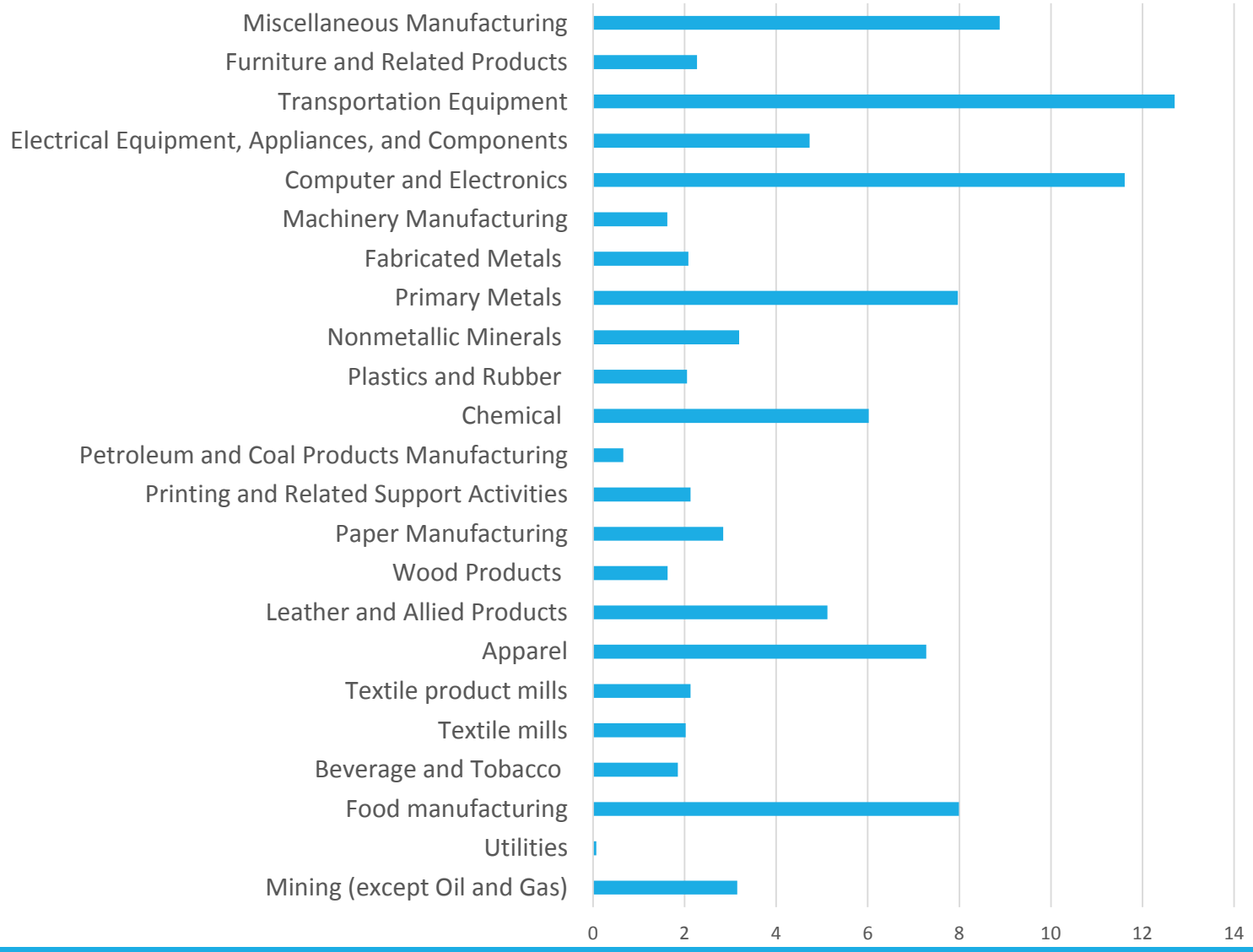
- 87% of the firms in our sample are big firms.
- 40% of the firms were older than 27 years in 2012.

Table 1. Summary statistics 2012

	Sample				Whole			
Variable	Mean	sd	p10	p90	Mean	sd	p10	p90
Computers-per-worker	0.28	0.23	0.07	0.57	0.39	0.36	0.06	0.95
Share of labor with Internet	0.20	0.19	0.03	0.40	0.30	0.29	0.03	0.83
Share of labor with computer	0.24	0.22	0.06	0.50	0.34	0.30	0.04	0.93
Sales-per-worker	1,005.39	1,407.87	131.20	2,494.11	1,018.02	1,608.47	66.00	2,471.17
Share of white-collar workers	0.25	0.23	0.06	0.59	0.37	0.33	0.06	1.00
Exports/total sales	0.38	0.43	0.00	1.00	0.16	0.33	0.00	0.93
Share of FDI	42.94	48.73	0.00	100.00	17.16	36.74	0.00	100.00
Number of workers	841.58	1,586.61	48.00	1,911.00	71.62	978.90	6.00	86.00

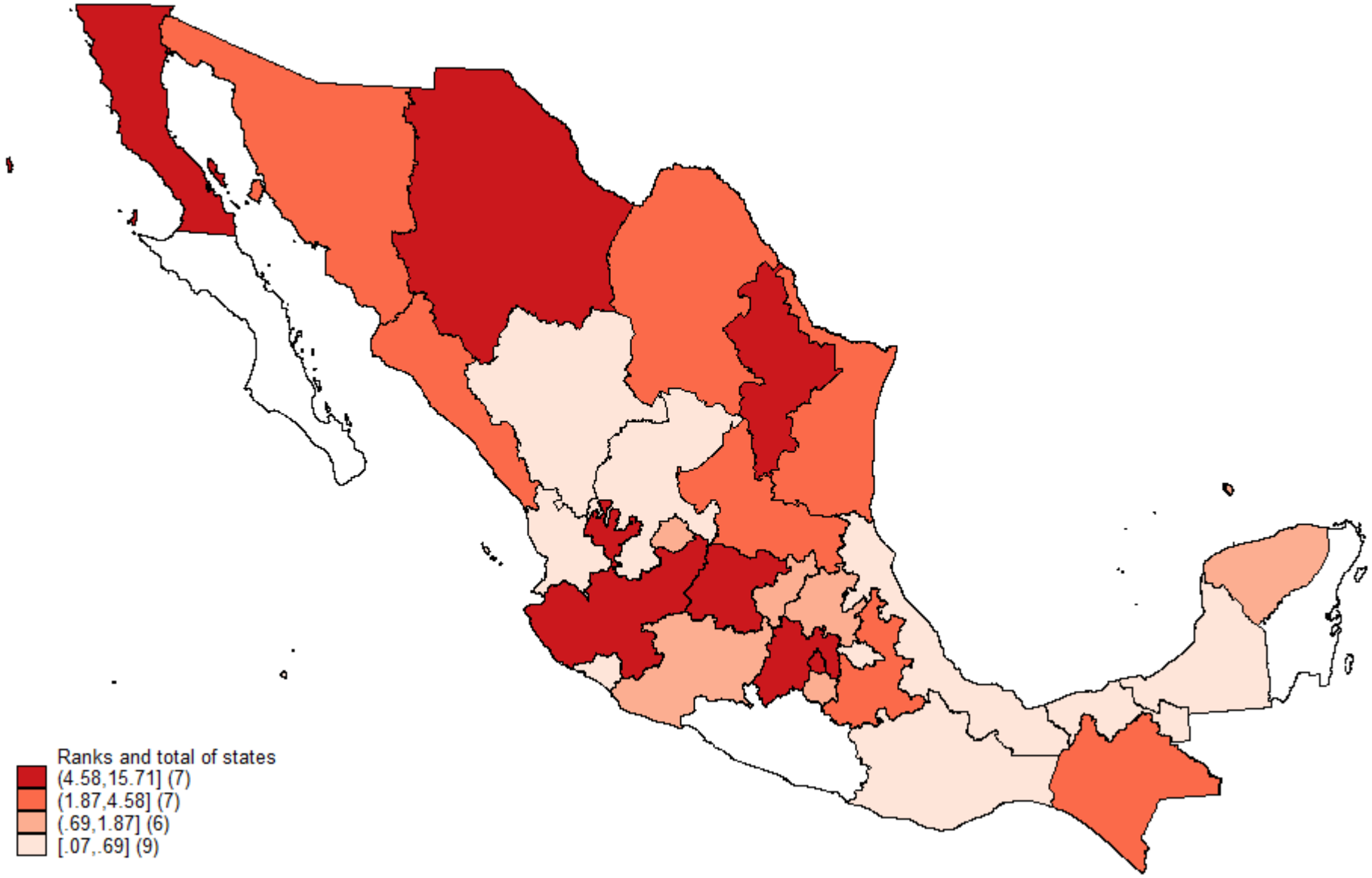
Source: Authors' calculations using data from ENTIC, INEGI

Firms in our sample are from sectors…



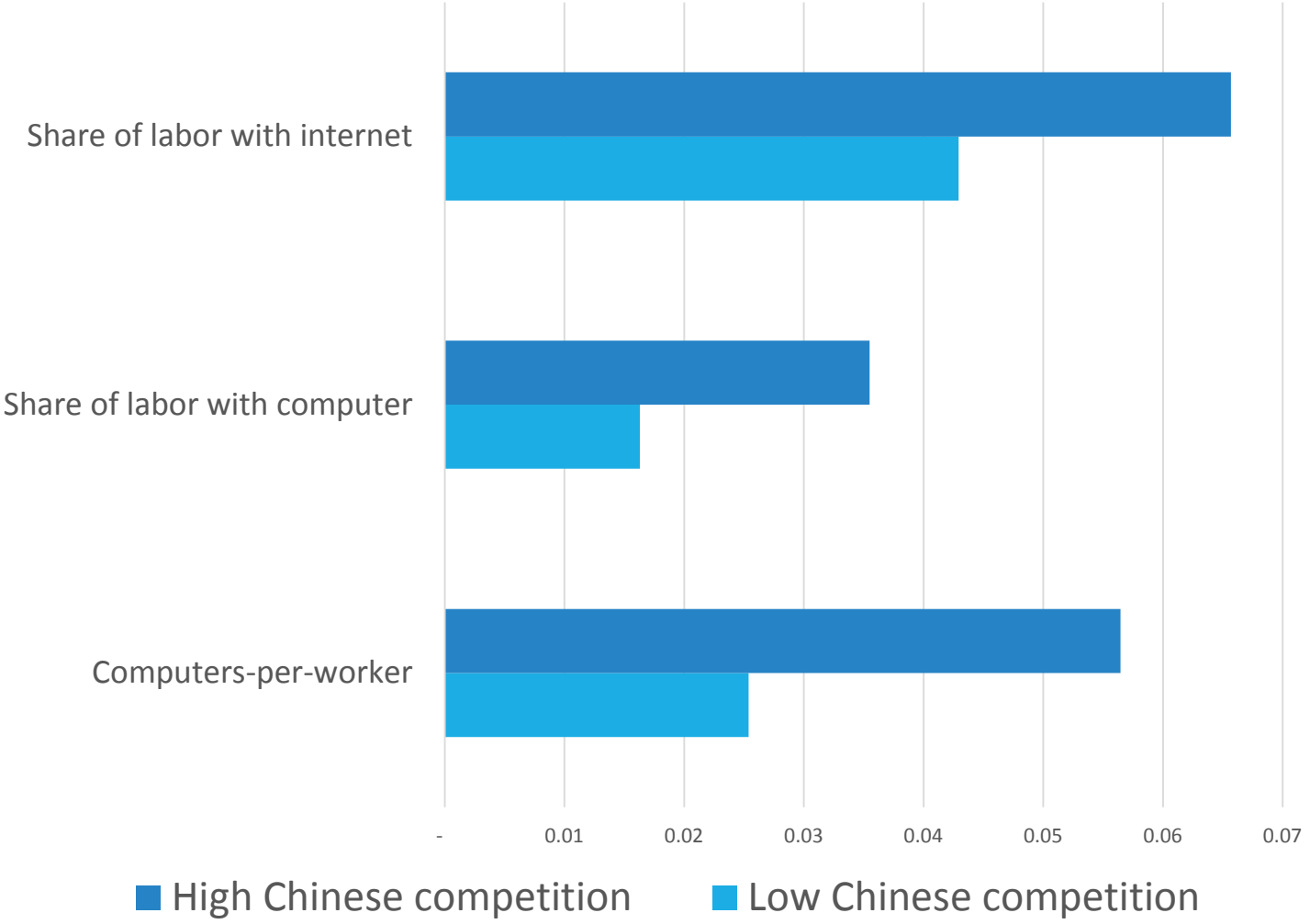
Source: Authors' calculations using data from ENTIC, INEGI

And are located in…



Source: Authors' calculations using data from ENTIC, INEGI

Larger increase in ICT use in sectors hit by stronger Chinese competition



Source: Authors' calculations using data from ENTIC, INEGI and WITS

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Empirical Strategy

$$log(sales/worker)_{i,t} = \beta_0 + \beta_1 * ICT_{i,t} + \beta_2 x_{i,t} + \alpha_i + u_{i,t}$$

Where

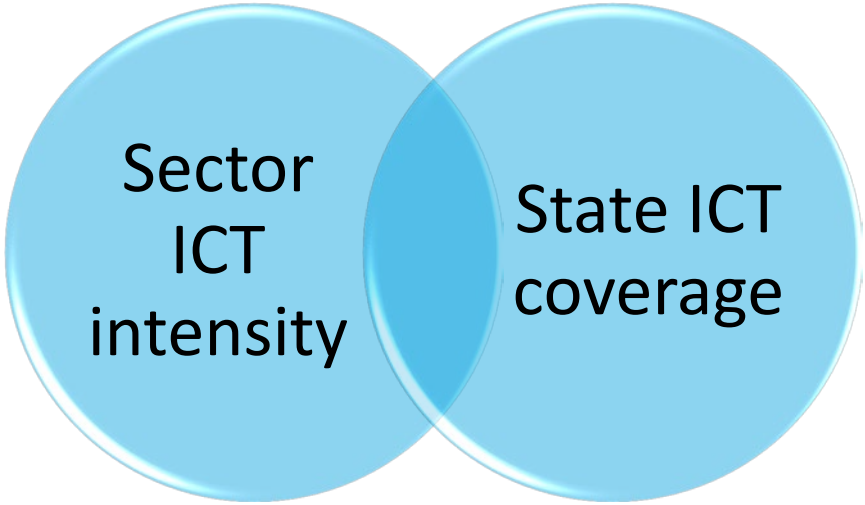
$log(sales/worker)_{i,t}$=Logarithm of sales-per-worker for firm i at time t

$ICT_{i,t}$=ICT use of firm i at time t

$x_{i,t}$=Vector of control variables such as age, firm's size and share of skills

α_i=firm fixed effects

Instrumenting ICT use



First stage:

$$ICT_{ijst} = ICTintensity_j * ICTcoverage_{st}$$

$Where$:

$ICT_{ijst} = ICT\ use\ firm\ i\ from\ sector\ j\ at\ state\ s\ at\ time\ t$

$ICTintensity_j = ICT\ intensity\ of\ sector\ j\ in\ the\ U.S.$

$ICTcoverage_{st} = Share\ of\ households\ that\ have\ a\ computer\ in\ state\ s\ at\ time\ t$

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ICT use increases productivity

Table 2. IV estimates of the effect of ICT use on firm-level productivity

	(1)	(2)	(3)	(4)	(5)
Dependent variable log(sales/worker)					
Computers-per-worker	2.422*	2.743***	3.458***	3.377***	3.296***
	(1.275)	(0.992)	(1.262)	(1.295)	(1.258)
Share of labor with Internet	2.200*	2.794***	3.319***	3.337**	3.255***
	(1.225)	(1.054)	(1.251)	(1.298)	(1.258)
Share of labor with computer	3.544**	3.828**	4.457**	4.323**	4.517**
	(1.682)	(1.636)	(1.786)	(1.730)	(1.852)
Controls					
Age	No	Yes	Yes	Yes	Yes
Firm size	No	No	Yes	Yes	Yes
Share of white-collar workers	No	No	No	Yes	Yes
Exports/sales	No	No	No	No	Yes
FDI share	No	No	No	No	Yes
N	1430	1430	1430	1430	1430

Source: Authors' calculations using data from ENTIC, INEGI

ICT use has no effect in low (Chinese) competition sectors

Table 3 .IV estimates of the effect of ICT use on firm-level productivity

a) Low Chinese competition

Dependent variable: log(sales/worker)	(1)	(2)	(3)	(4)	(5)
Computers-per-worker	-0.646	0.216	1.580	1.436	1.456
	(1.714)	(2.294)	(4.087)	(4.355)	(4.181)
Share of labor with Internet	0.530	0.475	0.251	0.341	0.211
	(1.493)	(1.459)	(1.277)	(1.283)	(1.261)
Share of labor with computer	0.720	0.375	0.0648	0.121	0.0638
	(1.144)	(1.075)	(0.870)	(0.868)	(0.866)
Controls					
Age	No	Yes	Yes	Yes	Yes
Firm size	No	No	Yes	Yes	Yes
Share of white-collar workers	No	No	No	Yes	Yes
Exports/sales	No	No	No	No	Yes
FDI share	No	No	No	No	Yes
N	700	700	700	700	700

Source: Authors' calculations using data from ENTIC, INEGI

ICT use increases productivity only in high (Chinese) competition sectors

Table 3. IV estimates of the effect of ICT use on firm-level productivity

b) High Chinese competition

Dependent variable: log(sales/worker)	(1)	(2)	(3)	(4)	(5)
Computers-per-worker	2.825***	2.733***	2.933***	2.870***	2.975***
	(0.500)	(0.575)	(0.604)	(0.597)	(0.640)
Share of labor with Internet	2.350***	2.475***	2.744***	2.801***	2.767***
	(0.457)	(0.580)	(0.612)	(0.632)	(0.658)
Share of labor with computer	3.979***	3.784***	4.154***	4.231***	4.575***
	(0.774)	(0.862)	(0.950)	(0.986)	(1.132)
Controls					
Age	No	Yes	Yes	Yes	Yes
Firm size	No	No	Yes	Yes	Yes
Share of white-collar workers	No	No	No	Yes	Yes
Exports/sales	No	No	No	No	Yes
FDI share	No	No	No	No	Yes
N	730	730	730	730	730

Source: Authors' calculations using data from ENTIC, INEGI

Only in sectors with high competition ICT use increases productivity

Table 4. IV regression ICT use on firm-level productivity

Dependent variable: log(sales/worker)	(1)	(2)	(3)	(4)
Computers-per-worker	0.309	1.458	1.452	1.057
	(0.839)	(1.327)	(1.329)	(1.377)
China's competition*computers-per-worker	10.50***	10.70***	10.83***	10.84***
	(3.967)	(4.030)	(4.008)	(3.937)
China's competition	-3.304**	-3.747**	-3.825**	-3.675**
	(1.667)	(1.713)	(1.699)	(1.694)
Share of labor with internet	-1.311	-0.721	-0.700	-0.993
	(1.124)	(1.523)	(1.524)	(1.556)
China's competition*share of labor with Internet	15.48***	14.71***	14.66***	14.44***
	(5.043)	(5.273)	(5.213)	(5.133)
China's competition	-2.385**	-2.403**	-2.376**	-2.193**
	(1.142)	(1.143)	(1.115)	(1.108)
Share of labor with computer	0.231	0.770	0.763	0.857
	(1.334)	(1.550)	(1.544)	(1.602)
China's competition*share of labor with computer	11.53*	11.63*	11.63*	11.07*
	(6.481)	(6.577)	(6.565)	(6.433)
China's competition	-2.467	-2.721	-2.701	-2.491
	(1.915)	(1.935)	(1.922)	(1.878)
N	1430	1430	1430	1430

Source: Authors' calculations using data from ENTIC, INEGI

…also when we focus on competition in the US

Table 5. IV regression ICT use on firm-level productivity

Dependent variable: log(sales/worker)	(1)	(2)	(3)	(4)
Computers-per-worker	0.240	0.500	0.558	0.392
	(0.678)	(0.720)	(0.716)	(0.731)
Competition in US*computers-per-worker	4.979**	5.268**	5.051**	5.125**
	(2.111)	(2.182)	(2.174)	(2.192)
Competition in US	-0.974	-1.054	-1.030	-1.010
	(0.766)	(0.792)	(0.789)	(0.803)
Share of labor with Internet	-0.987	-0.504	-0.470	-0.709
	(0.763)	(0.857)	(0.853)	(0.856)
Competition in US*Share of labor with Internet	6.342***	5.308**	5.326**	5.318**
	(2.283)	(2.283)	(2.327)	(2.325)
Competition in US	-0.331	-0.176	-0.199	-0.121
	(0.482)	(0.478)	(0.476)	(0.482)
Share of labor with computer	-0.203	-0.139	-0.0379	-0.317
	(1.051)	(1.073)	(1.058)	(1.087)
Share of labor with computer*Competition in US	5.129*	5.268*	5.157*	5.318*
	(2.941)	(2.775)	(2.780)	(2.746)
Competition in US	-0.462	-0.487	-0.482	-0.474
	(0.751)	(0.717)	(0.717)	(0.712)
N	1430	1430	1430	1430

Source: Authors' calculations using data from ENTIC, INEGI

Robustness

- Pooled regressions (without FE) yield slightly higher results but the same conclusions.
- Controlling for a proxy of capital/worker doesn't change results
- Results are robust to alternative IVs.

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Conclusions

- We find that ICT use increases productivity but only when firms face competition.
  - More effective use of ICT in order to cope with the pressure of Chinese competition.
  - Willingness to make organizational changes to improve the returns of ICT use.
- Possible extensions:
  - Using better data regarding management and firm organization.
  - Same analysis for SMEs.

Policy implications

- Are these high levels of investment in ICT going to increase significantly firms' productivity?
  - No, unless we generate the appropriate incentives through competition.
  - Back to the basic
    - ICT investments are highly complementary to policies that increase competition in the market.