PRODUCTIVITY TRENDS IN RUSSIAN INDUSTRIES: FIRM-LEVEL EVIDENCE

Research and forecasting department

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# Productivity dispersion in Russian industries

- We analyze whether the decline in productivity growth is homogeneous

- And whether the productivity gap between leaders and other companies increases or decreases?

- We define labor productivity as a ratio of value added to labour input

- Rosstat uses hours worked as labour input (Rosstat's decree 28.04.2018 N 274)

- We use the number of employees of establishments

- We use multifactor productivity as alternative indicator to check or results

Labour productivity growth
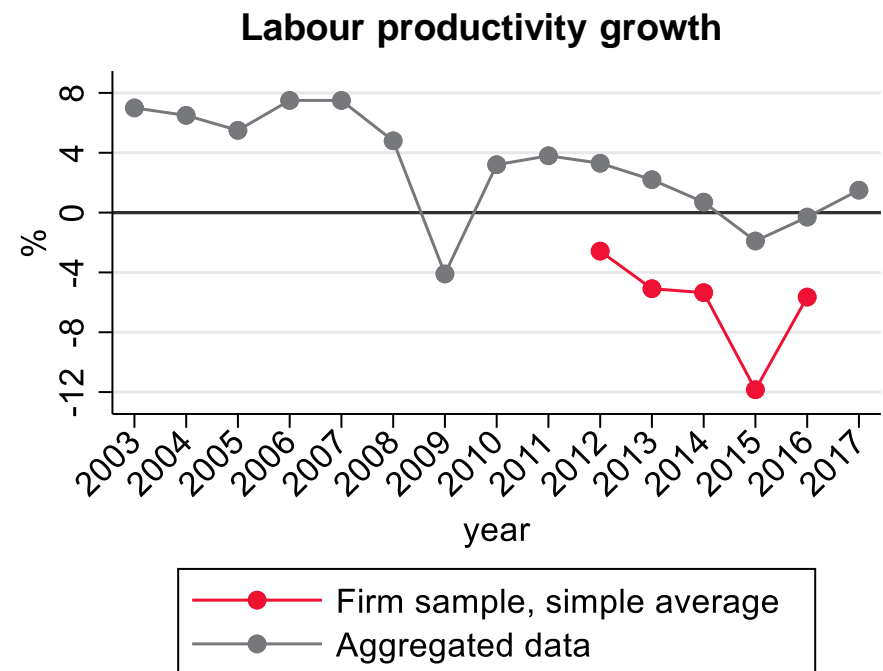
Thanks to access to firm-level data we can analyze what stands behind the aggregate productivity trends

Establishment's productivity is highly heterogeneous even within narrowly defined industries (Hsieh and Klenow, 2009)

- Productivity growth is negatively correlated with initial level of productivity (Griffith, Redding, Simpson, 2009)

- Andrews et al. (2016) and Cette et al. (2018) confirm that for OECD countries and France

- However despite fast laggards' fast growth the gap between them and leaders is wide and keeps growing (Berlingieri, Blanchenay, Calligaris, Criscuolo, 2017)

- We confirm this results for Russia and find that the gap in Russia is even higher than in several countries

- We confirm divergence by means of SFA

Labour productivity: value added per worker (2001-2013)
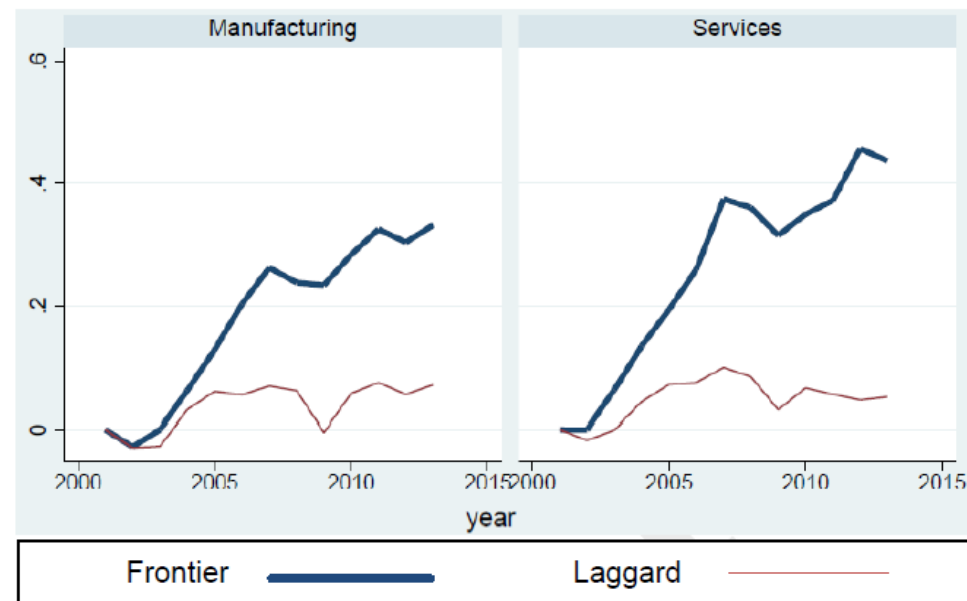
Source: Andrews D, Criscuolo C, Gal P (2016) The best versus the rest: The global productivity slowdown, divergence across firms and the role of public policy. OECD Productivity Working Papers, No. 5, pp. 1-50

Data on Russian establishments

- We use Ruslana database, which includes establishments' financials, data on labour

- 2011-2016 data includes: revenue, fixed assets, number of employees, cost of sales, labour cost, date of incorporation

$$\text{Value added} = \text{revenue} - \text{cost of sales} + \text{labour cost}$$

$$\text{Labour productivity} = \frac{\text{Value added}}{\text{Number of employees}}$$

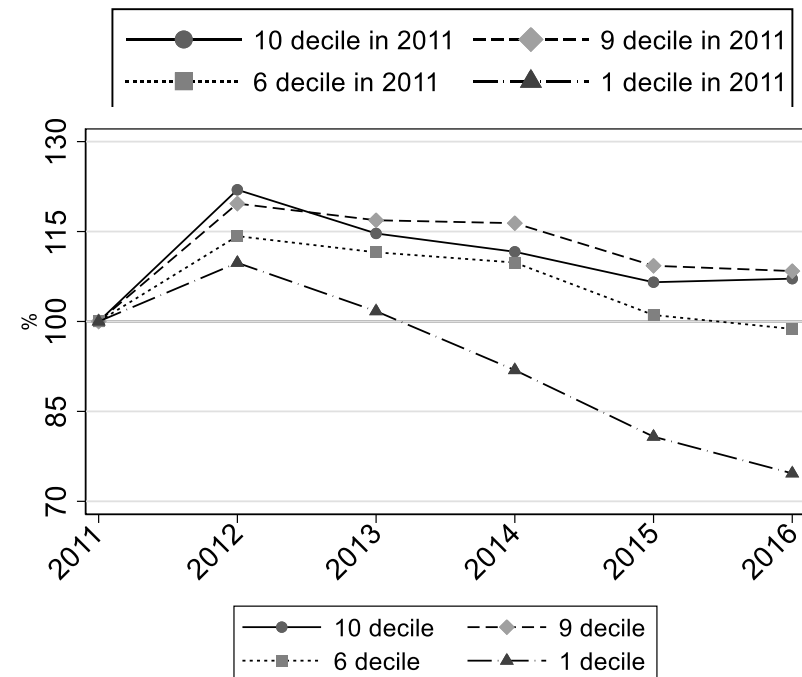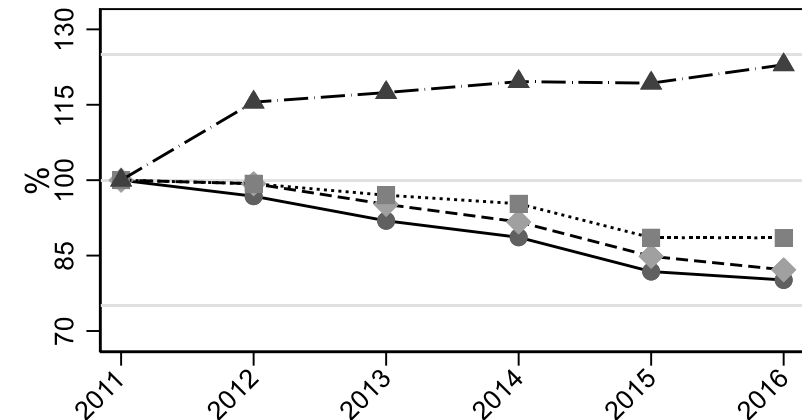|		2011	2012	2013	2014	2015	2016
C	Mining and quarring	916	960	1 226	1 417	1 508	1 378
D	Manufacturing	9 327	9 530	12 707	14 668	15 579	16 376
E	Electricity, gas and water supply	2 154	2 136	2 829	3 253	3 543	3 680
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	8 930	10 755	17 417	22 544	24 207	25 633
H	Hotels and restaurants	973	978	1 479	1 706	1 875	1 873
I	Transport, storage and communication	3 172	3 384	4 635	5 405	5 820	6 109
K	Real eatate, renting and busines activivties	7 531	7 980	11 412	14 457	16 262	17 705
O	Other community, social and personal sevice activities	1 606	1 556	2 407	2 671	2 671	2 707
	Total	**34 609**	**37 279**	**54 112**	**66 121**	**71 465**	**75 461**

Data on Russian establishments

- We exclude firms with number of employees less than 10

- Unbalanced panel made up of between 34 609 in 2011 and 75 461 in 2016

- On average our sample includes 25% of employees in selected sectors

- Distribution of employees between sectors is very close to Rosstat's

- We divide our sample into 173 industries (at 3-4 four digit level of OKVED). Within each industry we find groups of productivity leaders and estimate SFA models

Sectors' shares in total employment
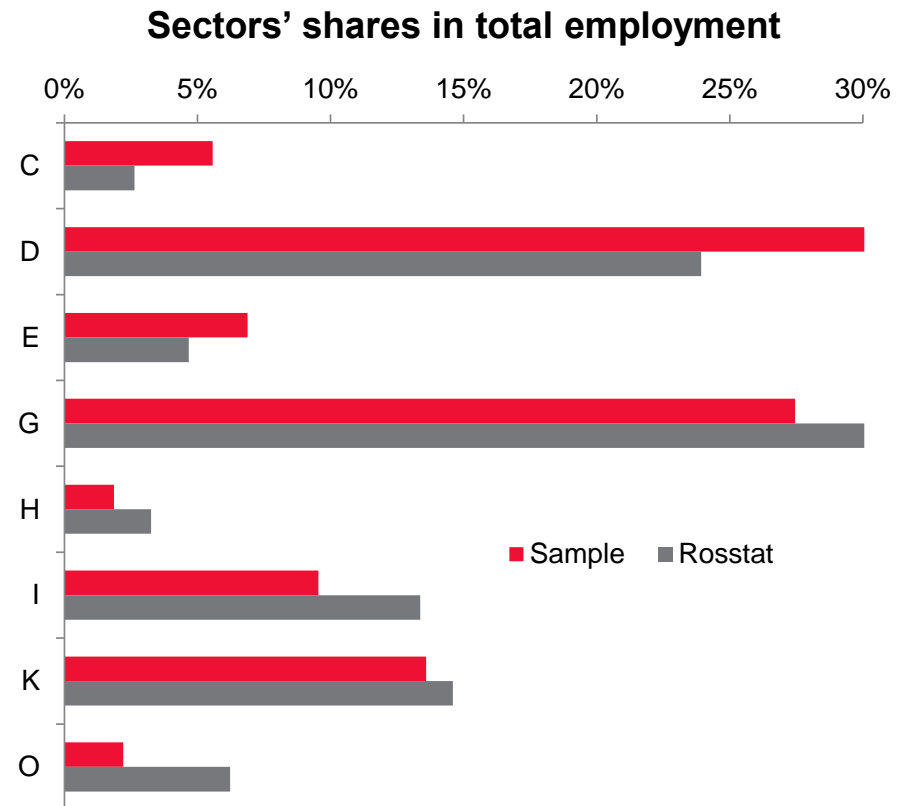
Leader groups definition influences the conclusion about convergence

- Cette et al. (2018) show that depending on leaders definition one can make opposite conclusions

- It is also true for Russian establishments:

  ❖ If groups of productivity leaders are fixed and they are defined according 2011 performance, then productivity of leaders decreases whereas productivity of laggards increases – argument for convergence

  ❖ If groups are defined with a renewal (each year of the companies that define it), then the gap between leaders and laggards opens up

- In order to check the hypothesis about productivity divergence we estimate SFA models which define leaders as the most productive establishments during the whole period

10 decile in 2011 — 9 decile in 2011
6 decile in 2011 — 1 decile in 2011

10 decile — 9 decile
6 decile — 1 decile

Differences between β- and σ- convergence

2 types of convergence:

β-convergence is necessary but not sufficient condition for σ-convergence

Fast growth of productivity of laggards doesn't mean that the gap is decreasing

	β convergence	σ convergence
When convergence is found	Laggards' productivity grow faster than leaders' productivity	Dispersion of productivity decreases
Sample	Only establishments present in sample for two consecutive years (survival bias)	All establishments
Permutation sensitivity	Permutation is regarded as convergence	Permutation is not regarded as convergence

Average labour productivity growth

- The highest growth was in 2012

- 2015 was the worst in terms of productivity growth

- In 2016 productivity growth returned to average in 2013-2014
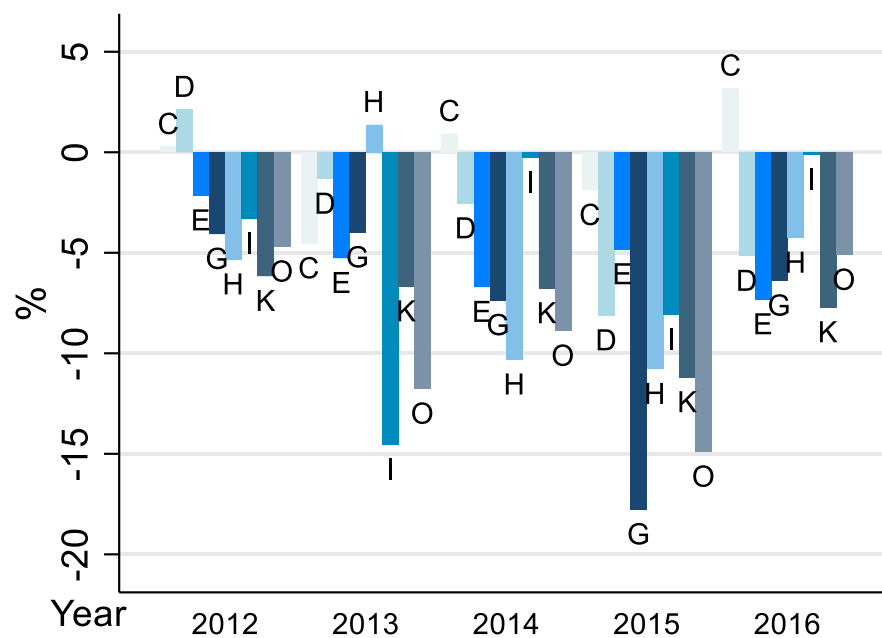
Labour productivity growth by years
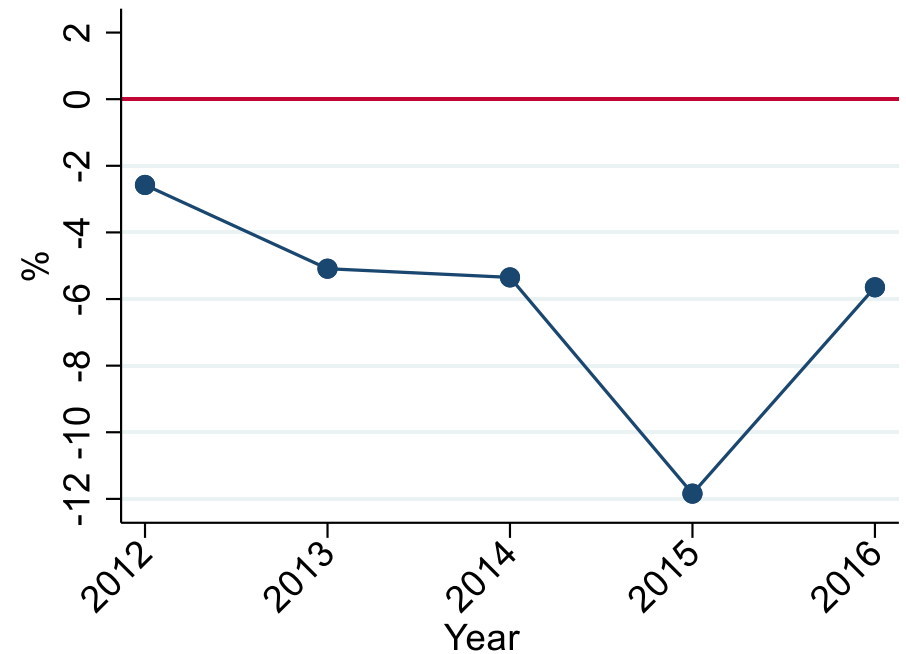
Average labour productivity growth

- Productivity in Mining and quarrying (C) grew faster than in other sectors

- Productivity in Wholesale and retail trade (G) decreased faster than in other sectors

Labour productivity growth by sectors

Average labour productivity growth

- Productivity grows fast in newly founded establishments

- After a few years productivity growth slows down
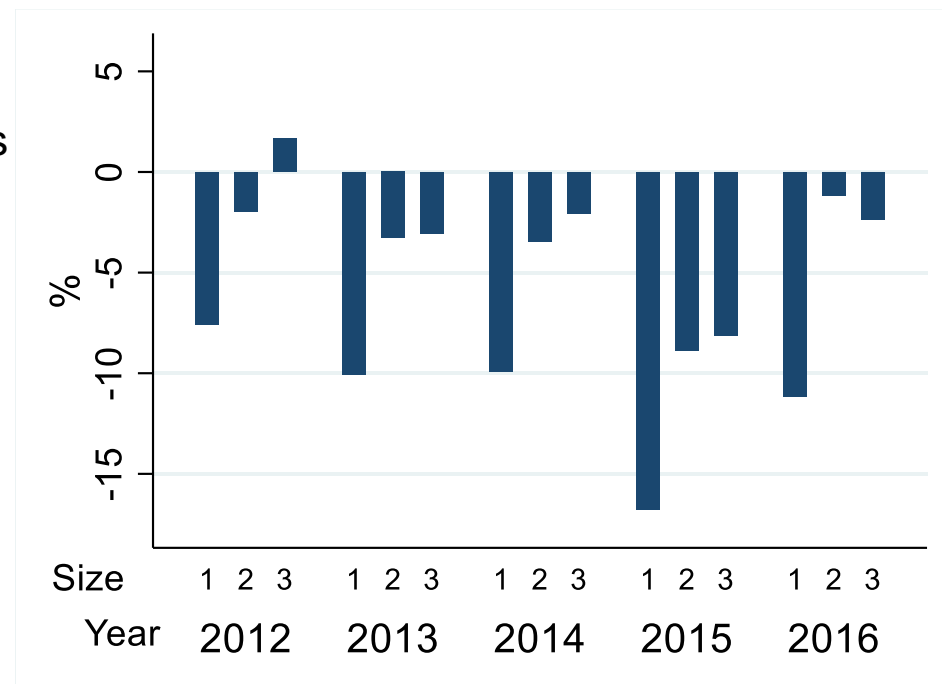
Labour productivity growth by age

Average labour productivity growth

- Productivity of large establishments declined less than productivity of other establishments
- Small establishments are on the contrary the most vulnerable

Labour productivity growth by size

Size 1: Workforce of less than 50 employees, Size 2: Workforce of 50 to 249 employees, Size 3: Workforce of 250 or more employees.

β- convergence

$$\Delta lp_{it} = \beta_0 + \beta_1 gap_{it-1} + controls$$

Δlp_{it} labour productivity growth

gap_{it-1} distance to frontier (frontier is defined as the average productivity among 10% the most productive firms in each of 173 industries)

Controls include dummies for years, sectors, size; as well as age and age squared

Productivity growth negatively correlated with the initial level of productivity.

This result is robust to different specification, including estimation of multifactor productivity instead of labour productivity

Δlp	Coef.	Std. Err.	95% Conf. Interval	
gap_{t-1}	0.03***	0.001	0.03	0.04
year				
2013	-0.03***	0.004	-0.03	-0.02
2014	-0.02***	0.004	-0.03	-0.01
2015	-0.08***	0.003	-0.08	-0.07
2016	-0.1***	0.003	-0.02	-0.01
sector				
D	-0.01	0.007	-0.02	0.00
E	-0.02***	0.008	-0.04	-0.01
G	-0.07***	0.007	-0.08	-0.05
H	-0.03***	0.009	-0.05	-0.01
I	-0.02***	0.007	-0.034	-0.005
K	-0.04***	0.007	-0.06	-0.03
O	-0.04***	0.008	-0.06	-0.02
size				
2	0.09***	0.002	0.08	0.09
3	0.09***	0.003	0.08	0.09
age	-0.003***	0.000	-0.003	-0.003
age^2	0.00002***	0.000	0.00001	0.00002
const	-0.10***	0.008	-0.12	-0.09

Number of obs 201,920
Adj. R-squared 0.023
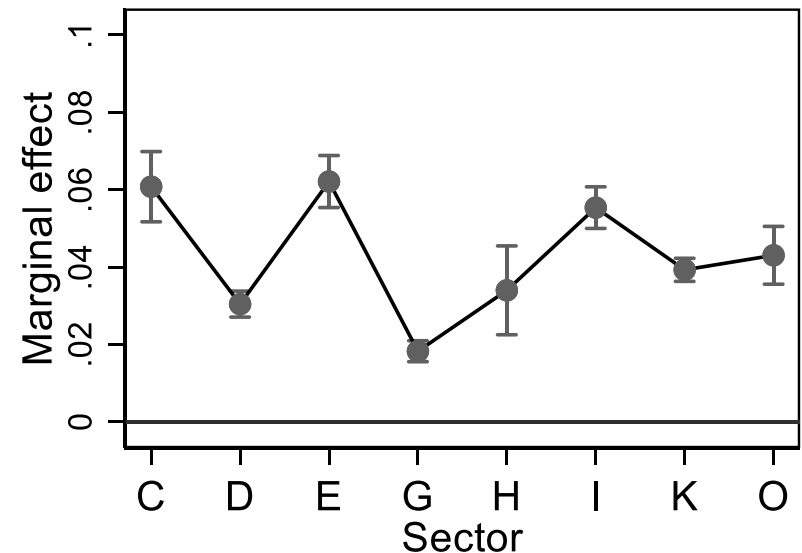*** p<0.01, ** p<0.05, * p<0.1

β- convergence by years and sectors
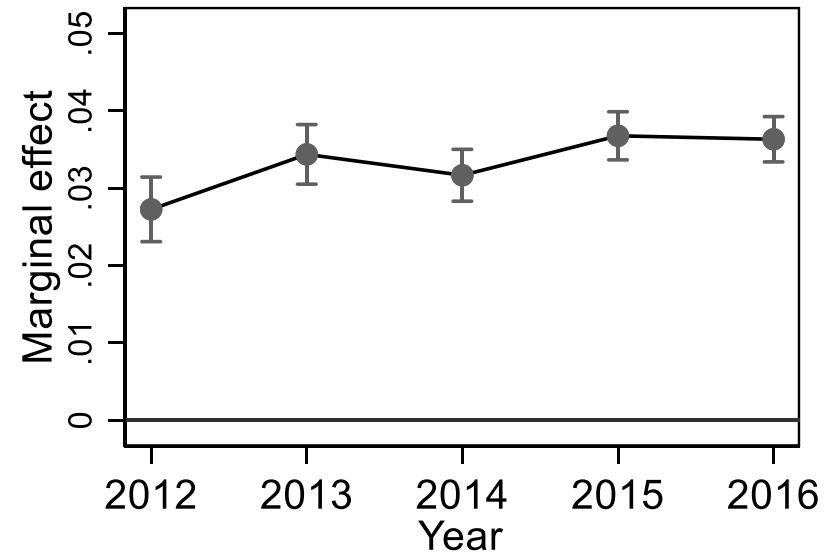
$$\Delta lp_{it}$$

$$= \beta_0 + \beta_1 gap_{it-1} + controls + \sum_{l=2013}^{2016} \beta_l * Y_l$$

$$* gap_{it-1} + \sum_{m=2}^{8} \beta_m * S_m * gap_{it-1}$$

Δlp_{it} labour productivity growth

gap_{it-1} distance to frontier (frontier is defined as the average productivity among 10% the most productive firms in each of 173 industries)

Y_l - dummy for year l

S_m - dummy for sector m

β- convergence by age

$$\Delta lp_{it}$$
$$= \beta_0 + \beta_1 gap_{it-1} + \beta_2 age_{it} + \beta_3 age_{it}{}^2$$
$$+ controls + \beta_4 age_{it} * gap_{it-1} + \beta_5 age_{it}{}^2$$
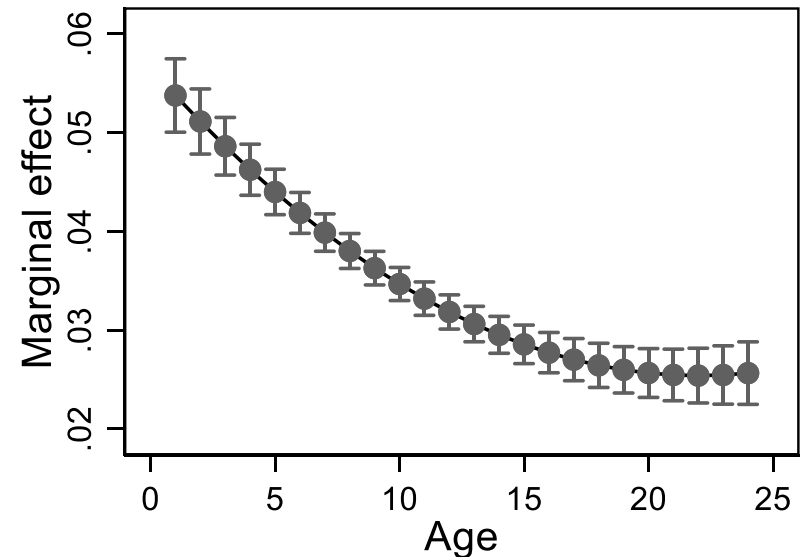$$* gap_{it-1}$$

Δlp_{it} labour productivity growth

gap_{it-1} distance to frontier (frontier is defined as the average productivity among 10% the most productive firms in each of 173 industries)

Y_l - dummy for year l

S_m - dummy for sector m

Catching up impulse dies out soon.
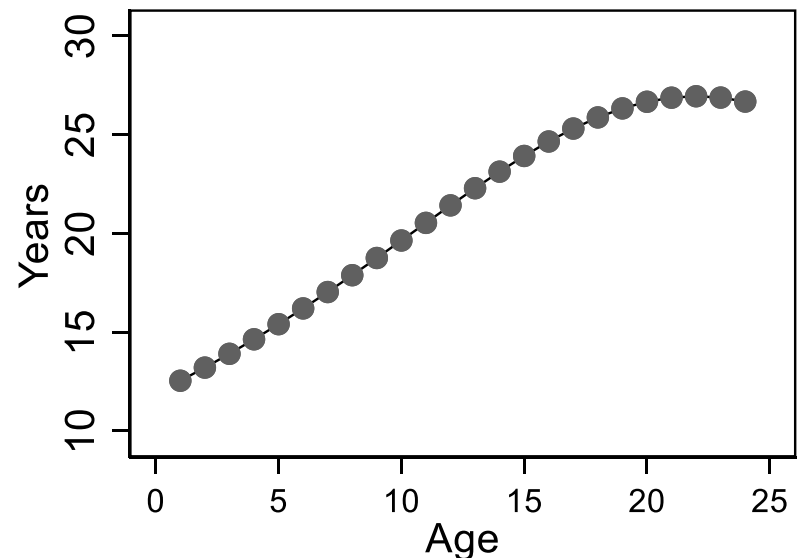
σ- convergence

- Dispersion as σ – convergence indicator is sensitive to outliers

- 90 to 10 ratio (ratio of 90th to 10th percentile of productivity distribution) is more robust to outliers

- According to 90 to 10 ratio the gap between leaders and laggards in Russia is bigger than in OECD countries (Berlingieri et al., 2017)

- In most industries the 90 to 10 ratio increases in 2011-2016 indicating divergence

90 to 10 ratio (log scale)
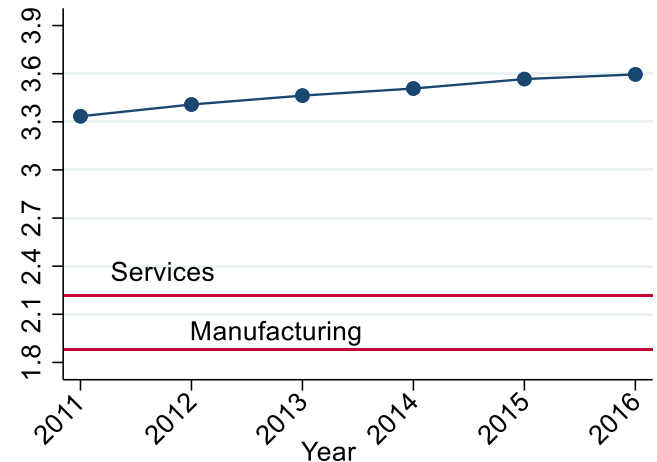
Distribution of industries by 90 to 10 change in 2011-2016
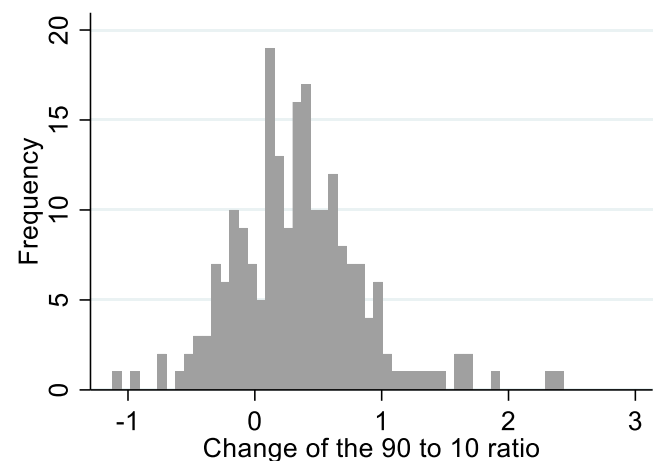
Red lines correspond to estimations of Berlingieri et al. (2017) for several countries

Stochastic frontier model for convergence

Methodology:

- Not all establishments are technically efficient, some operates below the production frontier.

- For each industry we estimate the following production function

$$y_{it} = \beta_0 + \beta_1 l_{it} + \beta_2 k_{it} + \beta_3 l_{it} k_{it} + \beta_4 t + \beta_5 l_{it} t + \beta_6 k_{it} t + \beta_7 l_{it}^2 + \beta_8 k_{it}^2 + \beta_9 t^2 + v_{it} - u_{it} =$$

$$f(k, l, t) + v_{it} - u_{it}$$

$$v_{it} \sim N(0, \sigma_v^2)$$

$$u_{it} \geq 0 - \text{inefficiency term}$$

- Two specifications for inefficiency term

$$u_{it} = G(t)u_i, u_i \sim N^+(0, \sigma_u^2), G(t) = e^{\gamma(t-T)}$$

$$u_{it} = G(t)u_i, u_i \sim N^+(0, \sigma_u^2), G(t) = \left[1 + \exp\left(\sum_{p=2}^{3} \beta_p * G_p + \sum_{j=2013}^{2016} \beta_j * Y_j\right)\right]^{-1}$$

γ – convergence rate, if $\gamma > 0$ establishments converge to the frontier
t – time
T – terminal period
G_p - dummy for size
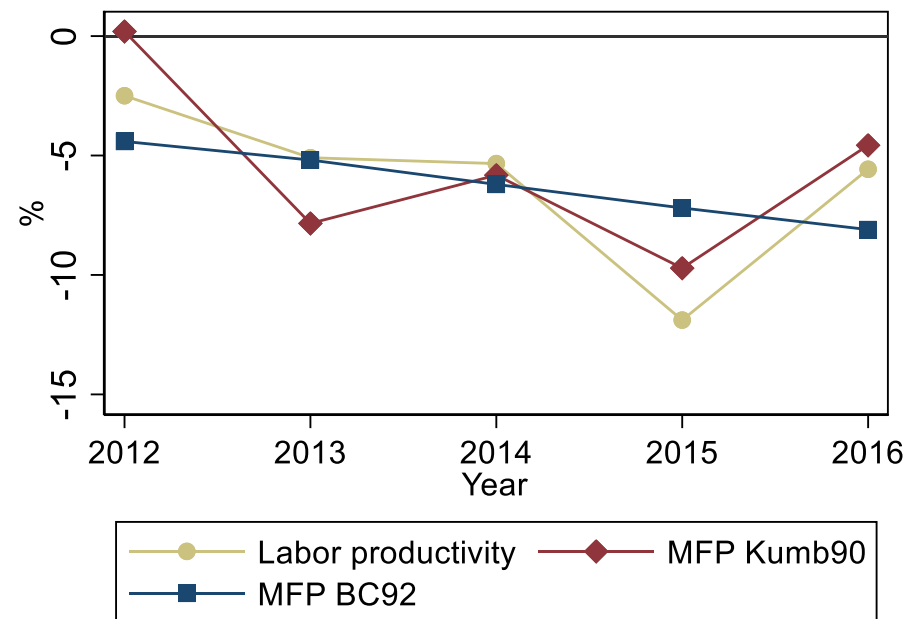Y_j - dummy for year j, $\beta_j < 0$ means increasing gap since the first years

Stochastic frontier models results

- Using stochastic frontier model we estimate the multifactor productivity (MFP) growth

- According to our both specifications MFP growth is close to labour productivity growth

MFP and labour productivity growth estiamtions

Stochastic frontier model results confirm divergence

- Leaders are defined according to their efficiency during the whole period

- According the first specification in 139 out of 173 industries establishments diverge from the frontier, in the rest of the industries the convergence rate is insignificant

- According to the second specification in 97 industries out of 171 the gap in 2016 was wider than in 2011, in 10 industries the gap in 2016 was narrower than in 2011
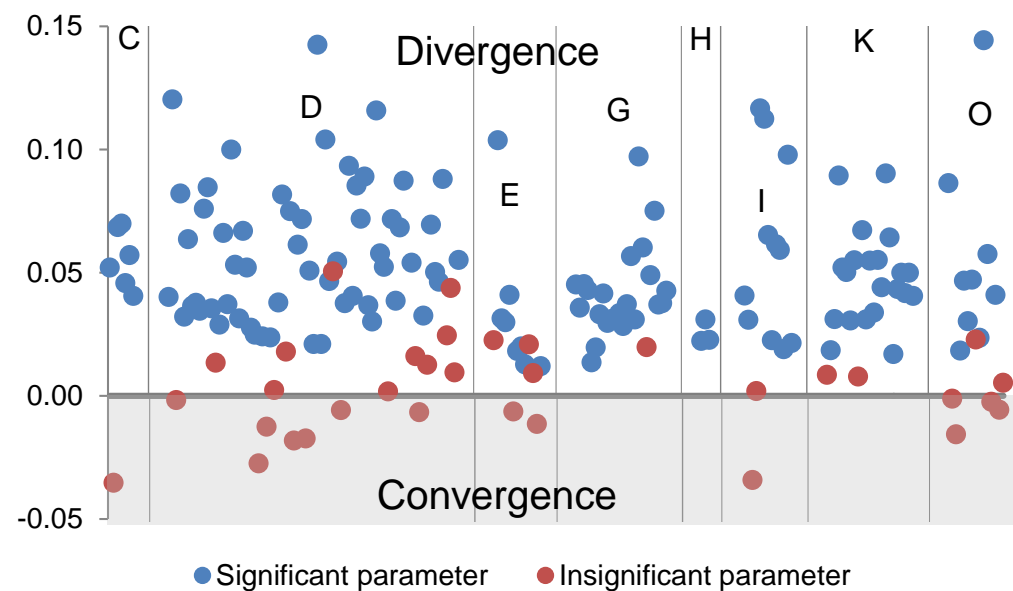
Conclusions

- According to series of studies productivity is highly heterogeneous even within narrowly defined industries.

- Almost in all studies concerning productivity growth and productivity level β-convergence is found. It means that laggards grow faster than leaders. However the gap between these groups remains wide.

- In Russia we confirm these results and show that the catching up process is mostly driven by young firms starting their life. As firms age the catching up impulse dies out soon. In Russia the gap to the frontier is even higher than in other countries.

- As β – and σ –convergence are sensitive to group of leaders/laggards definition, we check our results using stochastic frontier model. According to this model leaders are defined based on the establishment's performance during the whole period. The results confirm the conclusion that in most industries establishments diverge from the frontier.

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