Digital technologies and online platforms

The Holy Grails of productivity?

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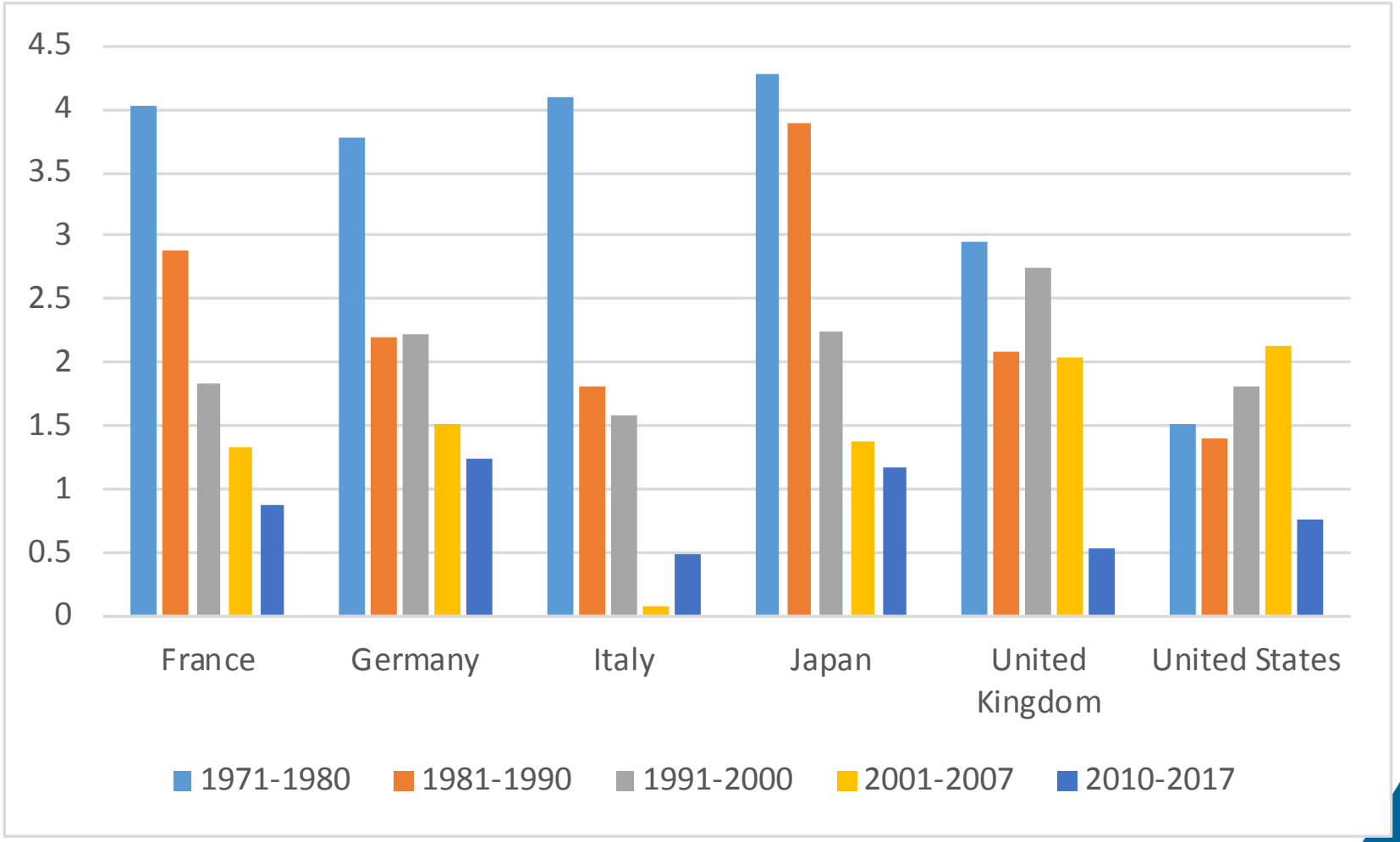
ECB conference *Challenges in a Digital Age*

OECD
BETTER POLICIES FOR BETTER LIVES

Productivity growth is weak, despite the *Digital Age*…

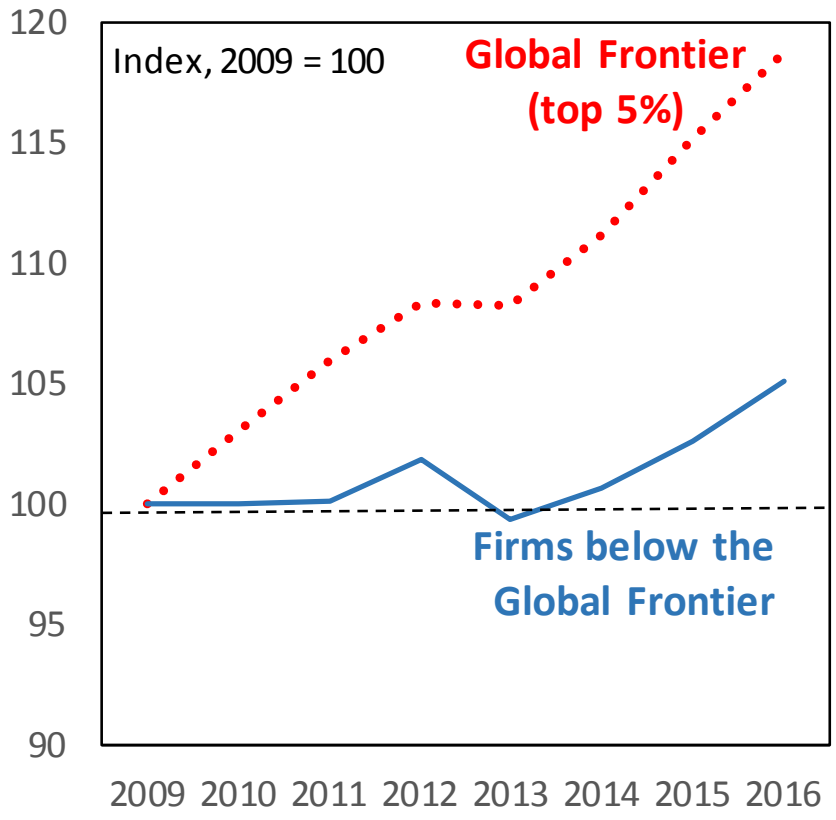
Labour productivity growth (in %, annual rate)



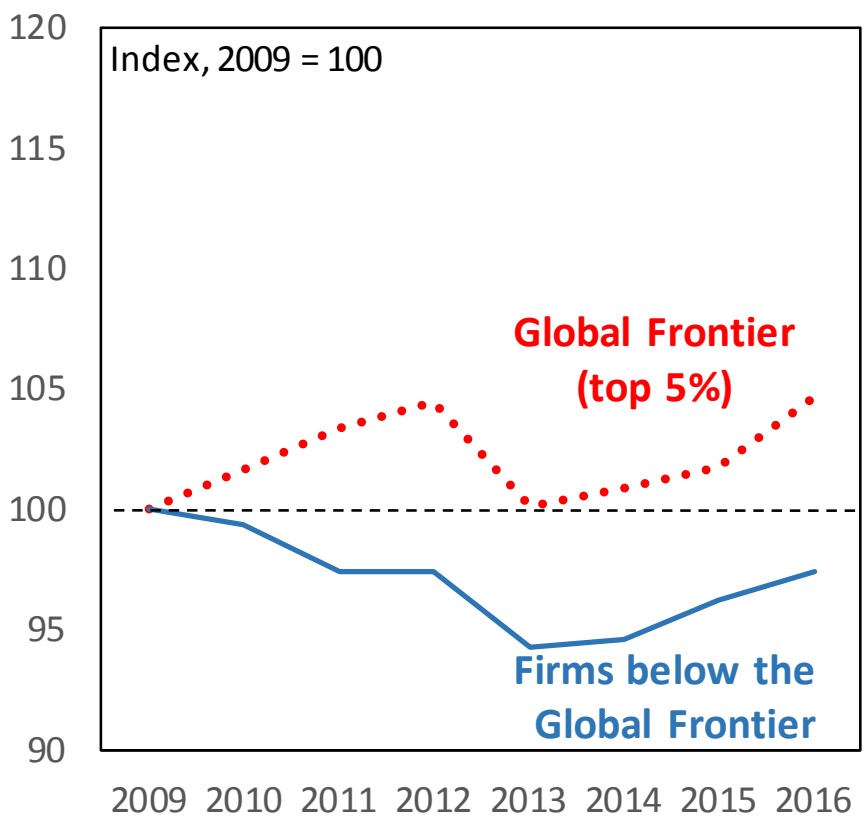
Source: OECD. Note: Labour productivity is measured by GFP per hours worked

… perhaps because its impact is not yet widespread enough across firms

Firm MFP in more digital intensive industries



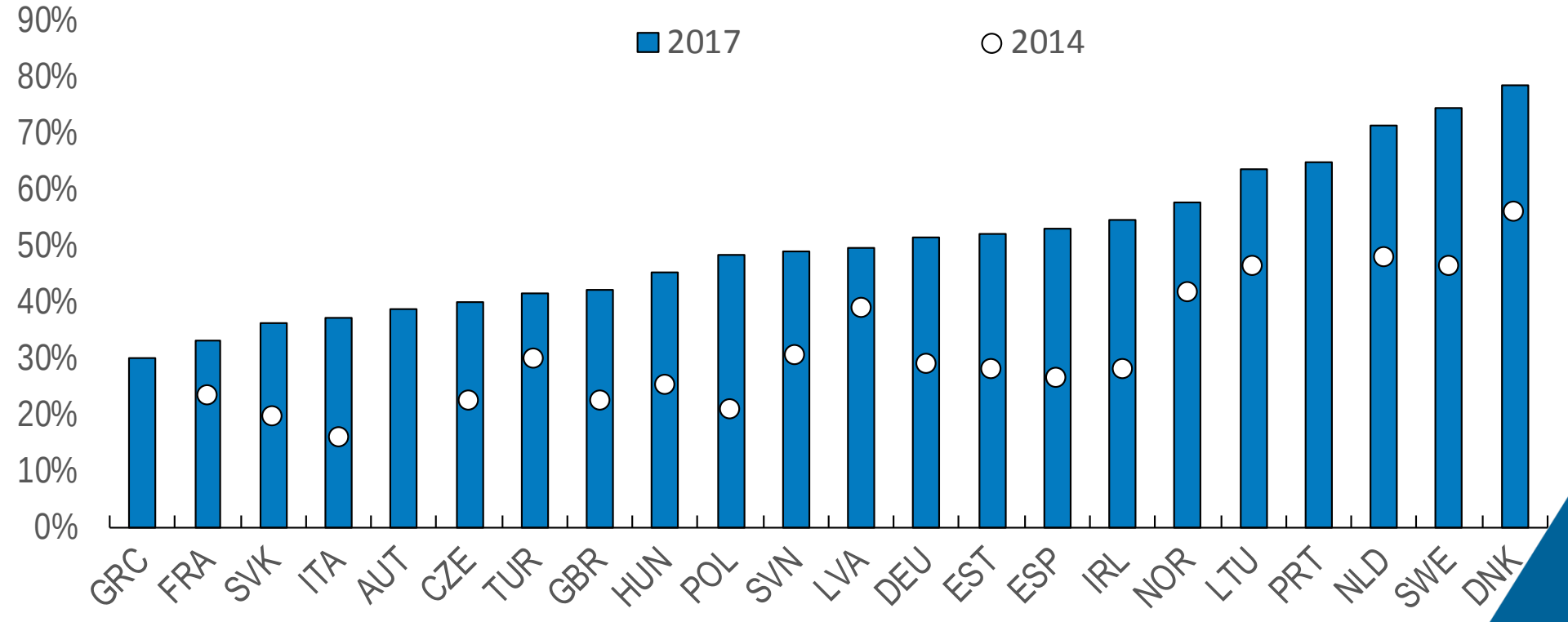
Firm MFP in less digital intensive industries



Notes: The "frontier" is measured by the 3-year moving average of log multi-factor productivity of the top 5% global firms within each industry and year. Industry groups that are classified either as having "high" or "low" digital intensities according to the methodology in Calvino et al. (2018).
See more details in Andrews, Criscuolo and Gal (2016) and Gal et al (2019).

… which may be linked to incomplete adoption rates

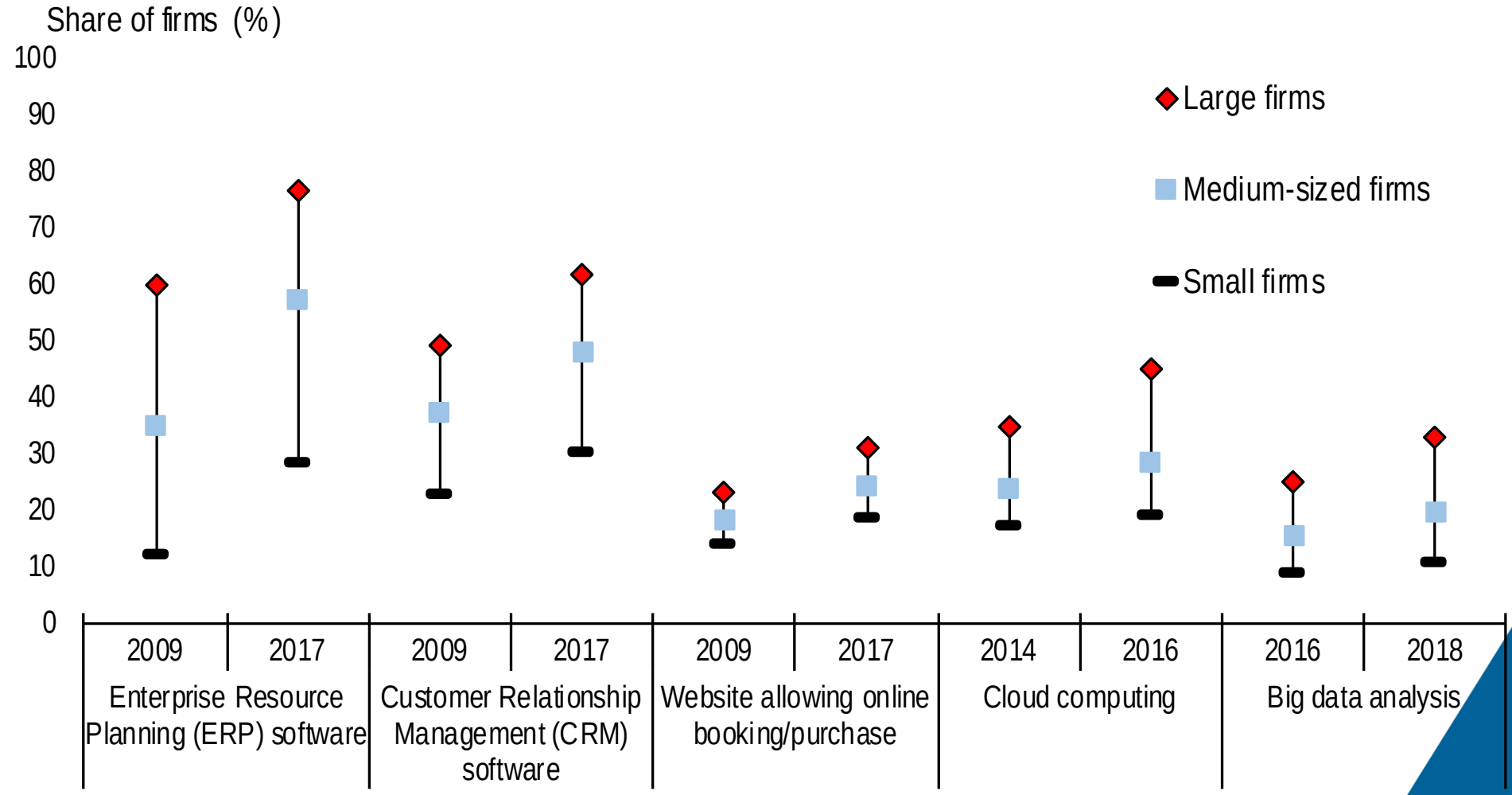
Access to high speed broadband is still incomplete and varies across countries



Source: Eurostat. High speed broadband is faster than 30Mbit/sec.

… and adoption rates incomplete for many other digital technologies too

Adoption rates of selected digital technologies across firm size



Source: Eurostat

II. DIGITAL TECHNOLOGY ADOPTION AND FIRM-LEVEL PRODUCTIVITY GROWTH

Data

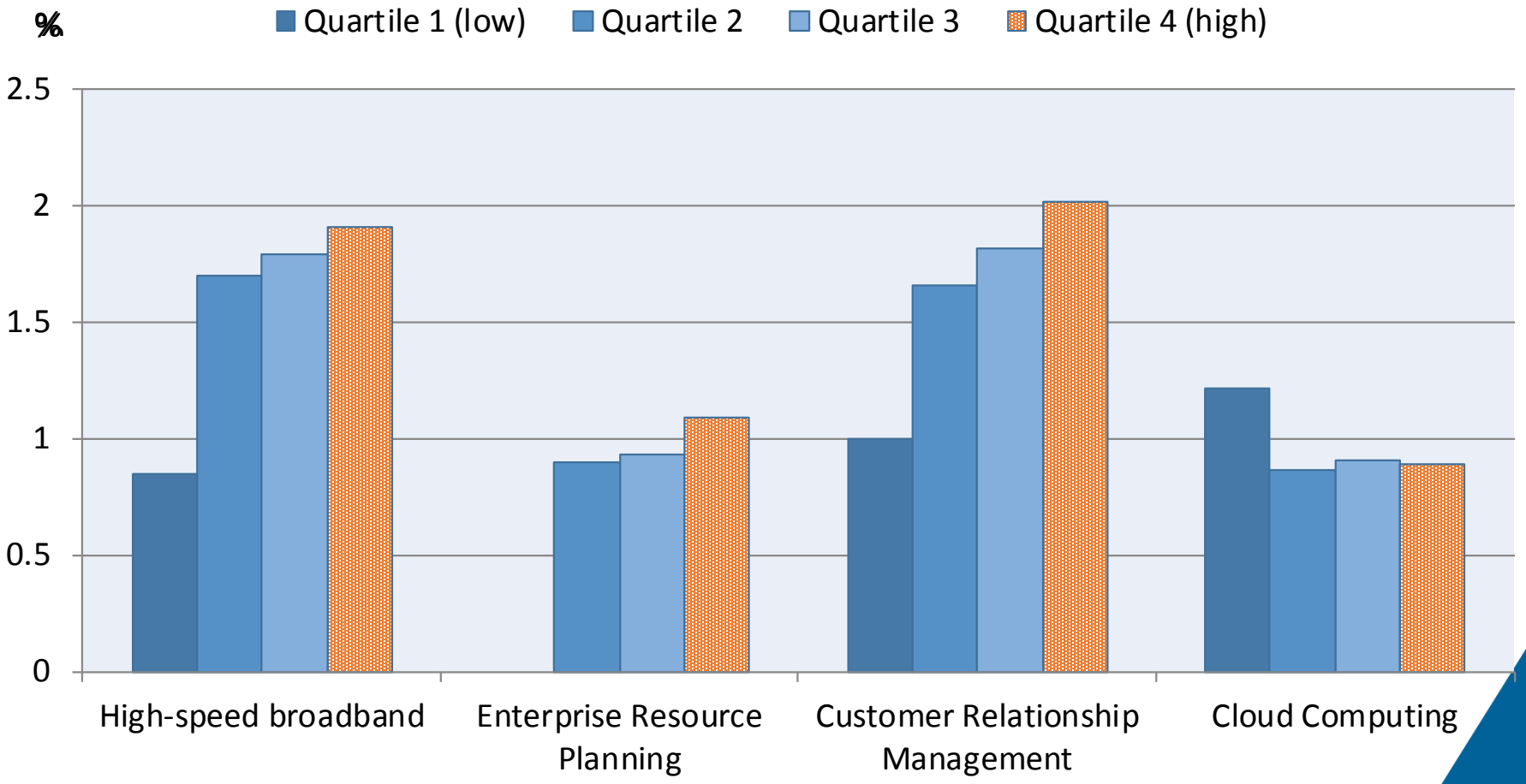
ICTs matched to firms, at the industry level

- **Industry-level digital technology adoption**
  - Infrastructure: Broadband use
  - Software / interface:
    - Supply chain and front office management: ERP, CRM
    - Cloud computing use
- **OECD *Skills for jobs* industry level database**
- **Firm-level productivity (Orbis)**
  - Largest worldwide firm-level dataset of companies, based on balance sheets and income statements
- 2009-15
- 21 EU countries
- 25 industries

Result (1)

Digital intensity positively linked to productivity, especially at the top of the firm productivity distribution

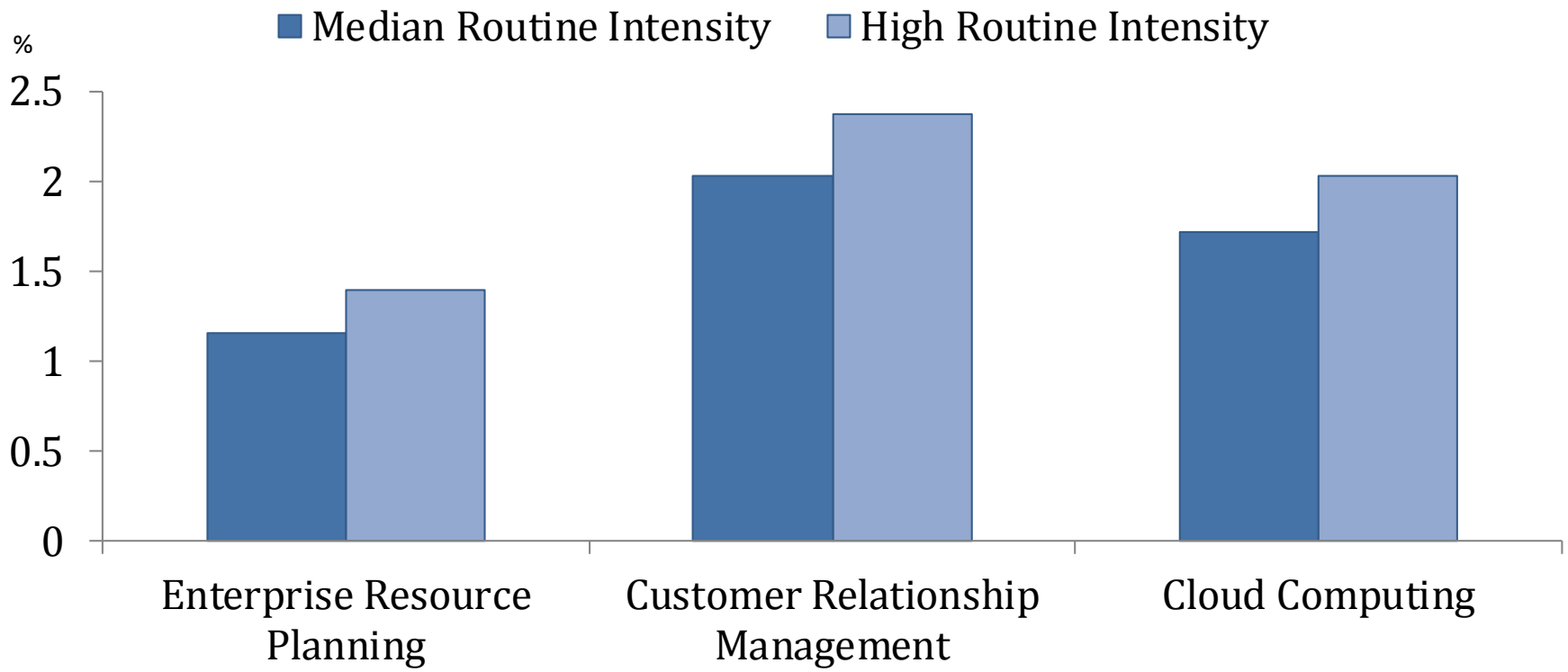
Firm-level MFP increase associated with
10 pp increase in industry level digital adoption



Result (2)

More routine intensive sectors – more productivity gains from digitalisation

Firm-level MFP increase in relation to 10 pp more digital adoption at the industry level



Note: Routine intensity indicator pertains to the US economy.

Some digital technologies, such as online platforms, come with challenges…

Booking.com

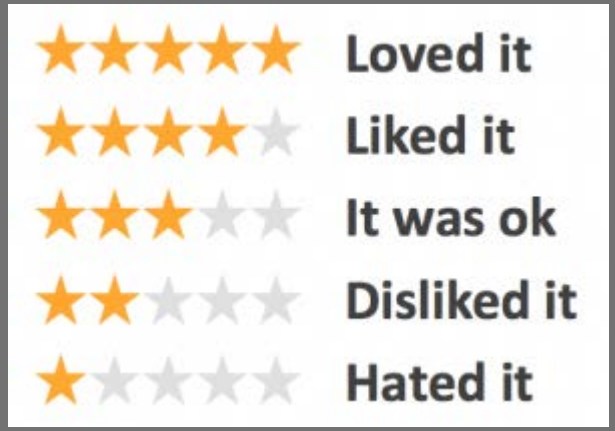
airbnb

Uber

amazon

yelp

III. ONLINE PLATFORMS FOR SERVICES AND PRODUCTIVITY



Data

Platform use matched to firms by detailed industry

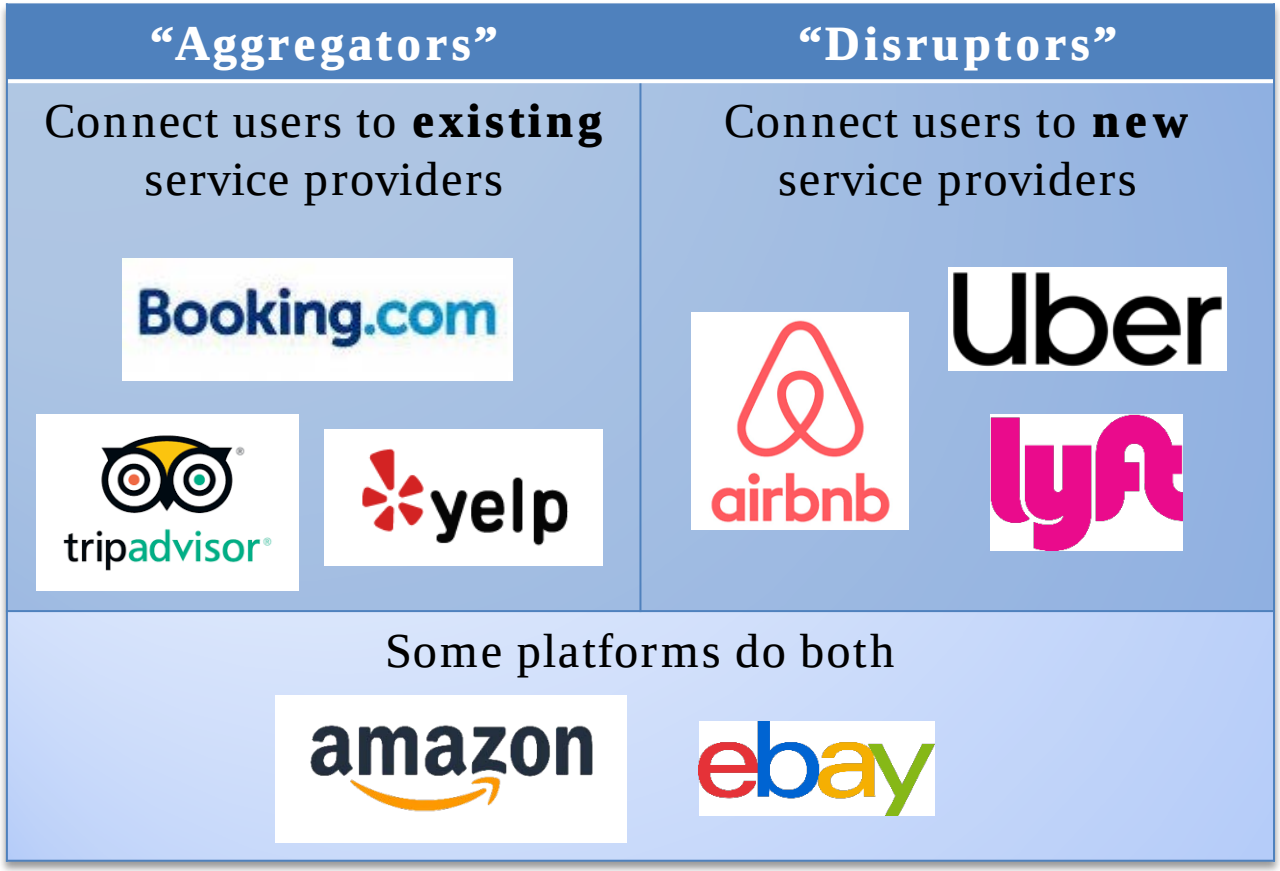
- We identified relevant platforms in 7 detailed services activities, which capture 25% of business sector employment

  1. Restaurants (*theFork*)
  2. Hotels (*booking.com, Airbnb*)
  3. Taxi services (*Uber*)
  4. Retail (4 subsectors; *Amazon*)

- We built a novel indicator of platform use intensity based on **Google Trends** internet searches for platforms in these sectors
- For 10 countries (BEL, DEU, ESP, FRA, GBR, HUN, ITA, POL, SWE, USA)
- For 13 years (2004-2016)
- After match to Orbis:

  744 912 firm-year observations (177,933 distinct firms)

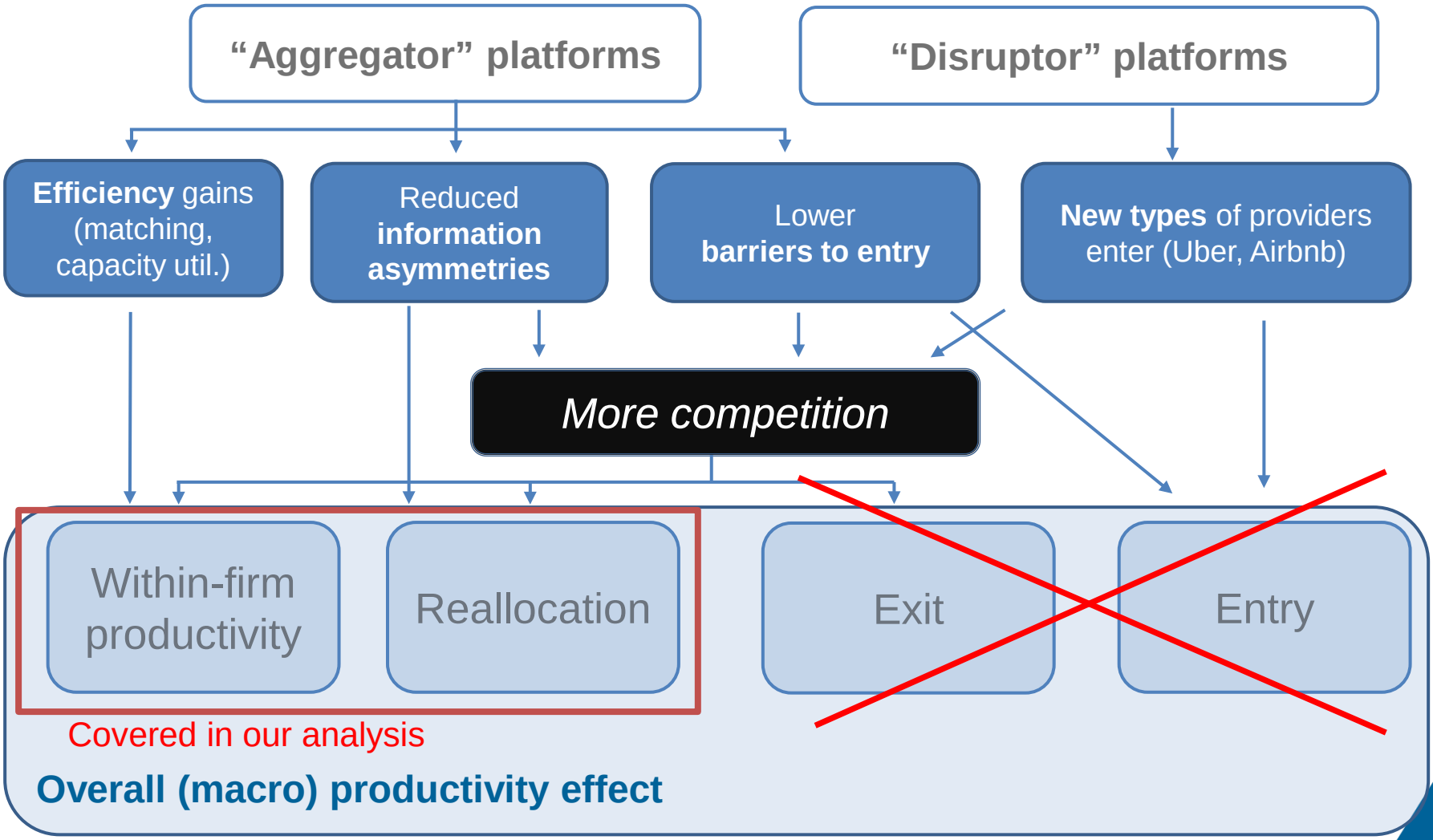
It's useful to distinguish between two broad types of platforms



- Our focus is on platforms **connecting consumers to service providers**,
- ….and using **rating/review systems**

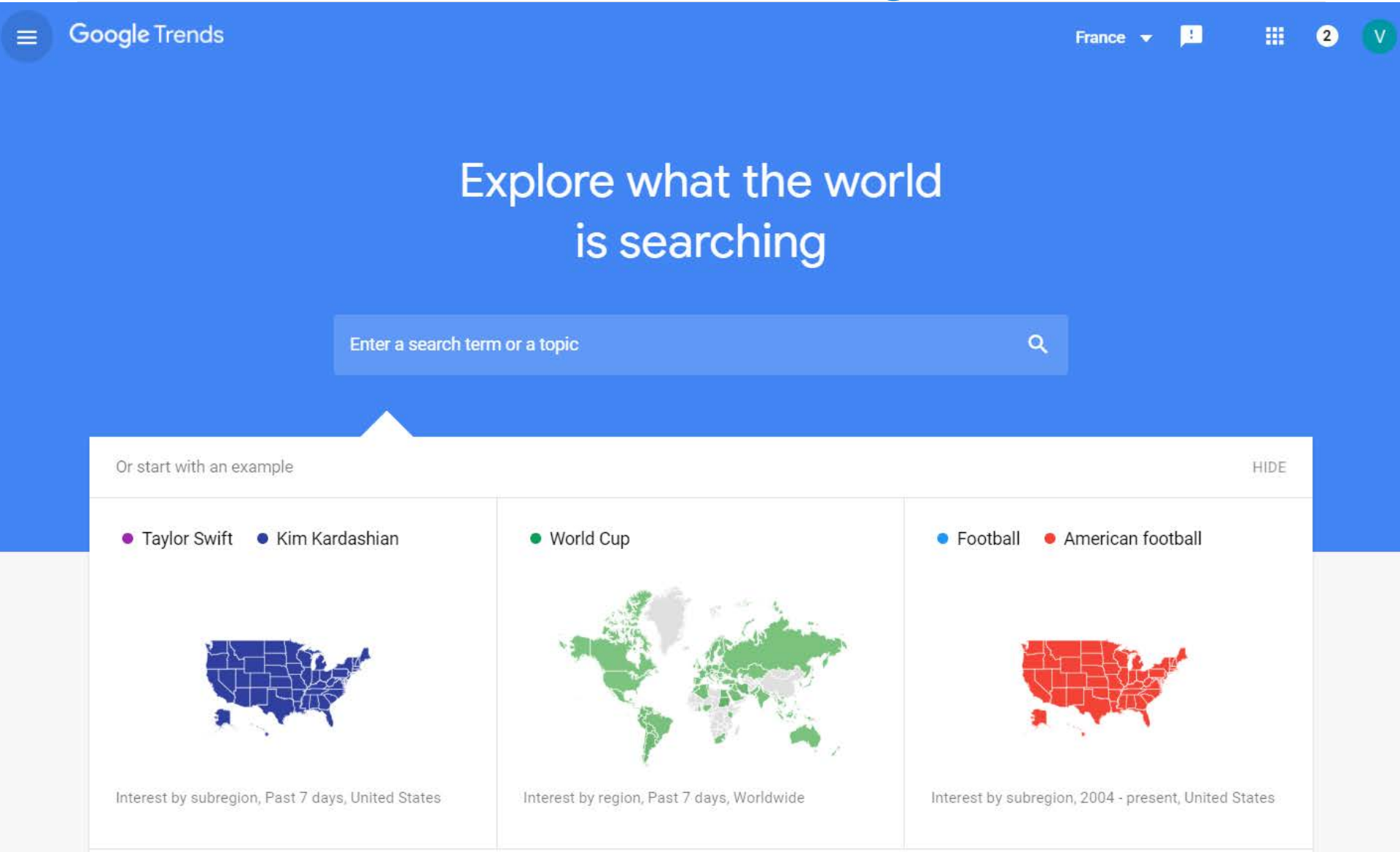
From *platform use* to *productivity*

A web of potential channels…



Google Trends

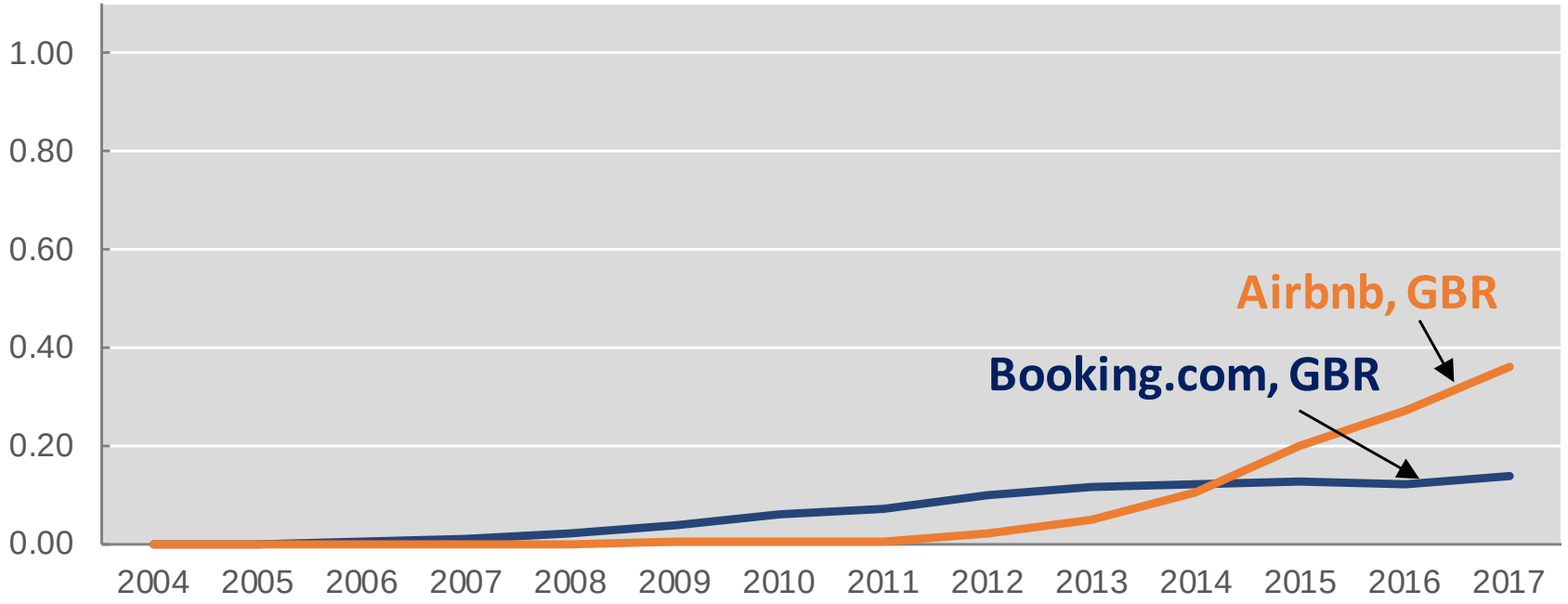
A rich database of Google searches



Building our platform use indicator

Intensity of interent searches for hotel platforms in the UK

Based on Google Trends search data



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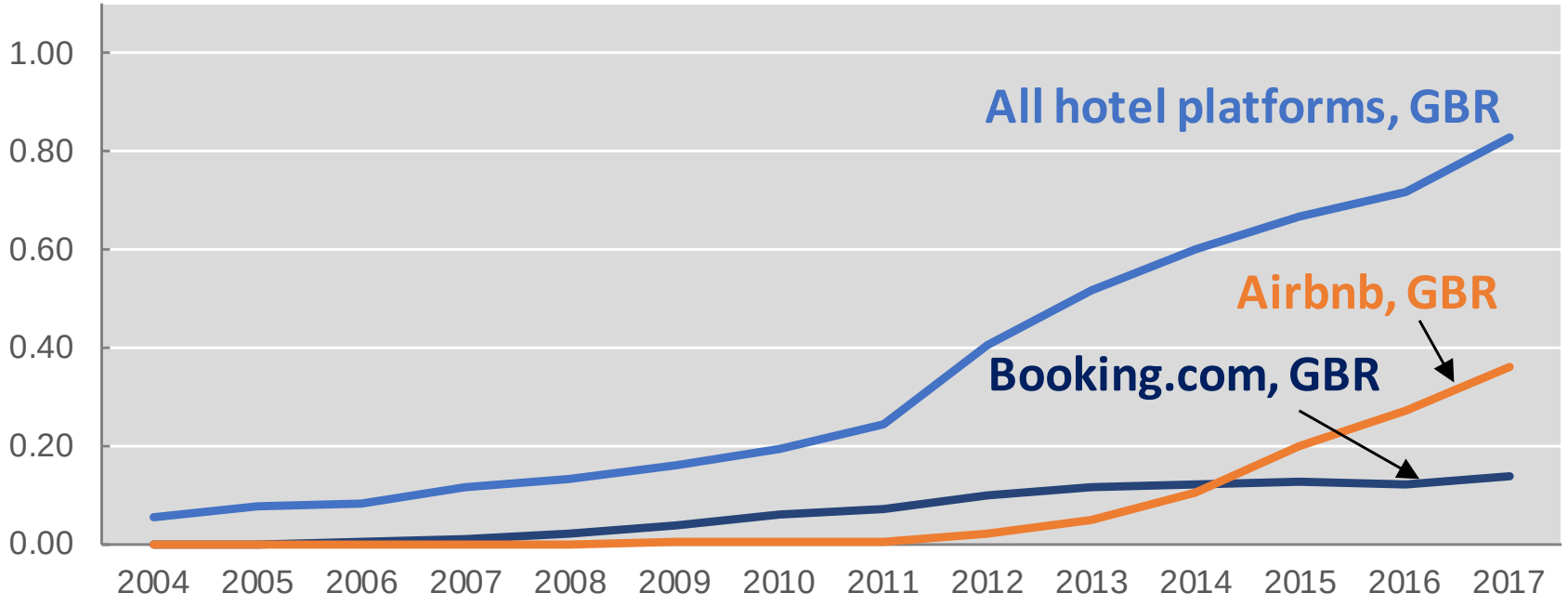


Platform use indicator

By country X sector X year

Note: The retail sector is an unweighted average of the five retail subsectors considered (books, shoes, cosmetics/perfumes, watches/jewellery, and toys). For each sector (and each retail subsector), values are normalised to one for the country and year with the highest platform use (usually 2017, but an earlier year in certain retail subsectors).

Regression results

Within-firm productivity growth and platform use

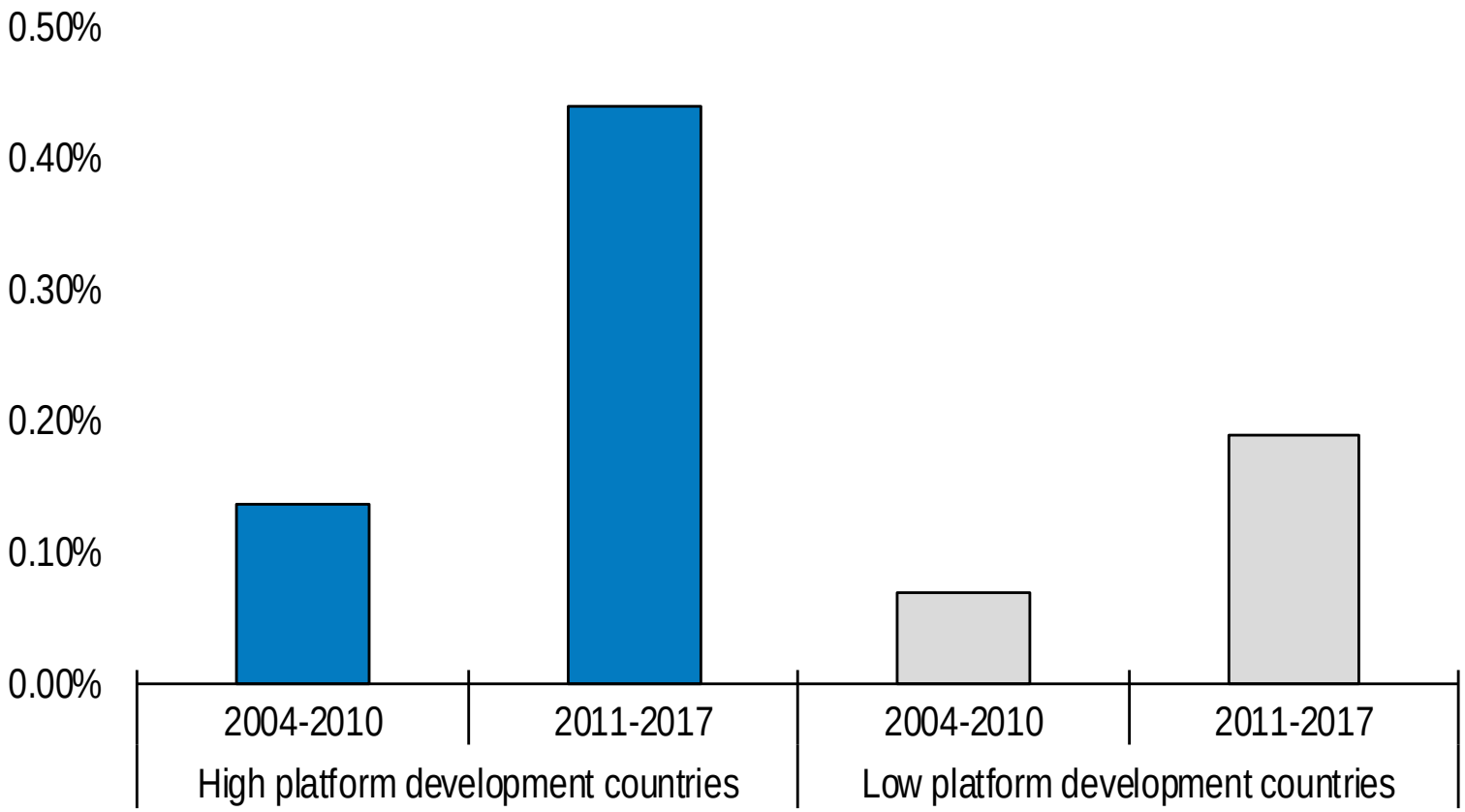
	(1)	(2)	(3)
	Dependent variable: ΔMFPi,t		
All platforms$_{c,s,t-1}$	0.08193***		
	(0.032)		
Aggregators$_{c,s,t-1}$		0.10434***	
		(0.032)	
Disruptors$_{c,s,t-1}$			0.01966
			(0.041)
Firm fixed effects	YES	YES	YES
Country*Year fixed effects	YES	YES	YES
Industry*Year fixed effects	YES	YES	YES
Observations	701,304	701,304	701,304
R2	0.171	0.171	0.171

$$\Delta MFP_{i,c,s,t} = \boldsymbol{\beta Platform_{c,s,t-1}} + \delta_i + \delta_{c,t} + \delta_{s,t} + \varepsilon_{i,c,s,t}$$

Economic significance

Platforms boosted the productivity of services

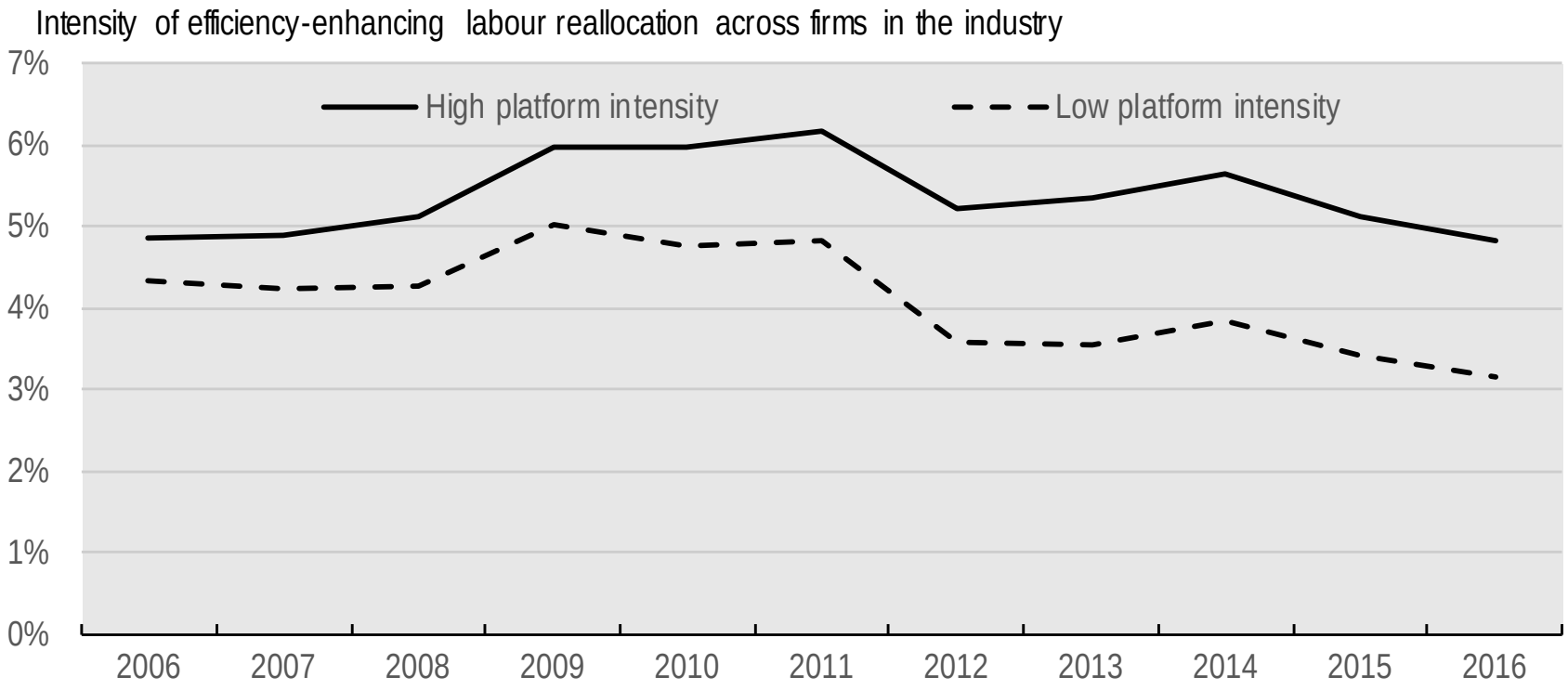
Annual average MFP growth associated with platform use



Note: Platform development is measured by the increase in platform use observed between 2011 and 2017. “High platform development” is the average of the five countries where this indicator is above median (France, Italy, Spain, United Kingdom, United States), while “Low platform development” is the average of the five other countries in the sample (Belgium, Germany, Hungary, Poland, Sweden).

Reallocation have fallen less where platforms are more developed

Intensity of labour reallocation to more productive firms

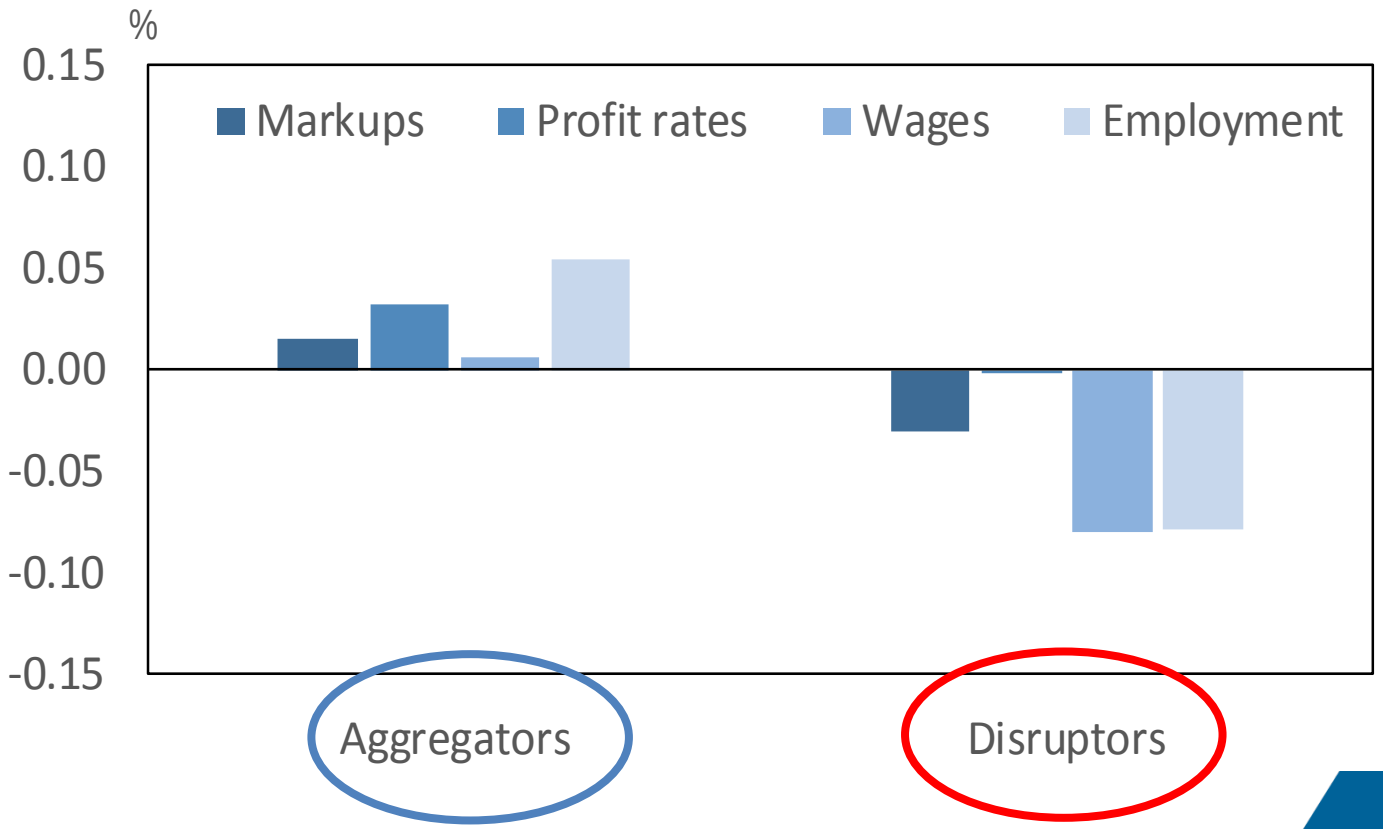


Note: . The intensity of labour reallocation corresponds to the effect of lagged productivity level on employment growth, estimated for each year by interacting lagged MFP with year dummies. The two lines correspond to high and low platform intensity (i.e. sectors at the 75th and 25th percentile of the distribution of platform intensity across countries and industries).

Impacts on other firm-level outcomes are smaller and depend on the *type of platforms*

- *Aggregators*: Positive technology shock dominates
- *Disruptors*: It's only a competition shock…

Impact of platform development on incumbent service providers in the following year

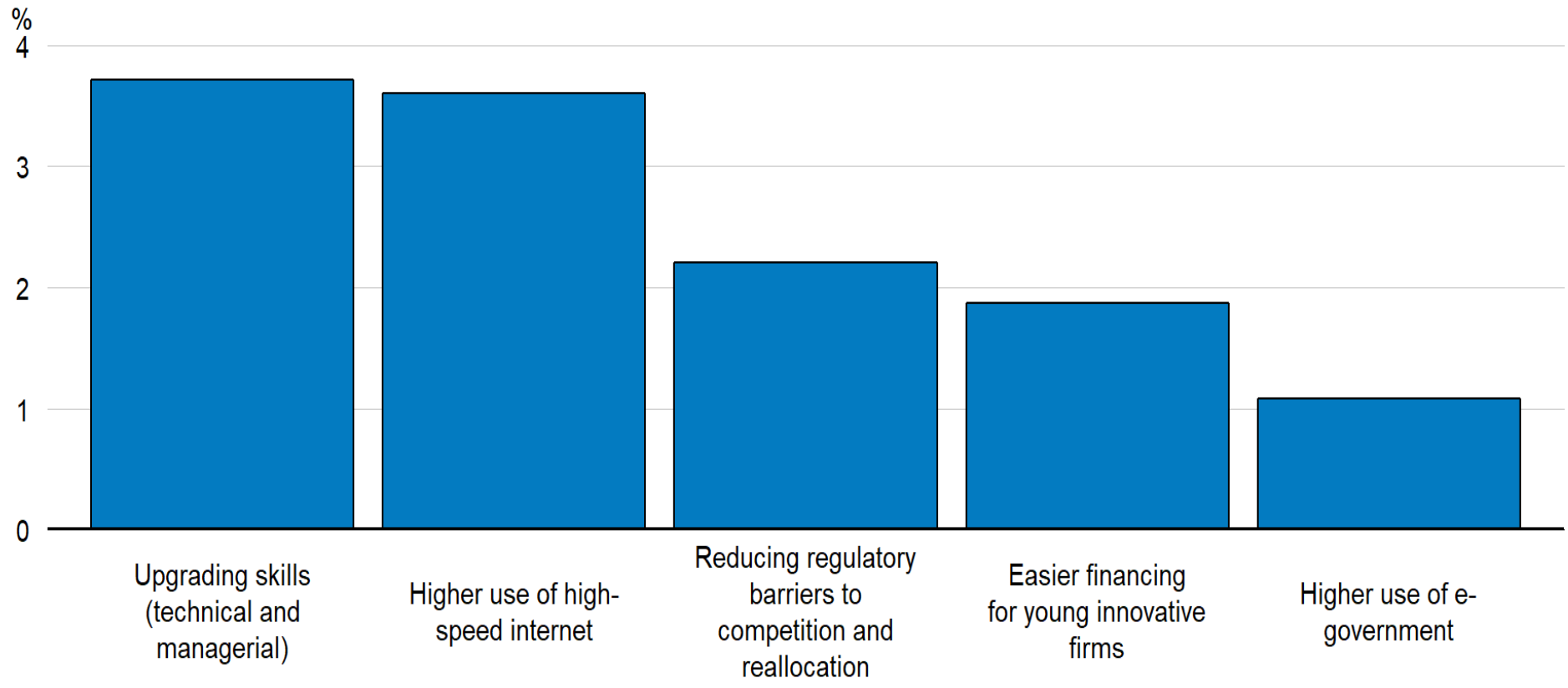


- Pattern is mostly led by *Hotels* and *Restaurants*

IV. THE ROLE OF PUBLIC POLICY

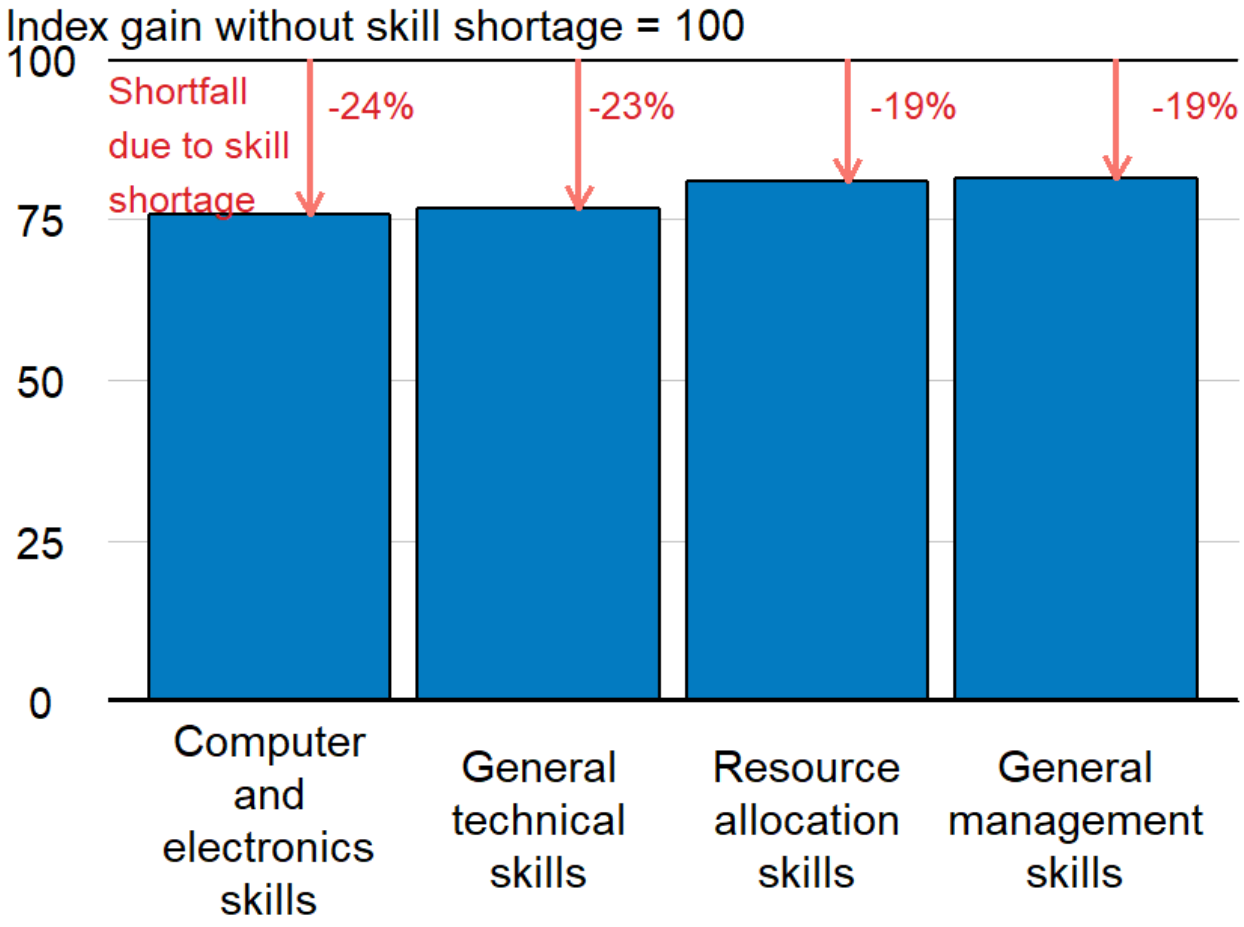
Policies support productivity through boosting digital technology adoption

MFP growth (after 3 years) from closing half of the gap with best performing EU countries in various policy areas



Skill development is a crucial complement to digital technologies (1)

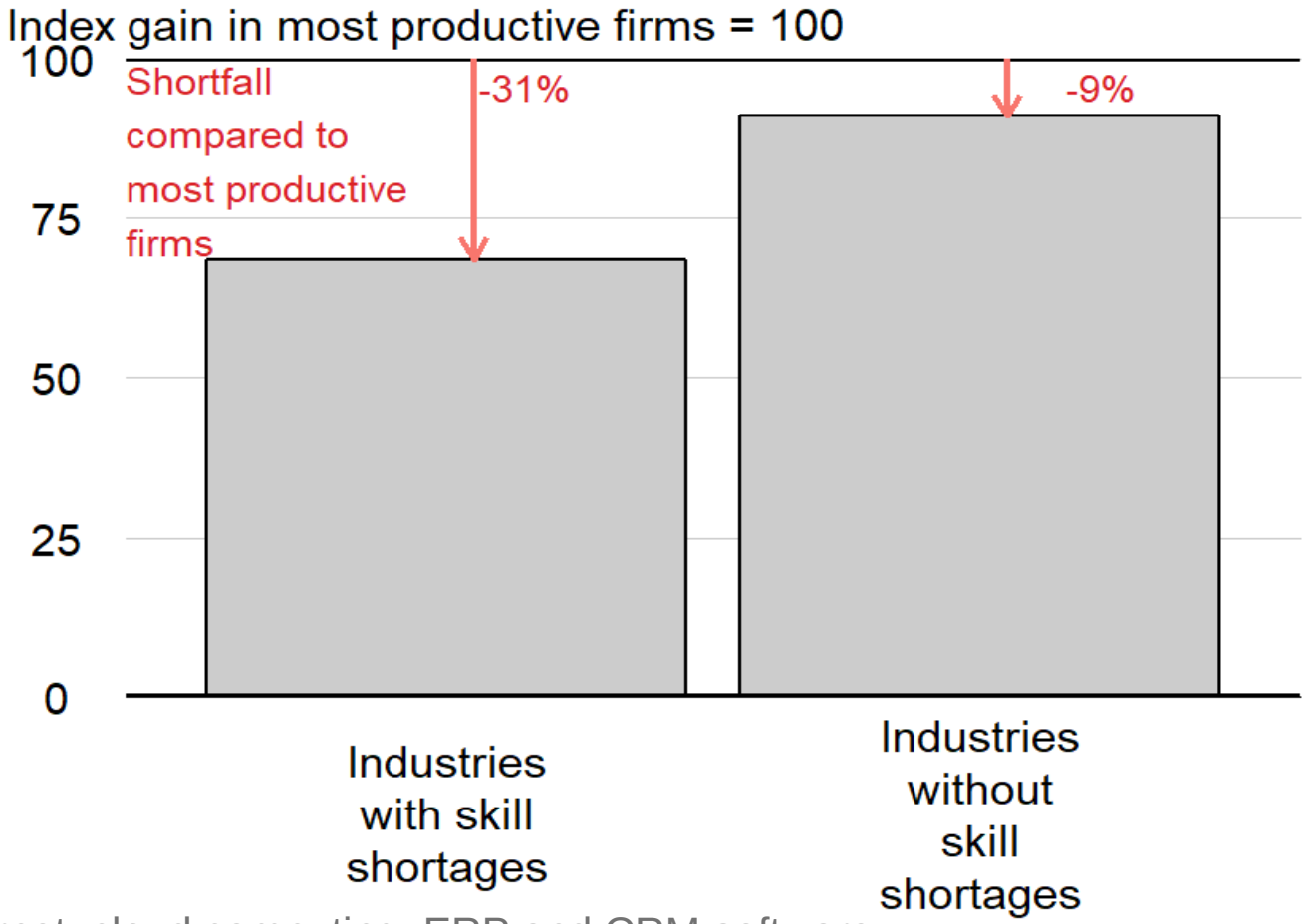
MFP gain from increasing a mix of selected technologies*, when skill shortages are present



*High-speed internet, cloud computing, ERP and CRM software

Skill development is a crucial complement to digital technologies (2)

MFP gains from increasing a mix of selected technologies*, in high productive vs low productive firms

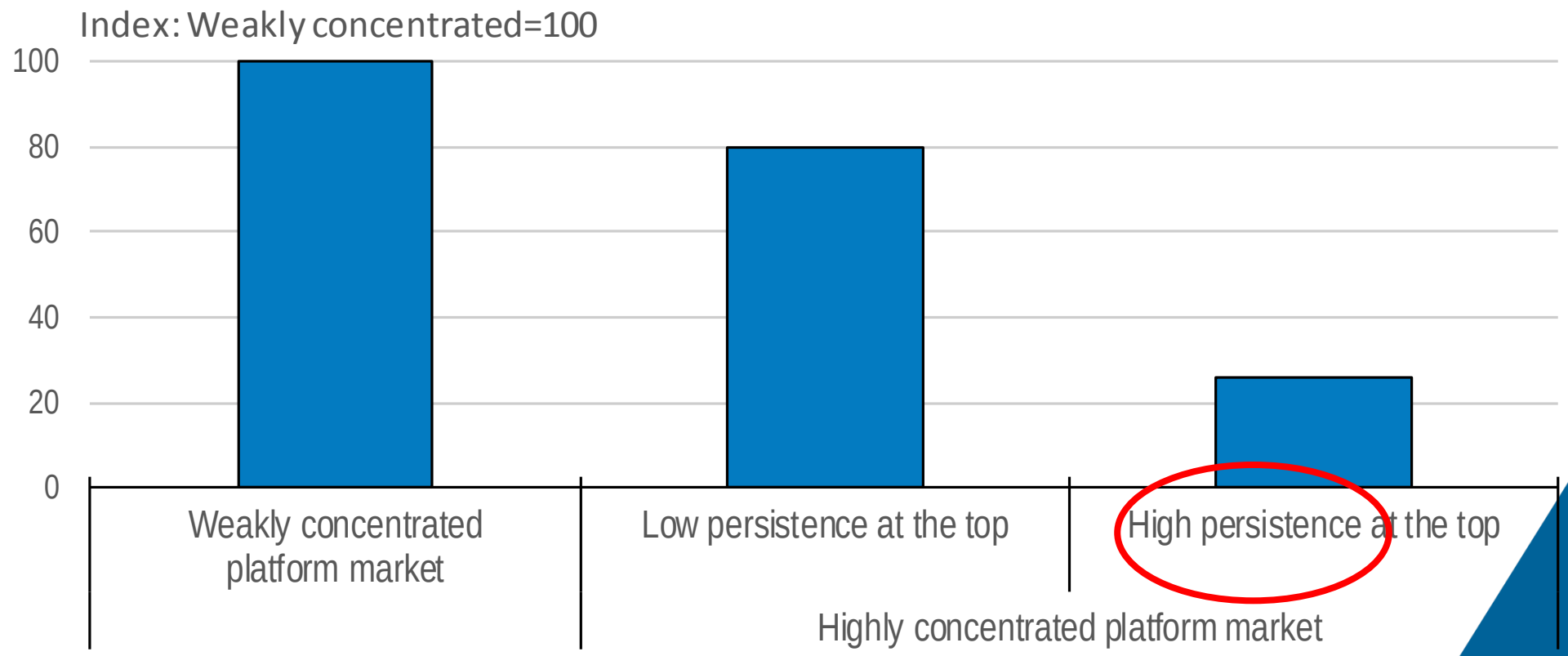


*High-speed internet, cloud computing, ERP and CRM software

Market structure of platforms

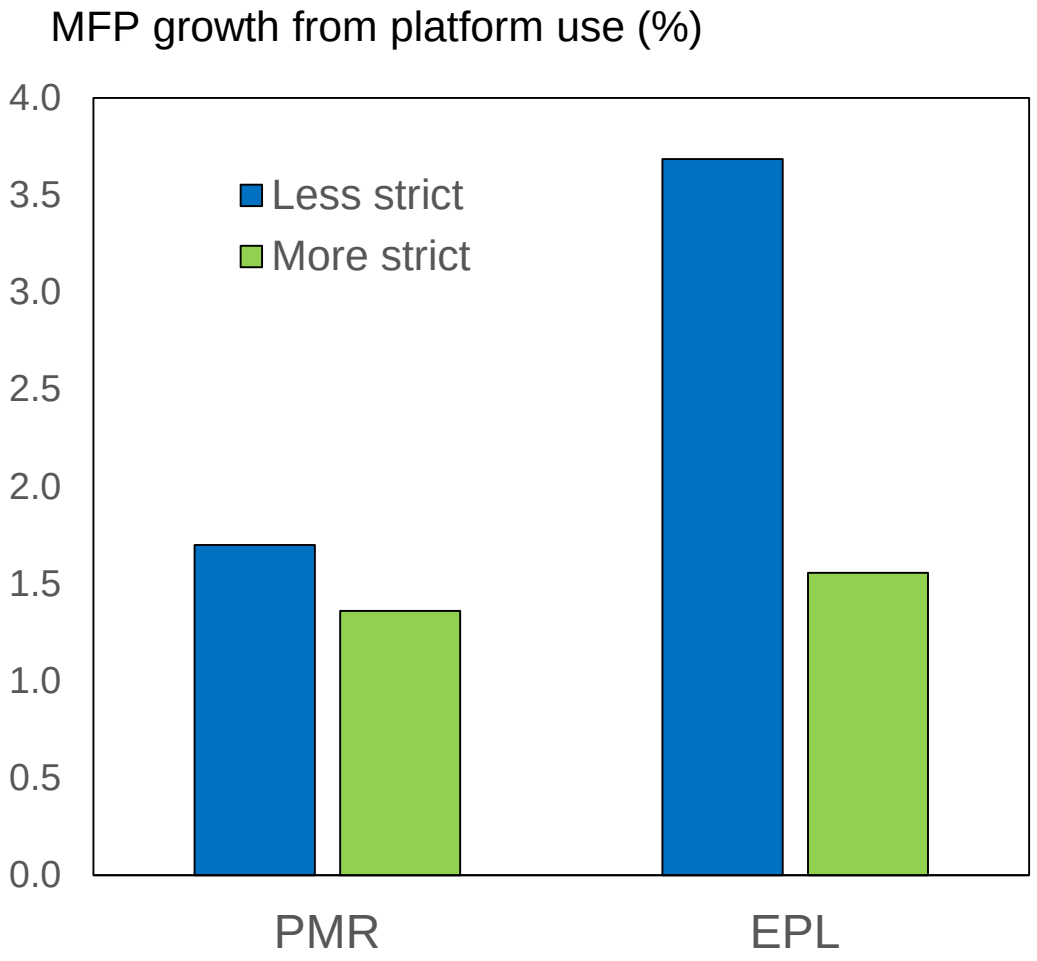
Platform concentration diminishes the productivity gains, but only when it is not contestable

MFP increase from higher platform use, depending on platform market structure

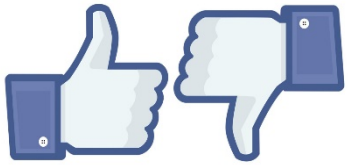


The role of regulations through allowing for flexible adjustment

- Heavily regulated product and labour markets hamper adjustment
  - *Holding back new entrants & upscaling* (PMR)
  - *Increasing or downsizing employment* (EPL)
- …thus lowering MFP gains from platform use
- … and making the negative impacts of disruptors more pronounced



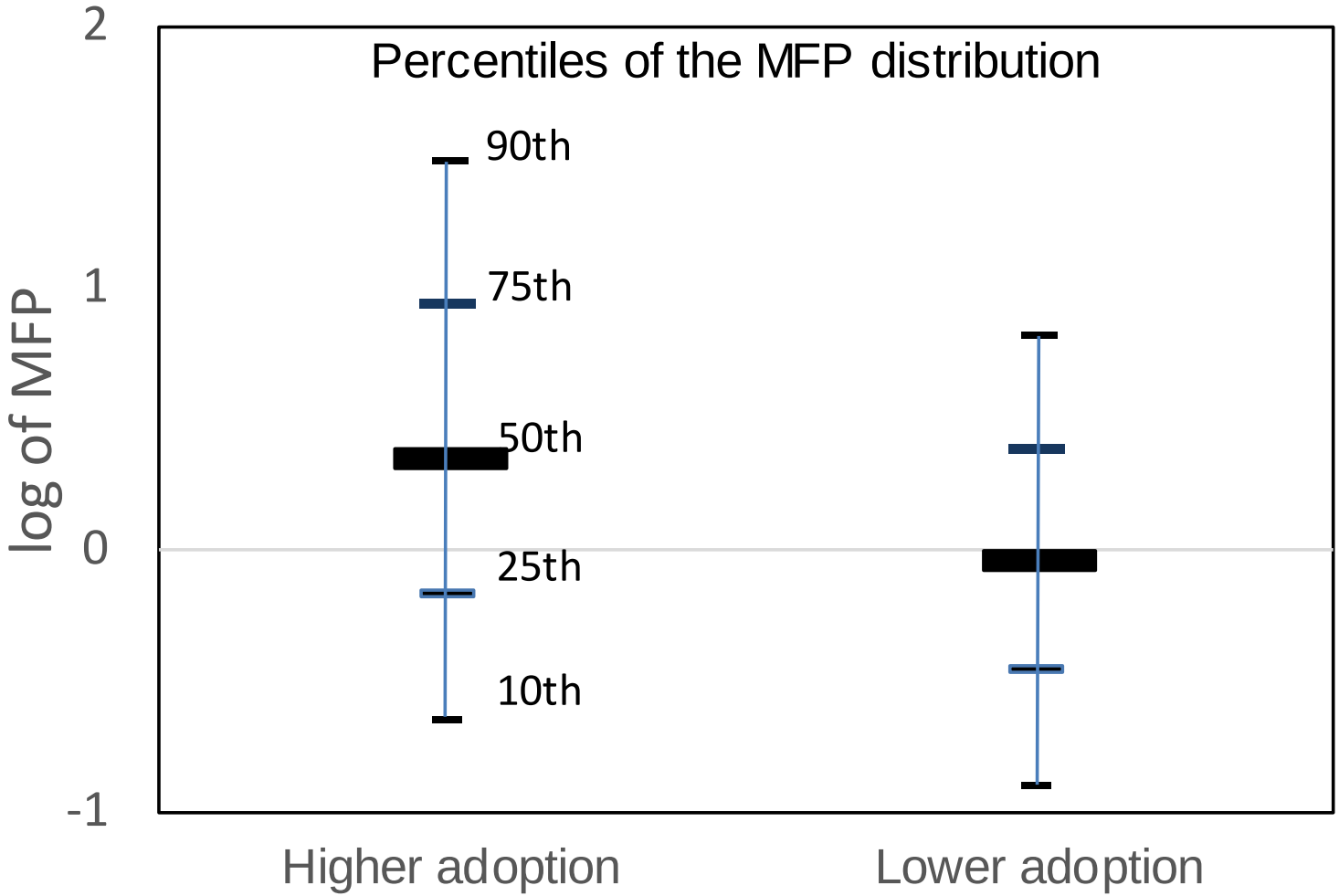
Conclusions



- Robust evidence that digital technologies and platform development affect firms:
  - Both infrastructure (BB) and software (ERP, CRM) matters
  - “Aggregator” platforms stimulate productivity of incumbents, also their mark-ups, profits and employment
  - “Disruptor” platforms have no clear effect on productivity but reduce mark-ups, employment and wages of incumbents
- Policies have a key role to play:
  - Drivers of adoption: ICT skill development, connectivity, e-gov
  - Complementarities: with skills; and across technologies
  - Supporting **platform market contestability** (e.g. by reducing switching costs between platforms) can bring productivity benefits
  - **Flexible product and labour market** settings can help service firms to adjust to rapid changes in demand induced by platform development

SPARES

Productivity is more dispersed in more digital intensive industries

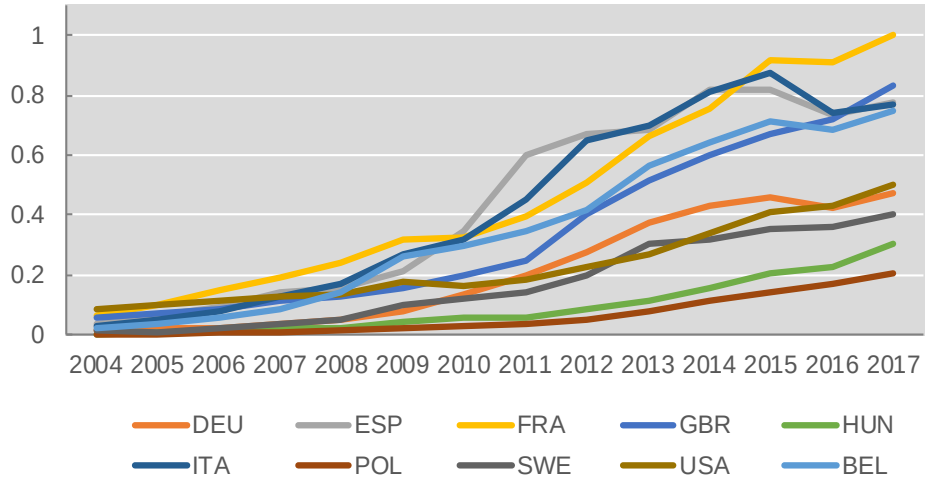


Selecting platforms – complete list

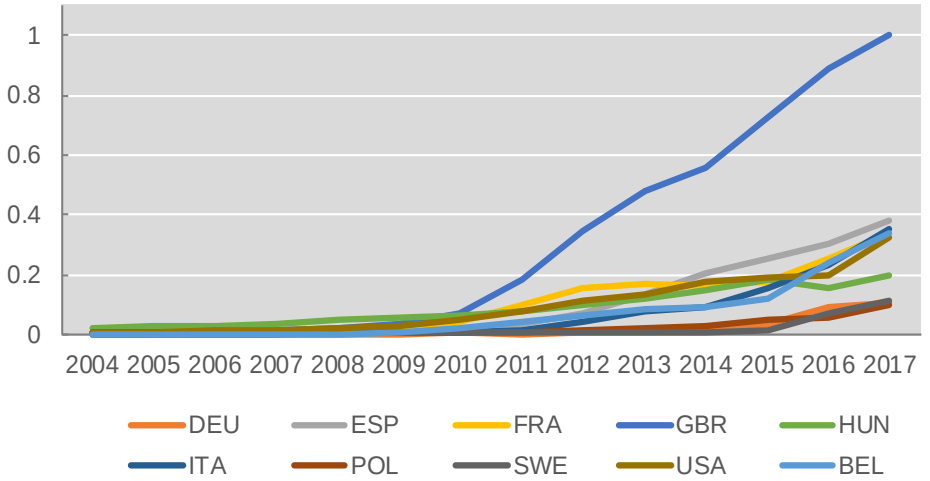
	Hotels	Restaurants	Taxi	Retail subsectors
Aggregators	Abritel Atrapalo Bedandbreakfast.com Booking.com Expedia Flipkey Homelidays Hosterworld Hotels.com Hoteltonight Housetrip Tripadvisor Trivago VRBO	Deliveroo Delivery hero Doordash Eatstreet Foodora Foodpanda Grubhub Hungry house Justeat Netpincer Opentable Pizzaportal Takeway.com Thefork Tripadvisor Ubereats Urbanspoon Wolt Yelp Zomato	Easytaxi Kabbee	Aliexpress
Disruptors	Airbnb Atraveo Couchsurfing Wimdu	-	Cabify Chauffeurprive Lecab Lyft Mytaxi Taxify Uber	Bestbuy Bookline
Mixed	Homeaway	-	-	Amazon Asos Ebay Flipkart Zalando

Platform development by country/sector

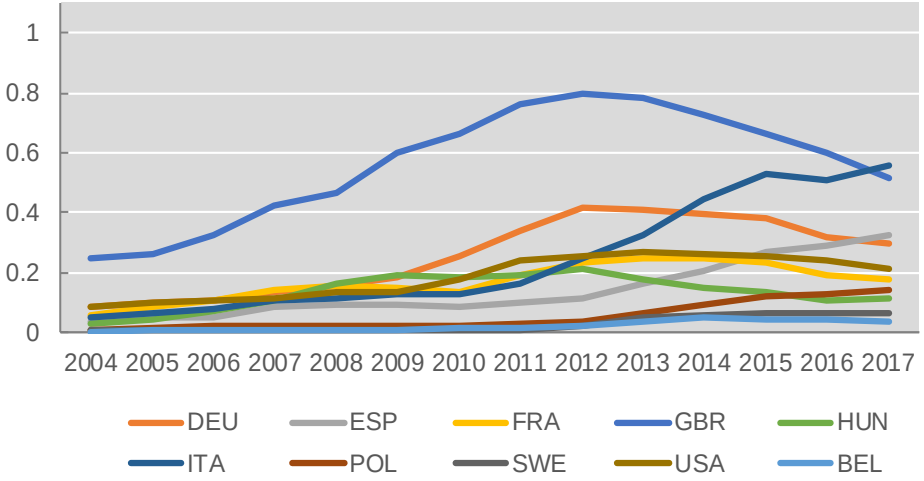
Hotels



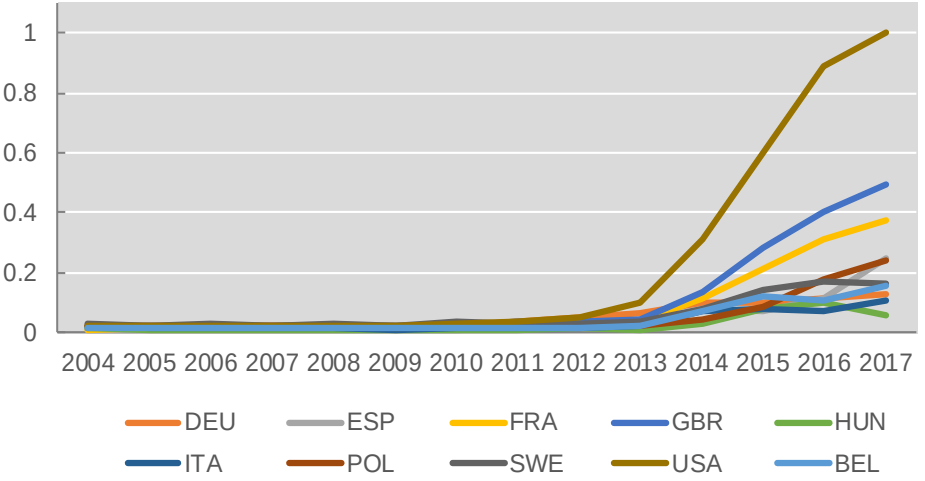
Restaurants



Retail subsectors



Taxi services



Google Trends data

- Google Trends series measure the evolution over time of searches containing a certain keyword in a given country, in proportion to overall searches in the same country:
  - Can be the keyword alone or with other words in the query (relatively flexible)
  - Normalised series, 100= maximum intensity of searches over the time period
- Good time and country coverage:
  - Google: 90% of the market of searches worldwide
  - All countries potentially covered (although with different representativeness)
  - Monthly data, aggregated to yearly (2004-2017)
- Increasingly used in empirical analysis in different fields, including economics (e.g. Askitas and Zimmermann, 2009, Preis et al. 2013, Carrière-Swallow et al. 2013, Graevenitz et al. 2016, Siliverstovs and Wochner, 2018)
- Recently used to measure online platform development, especially:
  - Number of workers participating in “online gig economy” (Harris and Krueger 2015)
  - Activity of online travel agents (Hunold et al. 2018)

Link to help

Firm-level dataset – descriptive statistics

Number of observations

Hotels	154,117
Restaurants	454,843
Taxi services	22,852
Retail subsectors	113,100
Books	15,244
Toys	9,985
Shoes	35,691
Perfume and cosmetics	20,212
Watches and jewellery	31,968
Total	744,912

Main variables: level

	Employment	Labour productivity	MFP (Solow residual)	MFP (Wooldridge)	MFP (Wooldridge, gross output based)	Markup corrected MFP
10th percentile	1.0	9.574	5.129	9.174	6.829	7.094
90th mercentile	25.0	11.043	6.919	10.740	9.846	11.131
Mean	28.2	10.328	6.014	9.977	8.557	9.447
Median	5.0	10.356	6.006	10.007	8.997	10.190
Standard deviation	653.391	0.634	0.745	0.666	1.196	1.648
Number of observations	692120	727686	744912	735306	702552	523161

Main variables: growth rate

	Employment	Labour productivity	MFP (Solow residual)	MFP (Wooldridge)	MFP (Wooldridge, gross output based)	Markup corrected MFP	Markup	Profit rate	Real wages
10th percentile	-0.288	-0.429	-0.412	-0.369	-0.185	-0.231	-0.093	-0.090	-0.287
90th mercentile	0.288	0.463	0.445	0.405	0.200	0.251	0.087	0.086	0.331
Mean	0.005	0.010	0.020	0.014	0.006	0.007	-0.002	-0.002	0.017
Median	0.000	0.000	0.022	0.005	0.001	0.001	0.000	-0.002	0.008
Standard deviation	0.257	0.412	0.403	0.368	0.177	0.219	0.097	0.082	0.280
Number of observations	640751	727686	744912	735306	701761	522084	526518	657554	652478

Platform use and within-firm productivity growth of existing service providers

$$\Delta MFP_{i,c,s,t} = \boldsymbol{\beta Platform_{c,s,t-1}} + \delta_i + \delta_{c,t} + \delta_{s,t} + \varepsilon_{i,c,s,t}$$

	(1)	(2)	(3)
	Dependent variable: ΔMFPi,t		
All platforms$_{c,s,t-1}$	0.08193***		
	(0.032)		
Aggregators$_{c,s,t-1}$		0.10434***	
		(0.032)	
Disruptors$_{c,s,t-1}$			0.01966
			(0.041)
Firm fixed effects	YES	YES	YES
Country*Year fixed effects	YES	YES	YES
Industry*Year fixed effects	YES	YES	YES
Observations	701,304	701,304	701,304
R2	0.171	0.171	0.171

Robust standard errors clustered at country*industry*year level

Platform use and productivity of existing service providers: results by sector

Direct effect on within-firm productivity growth

	All platforms	*Aggregators*	*Disruptors*
Hotels	0.080	0.161**	-0.359**
Restaurants	0.262**	0.262**	n.a.[2]
Taxi	-0.314	n.a.[1]	-0.336
Retail subsectors	0.082**	0.092**	0.083**
Total	0.082***	0.104***	0.020

Note: Dependent variable is firm-level MFP growth. Regressions also contain firm, country and year fixed effects. Robust standard errors clustered at country*year level

Effect on allocative efficiency

	All platforms	*Aggregators*	*Disruptors*
Hotels	0.057***	0.068***	0.109
Restaurants	0.130***	0.130***	n.a.[2]
Taxi	-0.157	n.a.[1]	-0.196
Retail subsectors	-0.006	-0.007	-0.006
Total	0.032***	0.039***	0.010

Dependent variable is firm-level employment growth. Coefficients correspond to the variable of platform use at the sector level interacted with lagged MFP at the firm level. Regressions also include lagged MFP and country*year fixed effects, and firm age and size controls. Robust standard errors clustered at country*year level.

Platform use and allocative efficiency

- Foster, Grim & Haltiwanger (2016): models of firm dynamics predict that conditional on size, firms with higher MFP grow more quickly (β_1>0):

$$\Delta L_{i,c,s,t} = \beta_1 \widetilde{MFP}_{i,c,s,t-1} + \boldsymbol{\beta_2 \widetilde{MFP}_{i,c,s,t-1} \times Platform_{c,s,t-1}}$$
$$+\delta_t \widetilde{MFP}_{i,c,s,t-1} + \delta_s \widetilde{MFP}_{i,c,s,t-1} + \beta_3 X_{i,c,s,t} + \delta_{c,s,t} + \varepsilon_{i,c,s,t}$$

	(1)	(2)	(3)	(4)
	Dependent variable: ΔLi,t			
$MFP_{i,t-1}$	0.02824***	0.03133***	0.03282***	0.02829***
	(0.010)	(0.010)	(0.010)	(0.010)
$MFP_{i,t-1}$* All platforms$_{c,s,t-1}$		0.03198***		
		(0.009)		
$MFP_{i,t-1}$* Aggregators$_{c,s,t-1}$			0.03899***	
			(0.011)	
$MFP_{i,t-1}$* Disruptors$_{c,s,t-1}$				0.01033
				(0.011)
$MFP_{i,t-1}$* Sector dummies	YES	YES	YES	YES
$MFP_{i,t-1}$* Time dummies	YES	YES	YES	YES
Firm Age and Size Controls	YES	YES	YES	YES
Country*Industry*Year fixed effects	YES	YES	YES	YES
Observations	692,095	692,095	692,095	692,095
R2	0.028	0.028	0.028	0.028

Robust standard errors clustered at country*industry*year level

Impacts on profits, wages and employment depend on the type of platforms, and are driven mainly by hotels and restaurants.

Estimated impacts of platform developments
on firm-level productivity by sector

	Aggregators				Disruptors			
	Markups	Profit Rate	Wages	Employment	Markups	Profit Rate	Wages	Employment
Hotels	+	+	+		-	-	-	-
Restaurants		+		+	na	na	na	na
Taxi	na	na	na	na			-	
Retail subsectors								
Total	+	+		+	-		-	-