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### The Productivity Gap: Determinants of Productivity and Misallocation Among Foreign and Domestic Firms in Slovakia

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## Motivation

- Has the convergence process stopped ? If yes, then why ? Tradiditonal production factors cannot explain the whole story.
- One of the alternative answers may lies in the allocation of resources.
- What is the role of foreign firms in the aggregate productivity developments ?



#### Slovak GDP p.c. and in PPP as % of EU and EA 19

### Introduction – the model

- Based on Hsieh, Klenow (2009)
  - Monopolistic competition
  - CRS
  - Constant mark-up and elasticity of substitution across sectors
  - Difference between revenue TFP and quantity TFP is crucial
- According to the model high dispersion of revenue productivities (TFPR) negatively affects aggregate TFP
- Dispersion of TFPR is caused by so called *distortions*

# Revenue vs. real productivity (example form Dias, et al. 2015)

Real TFP (hard to measure) 
$$TFPQ_{si} = A_{si} = \frac{Y_{si}}{\left(K_{si}^{\alpha_s} H_{si}^{\beta_s} Q_{si}^{1-\alpha_s-\beta_s}\right)}$$

and

Revenue TFP 
$$TFPR_{si} = P_{si}A_{si} = \frac{P_{si}Y_{si}}{\left(K_{si}^{\alpha_s}H_{si}^{\beta_s}Q_{si}^{1-\alpha_s-\beta_s}\right)}$$



## Economy in the model

- GDP is Cobb-Douglas (aggregating sectoral outputs)
- Sectoral GDP is CES production function (aggregating firm outputs)
- Firms use Cobb-Douglas PF (in this case 3-factor production function)

## Model formally

### Model

### Production functions

- Canonical model of monopolistic competition with heterogeneous firms (based on Melitz (ECTA 2003))
- Final output Y is the aggregation of the output  $Y_{s}$  in several industries:

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s} \quad \text{ with } \theta_s > 0 \text{ and } \sum_{s=1}^{S} \theta_s = 1$$

• Industry output is the aggregation of  $M_{s}$  differentiated products:

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \qquad \text{with} \ \sigma>1$$

(where  $\sigma$  is the elasticity of substitution of the Dixit-Stiglitz aggregator)

• Output of each differentiated product is given by,

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}$$

### Optimization

### Firm i optimization problem

- Firm *i* in sector *s*:
  - hires capital and labor in competitive markets (takes r and w as given)
  - sells output through monopolistic competition (affects own price  $P_{si}$ )
- Optimization problem:

$$\begin{split} \max_{L_{si},K_{si}} \left\{ \left(1-\tau_{Ysi}\right) P_{si}Y_{si} - \left(1+\tau_{Lsi}\right) w \, L_{si} - \left(1+\tau_{Ksi}\right) r \, K_{si} \right\} \\ \text{subject to} \qquad Y_{si} = A_{si}K_{si}^{\alpha_s}L_{si}^{1-\alpha_s} \end{split}$$

$$P_{si} = \bar{Y}_s Y_{si}^{-1/\sigma}$$

• This yields FOC

Distortions

$$MRPK := P_{si} \left(\frac{\sigma - 1}{\sigma}\right) \quad \alpha_s \quad A_{si} \left(\frac{K_{si}}{L_{si}}\right)^{\alpha_s - 1} = \left(\frac{(1 + \tau_{Ksi})}{(1 - \tau_{Ysi})}r\right)$$
$$MRPL := P_{si} \left(\frac{\sigma - 1}{\sigma}\right) (1 - \alpha_s) A_{si} \left(\frac{K_{si}}{L_{si}}\right)^{\alpha_s} = \left(\frac{(1 + \tau_{Lsi})}{(1 - \tau_{Ysi})}w\right)$$

## Misallocation formally

When  $A \equiv \text{TFPQ}$  and TFPR are jointly lognormally distributed, there is a simple closed-form expression for aggregate TFP:

(16) 
$$\log \text{TFP}_s = \frac{1}{\sigma - 1} \log \left( \sum_{i=1}^{M_s} A_{si}^{\sigma - 1} \right) - \frac{\sigma}{2} \operatorname{var} \left( \log \text{TFPR}_{si} \right).$$

In this special case, the negative effect of distortions on aggregate TFP can be summarized by the variance of log TFPR. Intuitively, the extent of misallocation is worse when there is greater dispersion of marginal products.

## Inštitút finančnej politiky Counterfactual allocation purged of distortions

Actual TFP 
$$\operatorname{TFP} = \prod_{s=1}^{S} \operatorname{TFP}_{s}^{\theta_{s}} = \prod_{s=1}^{S} \left[ \left( \sum_{i=1}^{M_{s}} \left( A_{si} \frac{\overline{\operatorname{TFPR}}_{s}}{\overline{\operatorname{TFPR}}_{si}} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}} \right]^{\theta_{s}}$$
(14)

This expression <u>clearly</u> shows how within-industry misallocation of labor and capital yields a lower measured aggregate TFP. To understand how costly are the idiosyncratic distortions one can define the optimal level of TFP (i.e. the TFP level in the absence of firm-specific distortions):

**Optimal TFP** 
$$\mathrm{TFP}^{*} = \prod_{s=1}^{S} \mathrm{TFP}_{s}^{*^{\theta_{s}}} = \prod_{s=1}^{S} \left[ \left( \sum_{i=1}^{M_{s}} \left( A_{si} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}} \right]^{\theta_{s}}$$
(15)

The ratio of optimal TFP to observed TFP (i.e.  $\frac{\text{TFP}^*}{\text{TFP}} - 1$ ) is the potential TFP gain from reallocation that we use in the paper. In particular, we analyze its evolution over time as an indication of the relevance of changes in within sector misallocation to explain the evolution of aggregate TFP growth in Spain.

## Dias et al. (2015) extension

 As emphasized in Dias et al. (2015) instead of setting distortions to zero we calculate the model under the assumptions that after optimal allocation is introduced, firms face identical sector-wide average wedges.

$$TFPR_s^* = \left(\frac{\sum_{i=1}^{M_s} (A_{si})^{\sigma-1}}{K_s^{\alpha_s} L_s^{\beta_s} Q_s^{1-\alpha_s-\beta_s}}\right)^{\frac{1}{\sigma}}$$
(20)

where  $K_s$ ,  $L_s$  and  $Q_s$  are the actual industry levels of the capital stock, labor (personnel costs) and intermediate inputs, respectively.<sup>9</sup> Then sectoral TFP (output) gains can be estimated as follows:

$$\frac{Y_s^*}{Y_s} = \left[\frac{\sum_{i=1}^{M_s} (A_{si})^{\sigma-1}}{\sum_{i=1}^{M_s} (A_{si} \frac{TFPR_s^*}{TFPR_{si}})^{\sigma-1}}\right]^{\frac{\sigma}{\sigma-1}}$$
(21)

and using Cobb-Douglas aggregator, economy-wide TFP gains are given by:

$$\frac{Y^*}{Y} = \prod_{s=1}^{S} \left(\frac{Y^*_s}{Y_s}\right)^{\theta_s} \tag{22}$$

where  $Y_s^*$  and  $Y^*$  denote optimal sectoral and total output, respectively. In the paper we use this modification to calculate the results. We also analyze evolution of TFP gains over time as an indication of the relevance of changes in within sector misallocation to explain the evolution of aggregate TFP growth in Slovakia.

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### Parametrization and the data

- Capital price interest rate to non-financial sector
- Elasticity of substitution = 3
- Depreciation = 5 %
- Sectoral factor shares of labor and intermediate inputs taken from the Eurostat (Germany as a benchmark economy)
- Comprehensive micro firm-level dataset compiled from multiple sources

# I The role of foreign firms in the Slovak economy

	Share (70 of total)										
Sector	foreign firms	turnover	VA	employment	capital						
Agriculture	7.6	12.3	13.5	7.6	12.1						
Construction	7.3	25.5	28.6	13.9	23.3						
Manufacturing	18.2	81.3	75.2	62.9	77.8						
Mining	27.7	45.1	45.3	19.3	61.8						
Services	12.7	43.6	51.5	33.8	51.7						
Trade	20.7	49.5	51.4	37.0	47.5						
Transport	17.2	39.2	26.2	23.5	3.9						

Table 1: Foreign firms demographics

Share (% of total)

- Foreign firms dominate in every area: on average, they are bigger, more capital intensive, have higher intangibles share, are more productive and employ lower share of low skilled workers.
- Additionally, labor productivity and capital intensity are more than two-times higher

# I The role of foreign firms in the Slovak economy

Variables	Ν	Mean s.d.		$\mathbf{Min}$	Max							
Foreign												
Employment	18,329	28.31	215.3	0	13,024							
Intangibles share	9,468	0.0491	0.180	0	1							
VA per worker	9,724	44,333	311,915	0	2.811e+07							
Labor share	15,038	0.718	4.629	0	334.5							
Share low skill	9,724	0.197	0.312	0	1							
Capital per worker	9,724	71,132	0	8.014e + 07								
Domestic												
Employment	125,528	5.652	72.31	0	15,779							
Intangibles share	69,282	0.0191	0.118	0	1							
VA per worker	78,371	$18,\!580$	47,493	0	3.835e + 06							
Labor share	111,228	1.037	27.76	0	6,628							
Share low skill	78,371	0.355	0.395	0	1							
Capital per worker	78,371	26,614	233,438	0	2.708e + 07							

Table 2: Selected summary statistics (2017)

# I The role of foreign firms in the Slovak economy





Note: Labor input measured as personnel costs. Firms with 10 and more employees. X-axis in ln(TFPQ).

### Results

Figure 3: Baseline TFP gains in %



Note: Labor input measured as personnel costs. Firms with 10 and more employees.

Figure 4: Sectoral TFP gains in %



Note: Labor input measured as personnel costs. Firms with 10 and more employees. Average over 2013-2017.

### Results

Figure 5: Sectoral TFP gains in % - Domestic vs. for eign firms



Note: Labor input measured as personnel costs. Firms with 10 and more employees. Average over 2013-2017.

## TFPR regression methodolgy

- Control function approach regressions run sector by sector
- Cobb-Douglas specification
- $\ln(Output_{sit}) = \alpha_{sit} + \beta_1 \ln(wL_{sit}) + \beta_2 \ln(capital_{sit}) + \beta_3 \ln(inter\_inp_{sit}) + \delta_t + \vartheta_{sit} + \varepsilon_{sit}$
- 3-digit NACE sector (all active firms)
- $\vartheta_{sit}$  unobservable productivity (TFPR)
- The main idea behind the method is to identify  $\vartheta_{sit}$  , such that it is different from  $\varepsilon_{sit}$

### **Regression results**

- Foreign firms productivity premium up to 50 % (labor productivity), up to 10 % (TFP). Foreign firms are also bigger and more capital intensive.
- Tougher regulation leads to slower TFP growth/level
- Intangibles and human capital positively affects labor productivity (some TFP inconsistencies)
- Larger firms more productive than smaller ones.
- ALMP, EU funds and public procurement inconsistent or negligible effects

### **Regression results**

Table 7: Firm TFPR regressions, TFPR level

VARIABLES	(1) Unbalanced	(2) Balanced	(3) Balanced - growth	(4) 14/17	(5) 14/17	(6) 14/17	(7) 14/17	(8) 14/17	$(9) \\ 14/17$	(10) 14/17	(11) 14/17	(12) 14/17	(13) 14/17
Foreign	$0.0273^{***}$	0.110***	-0.0252*	,	,	,	,	,	,	,	,	,	0.131***
Reg. impact (wide)	(0.00031)	(0.00031)	(0.0130)	-0.192**									-0.163**
Public				(0.0833)	0.188***								(0.0814) $0.108^{***}$
Intabgibles share					(0.0359)	0.0227							(0.0249) $0.101^{***}$
Mark up						(0.0240)	0.546***						(0.0200) $0.482^{***}$
Human capital							(0.00402)	0.0332***					(0.00724) -0.0126**
Temporary employment								(0.00618)	-0.156***				(0.00552) - $0.156^{***}$
ALMP									(0.00753)	0.144***			(0.00707) $0.138^{***}$
Public sales										(0.00588)	0.000933***		(0.00471) 0.000460 (0.00156)
EU share											(0.000225)	0.0550	(0.00156) -0.00893
Constant	$2.912^{***}$ (0.0325)	$2.784^{***}$ (0.0311)	-0.103 (0.0751)	3.242*** (0.0303)	$3.216^{***}$ (0.0265)	$3.190^{***}$ (0.0255)	$3.191^{***}$ (0.0229)	$3.161^{***}$ (0.0257)	$3.174^{***}$ (0.0257)	$3.112^{***}$ (0.0262)	3.227*** (0.0264)	(0.0935) $3.212^{***}$ (0.0264)	(0.0594) 2.979*** (0.0260)
Observations	172,907	37,078	37,024	85,675	125,374	94,015	125,374	92,811	92,811	98,376	125,374	98,376	57,136
R-squared	0.511	0.847	0.017	0.674	0.603	0.665	0.818	0.701	0.703	0.695	0.603	0.693	0.869
Sector FE Size	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES	YES YES
			- 2000	Robus	st standard	errors in par	rentheses	- 1910					

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Note: Impact of regulation is measured as average over the years 2010 - 2013. OECD will issue updates for its market regulation indicators later in 2019. Regulatory impact indicator taken from the OECD market regulation database - REGIMPACT indicator. ALMP is a dummy variable indicating whether a firm participated in labor market policy program in 2014. EU and public sales shares are calculated as ratios of EU financing and public contract to firm sales in 2014. Mark up - log change of mark up calculated as in De Loecker and Eeckhout (2018). Dependent variable is TFPR level. Columns 14/17 that all continuous variables are averaged over the period of 2014 - 2017.

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### **Regression results**

Table 8: Firm regressions, labor productivity, lev	el
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VARIABLES	(1) Level VA	(2) Level VA	(3) Level VA	(4) Level VA	(5) Level VA	(6) Level VA	(7) Level VA	(8) Level VA	(9) Level VA	(10) Level VA	(11) Level VA	(12) Level VA
Capital intensity	0.0987***											0.112***
Reg. impact (wide)	(0.000952)	-0.497***										(0.00182) -0.366**
Foreign		(0.175)	0.524***									(0.174) $0.473^{***}$
Public			(0.0124)	0.0340								(0.0129) -0.0436
Intabgibles share				(0.0543)	0.211***							(0.0549) $0.624^{***}$
Mark up					(0.0414)	0.263***						(0.0444) $0.457^{***}$
Temporary employment						(0.00892)	-0.354***					(0.0157) - $0.149^{***}$
Human capital							(0.0174)	0.379***				(0.0233) $0.384^{***}$
ALMP								(0.0126)	-0.000659			(0.0154) - $0.0640^{***}$
Public sales									(0.0126)	0.00278***		(0.0114) $0.00879^{**}$
EU share										(0.000509)	-0.707**	(0.00383) -0.800***
Constant	9.017*** (0.0371)	$10.04^{***}$ (0.0493)	$9.636^{***}$ (0.0373)	$9.907^{***}$ (0.0383)	$9.953^{***}$ (0.0378)	$9.906^{***}$ (0.0373)	$9.919^{***}$ (0.0383)	$9.816^{***}$ (0.0377)	$9.942^{***}$ (0.0398)	$9.909^{***}$ (0.0383)	(0.314) $9.944^{***}$ (0.0385)	(0.195) 8.663*** (0.0485)
Observations R-squared Sector FE Size	85,501 0.261 YES YES	60,968 0.147 YES YES	85,501 0.168 YES YES	85,501 0.148 YES YES	70,037 0.147 YES YES	85,501 0.168 YES YES	85,501 0.154 YES YES	85,501 0.159 YES YES	70,924 0.149 YES YES	85,501 0.148 YES YES	70,924 0.149 YES YES	52,163 0.296 YES YES

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Note: Impact of regulation is measured as average over the years 2010 - 2013. OECD will issue updates for its market regulation indicators later in 2019. Regulatory impact indicator taken from the OECD market regulation database - REGIMPACT indicator. ALMP is a dummy variable indicating whether a firm participated in labor market policy program. EU and public sales shares are calculated as ratios of EU financing and public contract to firm sales in 2014. Mark up - log of mark up calculated as in De Loecker and Eeckhout (2018). Dependent variable is log of labor productivity (value added divided by number of employees). All continuous variables are averaged over the period of 2014-2017.

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### Conclusion – policy implications

### Allocative efficiency

- Entry and exit barriers time and administrative burdens on firms
- Size-contingent and tax regulations
- Energy prices deregulation
- Court efficiency and rule of law enforcement (commercial cases)

### TFP and labor productivity levels

- Skills and education
- Investment policy (aid) and technology transfer
- Capital intensity
- Domestic firms far behind the foreigns ones
- Convergence not possible without foreign MNCs ?