Resource misallocation in European firms: The role of constraints, firm characteristics and managerial decisions*

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*The views expressed are those of the authors and do not reflect those of the European Investment Bank.

Outline

1. Motivation and research question
2. Preview of main findings
3. Profit maximization model yielding MRPK and MRPL
4. Data: EIB Investment Survey and Orbis
5. Empirical model and estimates
6. Machado-Mata decomposition
7. Conclusion

Motivation and research question (1/2)

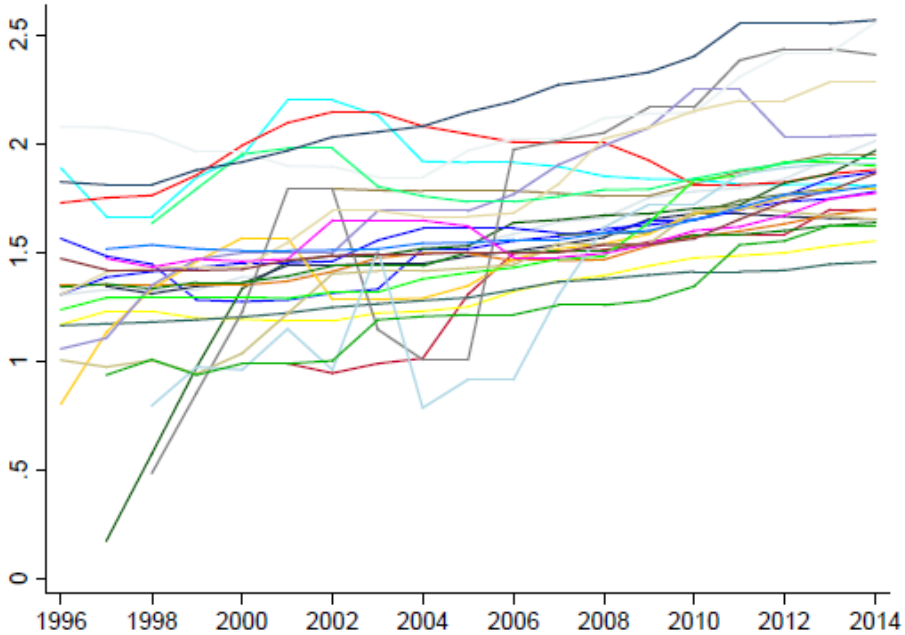
- What are the sources of the dispersion in
  - income per capita across countries?
  - productivity (level and growth) across countries and firms?
  - marginal revenue products of capital and labor across firms?
- Recent slowdown in productivity growth in the US, EU and other developed economies
- Need to identify impediments to productivity increases: rising misallocation of resources could be one explanation

Motivation and research question (2/2)

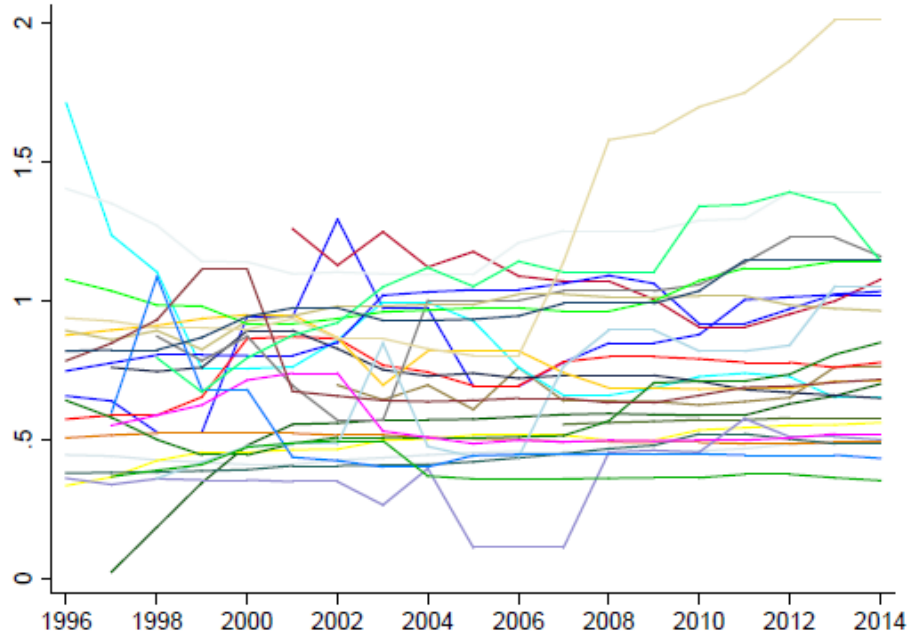
- By reallocating capital and labor to firms that perform better, the economy can increase productivity and output
- In a perfectly functioning spot market economy, cost-minimizing firms face identical input prices and MRPK and MRPL should be equalized across firms
- Previous research successful in measuring the dispersion of marginal products and assessing potential gains from better allocation of resources: e.g. Hsieh and Klenow (2009, QJE), Bartelsman et al. (2013, AER), Gopinath et al. (2017, QJE), Restuccia and Rogerson (2017, JEP)
- But little about *why* firms have different marginal products

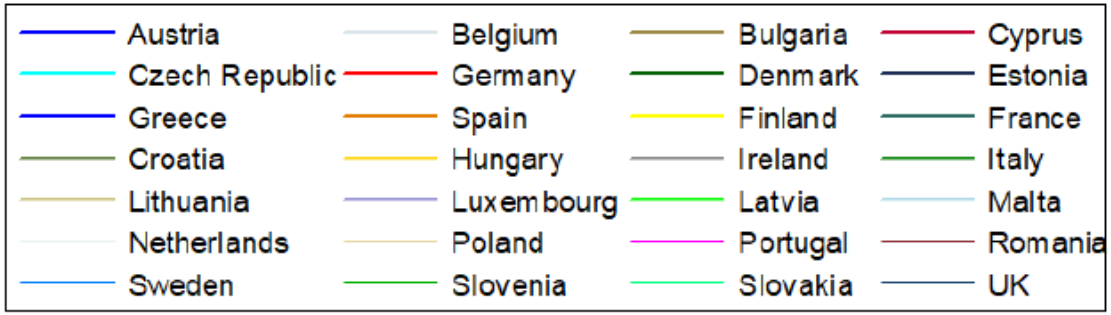
Increasing dispersion of MRPK over time, by country

Panel A. Marginal revenue product of capital (MRPK)



Panel B. Marginal revenue product of labor (MRPL)

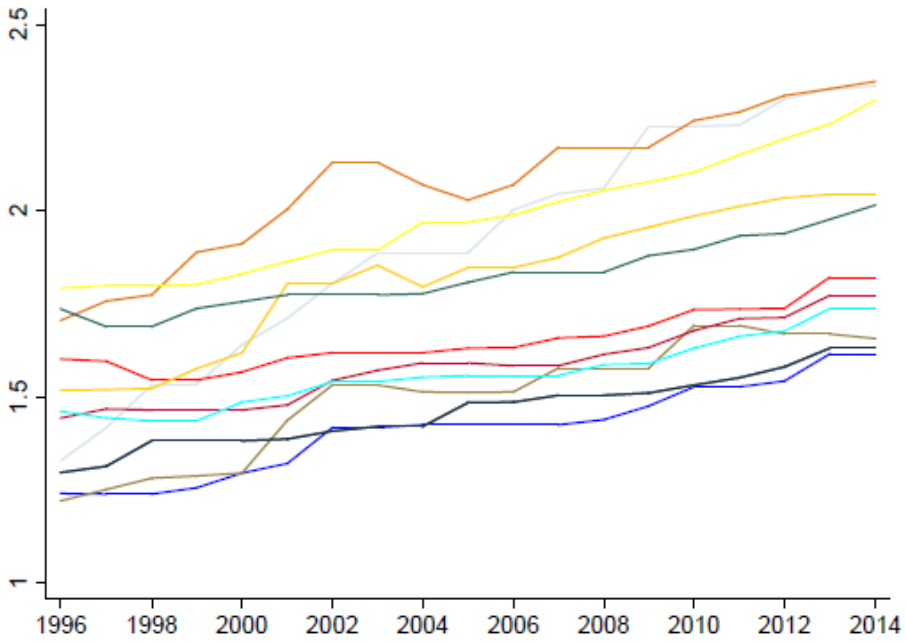




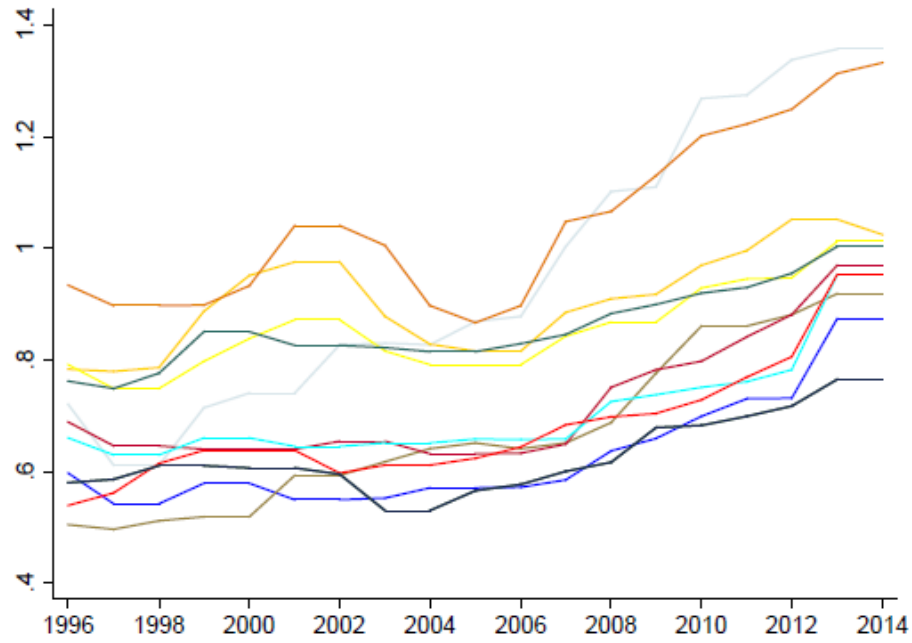
Note: The figure plots time series (3-year moving median) of the standard deviation of the logarithm of the marginal revenue product of capital (MRPK) and labor (MRPL) for each country using data on firms in Orbis. The dispersion is computed after projecting MRPK and MRPL on country × industry fixed effects (industry at 2-digit NACE).

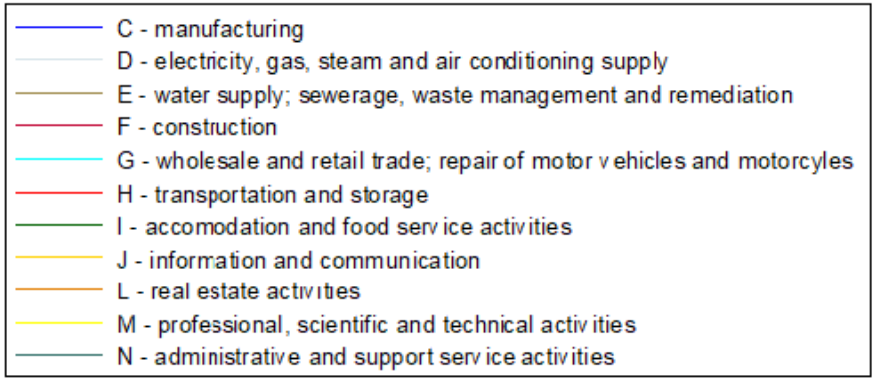
Increasing dispersion of MRPK and MRPL, by industry

Panel A. Marginal revenue product of capital (MRPK)



Panel B. Marginal revenue product of labor (MRPL)





Notes: The figure plots time series (3-year moving median) of standard deviation of log marginal revenue product of capital (MRPK) and labor (MRPL) for each country. The dispersion is computed after projecting log marginal revenue products on country × industry fixed effects (industry at 2-digit NACE).

Preview of main findings (1/4)

- Use cross-sectional data of EIB Investment Survey (EIBIS) and Orbis on 28 EU countries
- Estimate the dispersion of MRPK and MPRL within the EU and individual countries: to understand integration within EU common market
- Discuss whether the dispersion is driven by country or sector fixed effects, as opposed to firm-specific characteristics
- Perform Machado-Mata decomposition to construct counterfactual distributions of MRPK and MRPL for each country using the endowments (X) or how they are "priced" into outcomes (β in a regression framework) for firms in Greece and Germany

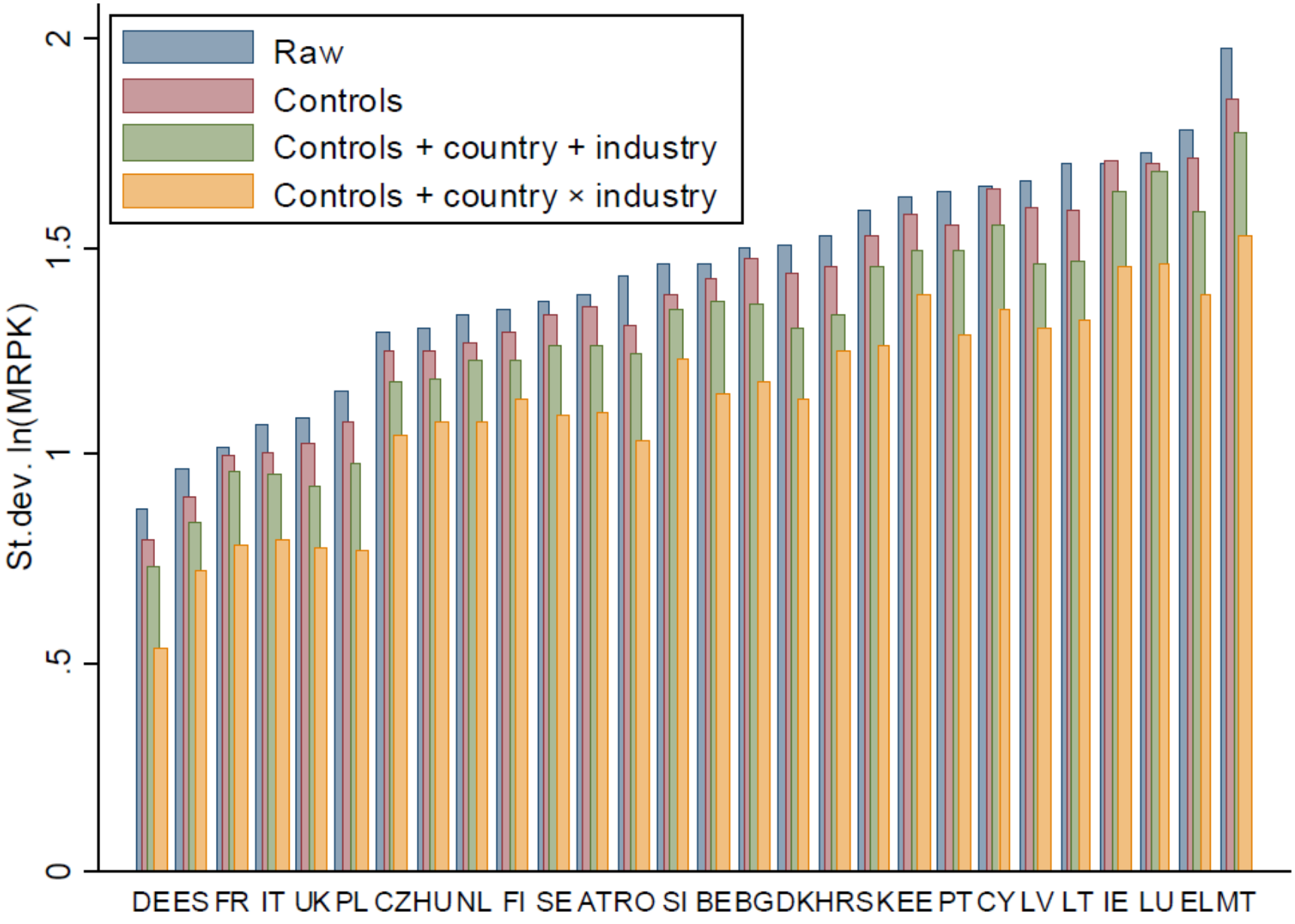
Preview of main findings (2/4)

- We find that there is a sizable dispersion of marginal products measured across all the firms in the EU
- Differences in the levels of MRPL are higher across countries than across industries
  - opposite for MRPK
  - national regulations and language barriers play an important part in the efficiency of resource allocation within the EU

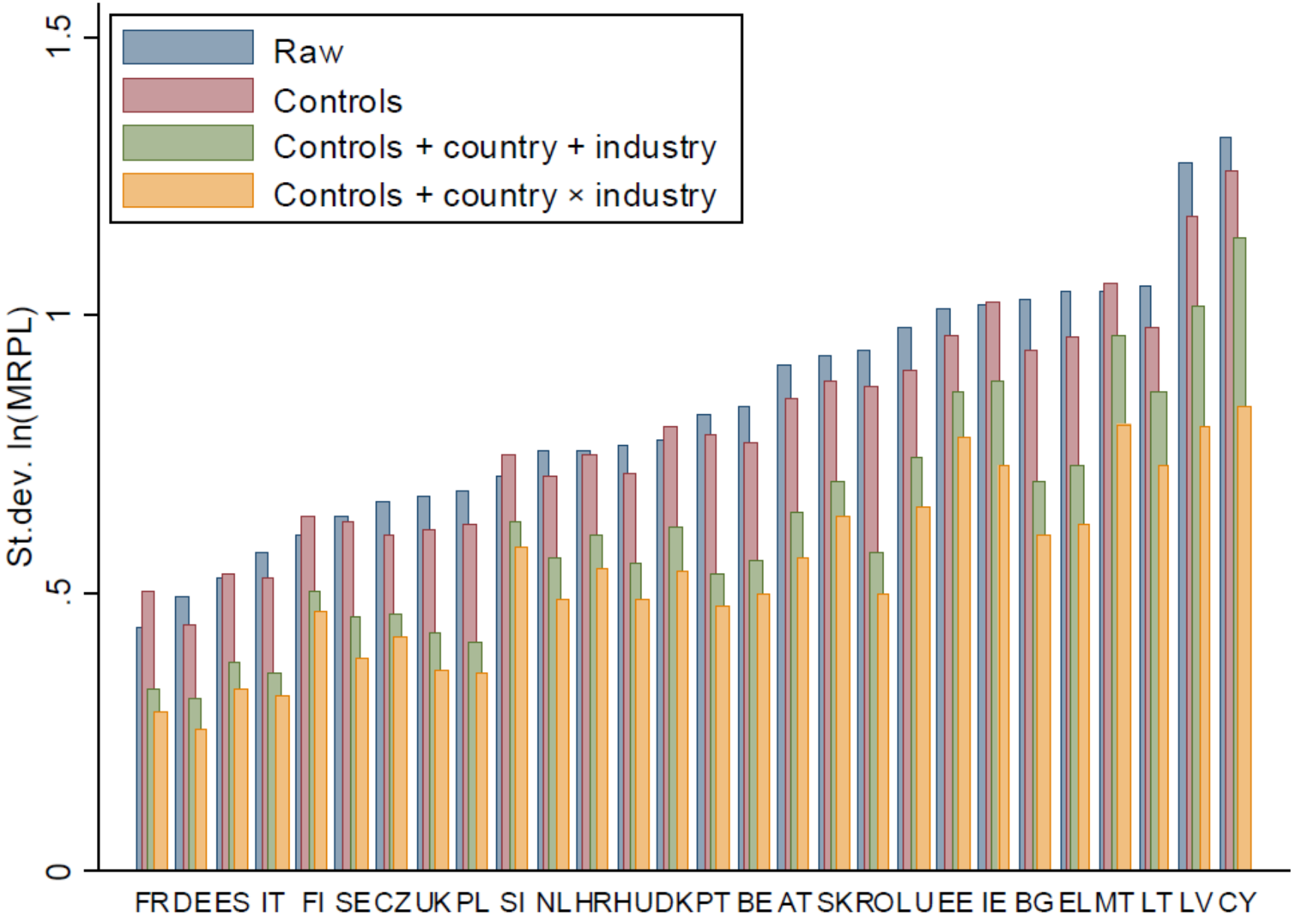
Preview of main findings (3/4)

- Firm-level characteristics account for 11% of the total variation in MRPK and 27% of the variation in MRPL
  - significant association of marginal revenue products with firm demographics, quality of inputs, utilization of resources, and dynamic adjustment of inputs
  - contribution of perceived constraints (or barriers) to investment more modest
- No exogenous variation
  - but predictive power of regressors sheds light on what factors are quantitatively important
  - and where future work could concentrate efforts to estimate causal effects

Firm characteristics account for 11% of variation in MRPK



Firm characteristics account for 27% of variation in MRPL



Preview of main findings (4/4)

- Using Machado-Mata decomposition we document that cross-country variation in the dispersion of marginal revenue products is largely brought about by
  - differences in the regression coefficients - reflecting how a countrys business, institutional and policy environment prices firm characteristics
  - rather than by differences in the ("endowments" of) firm characteristics
- We argue this result is important because it provides large-scale *microeconomic* evidence that institutions matter

Machado-Mata decomposition

Firm characteristics X	Prices β	St. dev. log(MRPK)	St. dev. log(MRPL)
Germany	Germany	0.98	0.46
Greece	Greece	1.81	0.77
Germany	Greece	2.37	0.86
Greece	Germany	1.08	0.52

- German business, institutional and policy environment help improve the equalization of returns across firms
- Variation of firm characteristics in Germany is greater than in Greece
- When combined with the Greek "prices", dispersion of MRPK and MPRL wider than the one actually observed in Greece

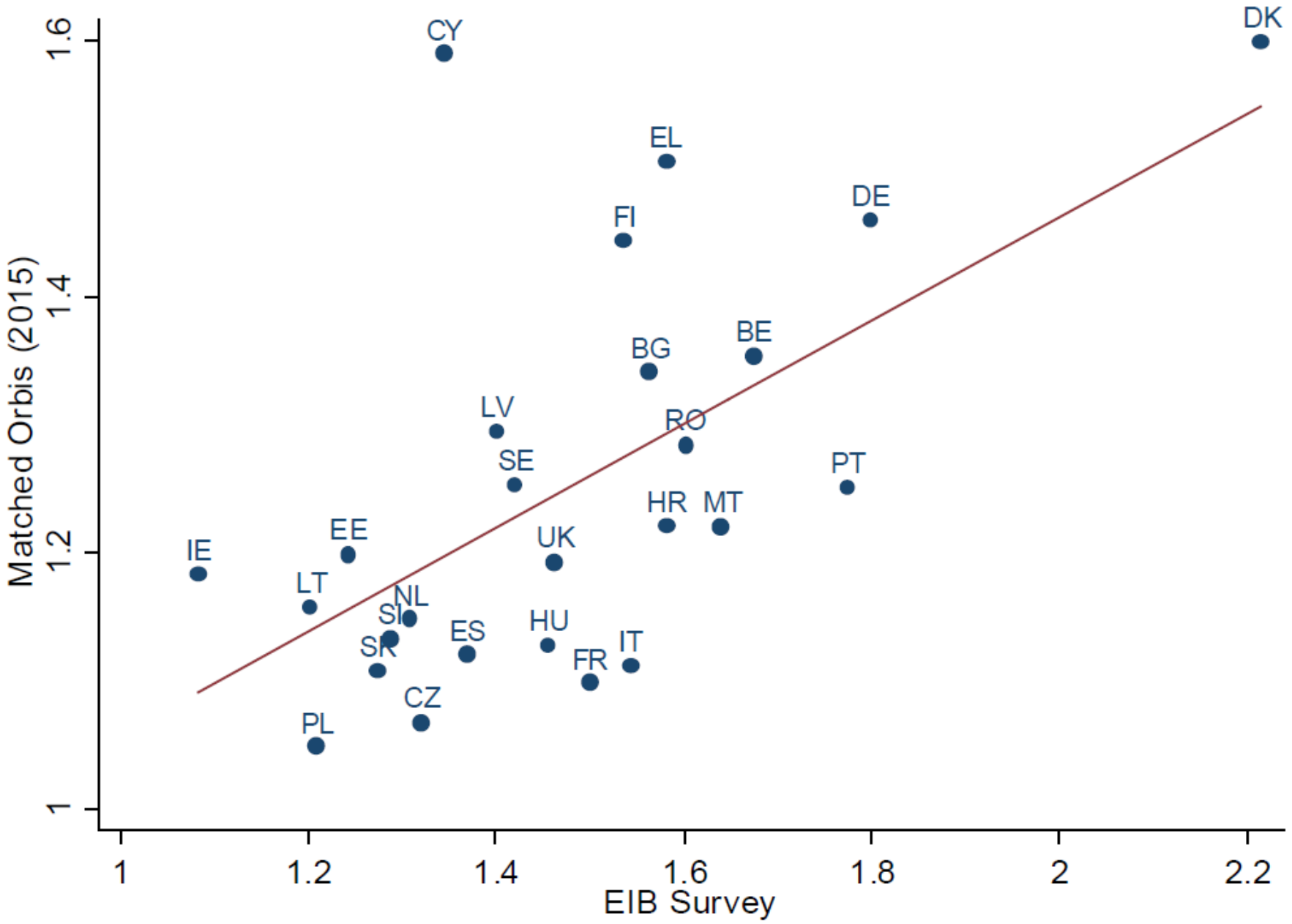
Data: EIB Investment Survey and Orbis (1/2)

- EIBIS: 12,483 non-financial enterprises in all 28 EU countries in NACE categories C to J
- An enterprise is defined as a company trading as its own legal entity: branches excluded from the target population but the definition is broader than a typical enterprise survey given that some company subsidiaries are their own legal entities
- Orbis dataset of Bureau van Dijk used as the sampling frame
- Interviews of senior persons with responsibility for investment decisions and how they are financed
  - Administrated by telephone using computer-assisting phone interviewing (CATI) in July to November 2016 (vast majority in August and September)

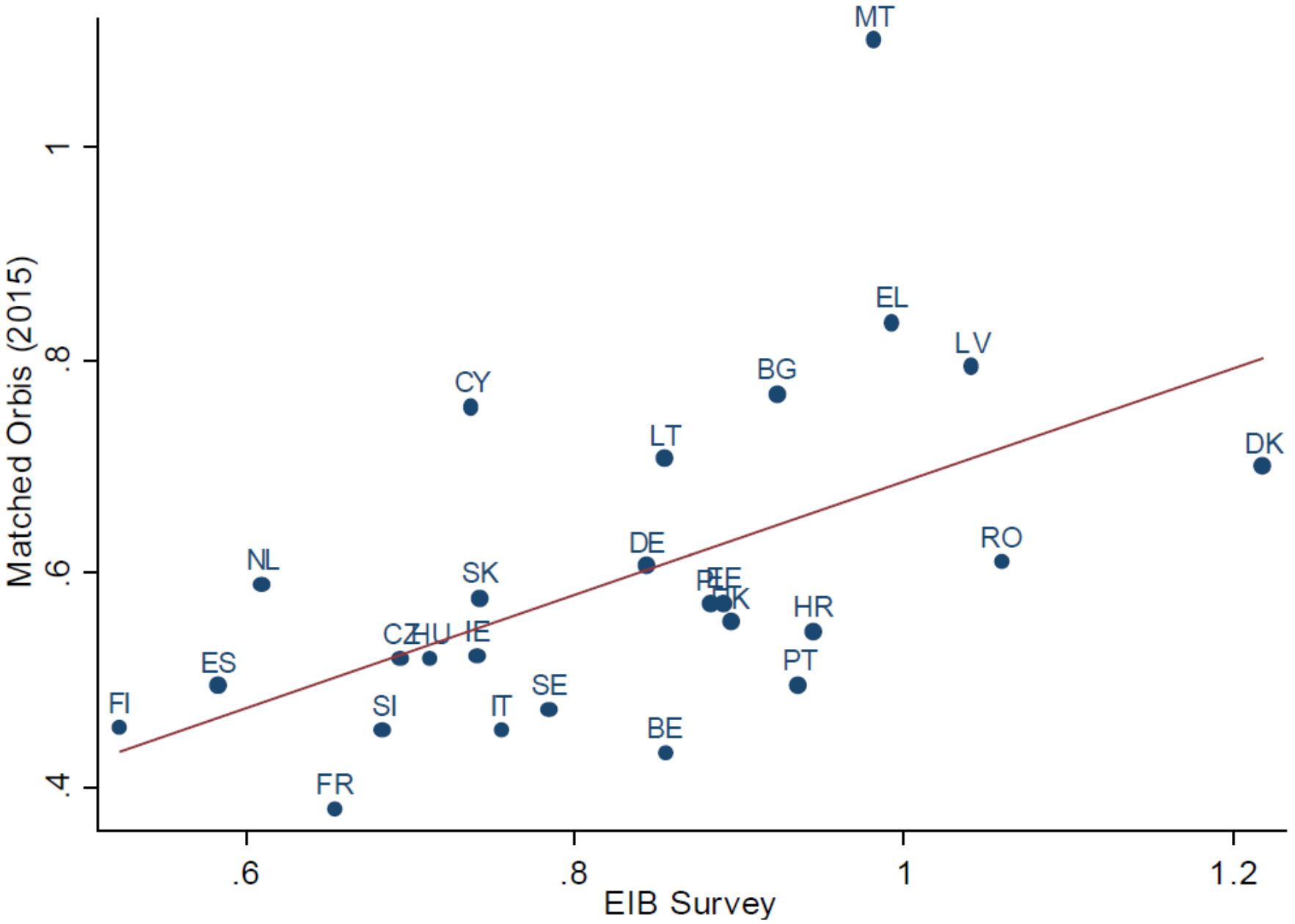
Data: EIB Investment Survey and Orbis (2/2)

- EIBIS sample stratified disproportionally by country, industry group (sector) and size-class, and stratified proportionally by region within the country
- The sample size ranges from 150 enterprises in Cyprus and Luxembourg to 622 in Italy
- The minimum number of employees is 5, with full-time and part-time employees being counted as one employee, and employees working less than 12 hours per week excluded
- We check the validity of EIBIS with Orbis and the correlation coefficient is
  - 0.80 for log sales
  - 0.82 for log fixed assets
  - 0.83 for number of employees

Dispersion of MRPK in EIBIS and Orbis (raw correl. 0.64)



Dispersion of MRPL in EIBIS and Orbis (raw correl. 0.78)



Explanatory variables in the regression analysis

- We use EIBIS questions on
  - basic demographics (age, size, subsdiary status, exporter status)
  - capacity utilization and quality of capital stock
  - obstacles to long-term investment
  - dynamic adjustments (investment rate, employment growth, investment plans)
  - sources of finance (share of internal vs. external finance, credit constraint)

Estimates of cost shares

- EIBIS does not collect information on cost shares; we use Orbis data and national statistics to construct cost shares
- Labor share: $s_{it}^{L} = \frac{\text{cost of employees}_{it}}{\text{cost of goods sold}_{it}}$
- Cost shares need to be between 0 and 1
- Capital share: $s_{it}^{K} = 1 - s_{it}^{L} - \frac{\text{material costs}_{it}}{\text{costs of goods sold}_{it}}$
- To minimize measurement error, we use an average of the cost shares over the 2000-2015 period or a subset of this period if information is available for fewer years
- When data on labor costs or material costs are missing in Orbis, we use OECD STAN or Eurostat SBS at the level of the country, year and industry (NACE 2 digit)

Descriptive statistics, employment sampling weights (1/3)

	Mean	St. dev.
Outcome variables		
log(sales)	16.36	2.26
log(fixed assets)*	15.16	2.74
log(employment)	4.61	1.93
log(MRPK)*	-0.14	1.44
log(MRPL)	10.15	0.93
Demographics		
Firm age		
less than 5 years	0.03	0.18
5-9 years	0.09	0.28
10-19 years	0.22	0.41
20+ years	0.67	0.47
Subsidiary	0.30	0.46
Exporter	0.49	0.50
Quality of capital		
Share of state-of-the art machinery and equipment	0.42	0.32
Share of high energy efficiency commercial building stock	0.37	0.33
Capacity utilization		
above maximum capacity	0.05	0.22
at maximum capacity	0.44	0.50
somewhat below full capacity	0.38	0.49
substantially below full capacity	0.10	0.29
Sample size (* $n = 8,164$)	9,202	9,202

Descriptive statistics, employment sampling weights (2/3)

	Mean	St. dev.
Obstacles to investment		
Demand for products or services		
Major	0.26	0.44
Minor	0.23	0.42
Availability of staff with the right skills		
Major	0.40	0.49
Minor	0.29	0.45
Energy costs		
Major	0.21	0.41
Minor	0.32	0.47
Access to digital infrastructure		
Major	0.11	0.31
Minor	0.25	0.43
Labor market regulations		
Major	0.29	0.45
Minor	0.30	0.46
Business regulations and taxation		
Major	0.31	0.46
Minor	0.28	0.45
Availability of adequate transport infrastructure		
Major	0.15	0.35
Minor	0.24	0.43
Availability of finance		
Major	0.25	0.43
Minor	0.21	0.41
Uncertainty about future		
Major	0.40	0.49
Minor	0.31	0.46
Sample size	9,202	9,202

Descriptive statistics, employment sampling weights (3/3)

	Mean	St. dev.
Adjustment		
Investment, log(1 + investment)	11.96	4.18
Percent change in employment in the last three years	0.14	0.55
Investment over the last three years		
too much	0.03	0.18
about the right amount	0.78	0.41
too little	0.17	0.38
company did not exist three years ago	0.00	0.02
Investment priority in the next three years		
replacing capacity	0.41	0.49
capacity expansion for existing products or services	0.24	0.43
developing new products, processes or services	0.24	0.43
no investment planned	0.10	0.30
Source of funds		
internal funds or retained earnings	0.66	0.37
external finance	0.32	0.36
intra-group funding	0.02	0.13
Finance constrained	0.07	0.26
Sample size	9,202	9,202

Empirical model and estimates

The theoretical dynamic model of profit maximizing firm yields

$$MRPK_{it} \approx s_i^K \frac{Y_{it}}{K_{it}}$$

$$MRPL_{it} \approx s_i^L \frac{Y_{it}}{L_{it}}$$

The empirical model uses cross-sectional data and

$$\log\left(MRPK_{isc}\right) = \log\left(s_{isc}^K\right) + \log\left(\frac{Y_{isc}}{K_{isc}}\right)$$

$$\log\left(MRPK_{isc}\right) = \psi_c + \kappa_s + X_{isc}\beta + \varepsilon_{isc}$$

where subscripts i, s, and c index firms, sectors and countries, ψ_c is the set of country fixed effects, κ_s is the set of industry fixed effects and X_{isc} is the vector of explanatory variables

Empirical strategy

- Identification
  - similar to Mincerian wage equation
  - estimates not causal relationships
- Estimation
  - Huber robust regression
  - with country $\times$ industry fixed effect (NACE 2-digit)
  - observations weighted so that the sample is representative of the population (Eurostat SBS) in terms of employment
- Inference
  - standard errors clustered by country and industry

Predictors of the dispersion of MRPK and MRPL (1/6)

	log(MRPK)	log(MRPL)
Demographics		
Firm age (omitted category: less than 5 years)		
5-9 years	-0.001	0.103***
	(0.075)	(0.032)
10-19 years	-0.204***	0.117***
	(0.063)	(0.029)
20+ years	-0.356***	0.131***
	(0.063)	(0.027)
log(employment)	0.027**	0.004
	(0.010)	(0.005)
Subsidiary	0.448***	0.110***
	(0.037)	(0.016)
Exporter	0.115***	0.180***
	(0.033)	(0.014)
Sample size	8,164	9,202

Predictors of the dispersion of MRPK and MRPL (2/6)

	log(MRPK)	log(MRPL)
Quality of capital and other inputs		
Share of state-of-the art machinery and equipment	-0.160***	0.096***
	(0.045)	(0.019)
Share of high energy efficiency commercial building stock	-0.182***	-0.005
	(0.041)	(0.016)
Capacity utilization (omitted category: somewhat below full capacity)		
above maximum capacity	0.319***	0.139***
	(0.055)	(0.025)
at maximum capacity	0.058**	0.026**
	(0.028)	(0.011)
substantially below full capacity	-0.280***	-0.093***
	(0.043)	(0.017)
Sample size	8,164	9,202

Predictors of the dispersion of MRPK and MRPL (3/6)

	log(MRPK)	log(MRPL)
Obstacles to investment (omitted category: not an obstacle at all)		
Demand for products or services		
Major	0.141***	0.041***
	(0.034)	(0.014)
Minor	0.117***	0.038***
	(0.029)	(0.013)
Availability of staff with the right skills		
Major	0.042	-0.036***
	(0.035)	(0.014)
Minor	0.028	0.018
	(0.034)	(0.014)
Energy costs		
Major	-0.115***	-0.062***
	(0.036)	(0.015)
Minor	-0.135***	-0.011
	(0.031)	(0.014)
Access to digital infrastructure		
Major	0.084**	0.035**
	(0.043)	(0.016)
Minor	0.001	0.006
	(0.032)	(0.014)
Sample size	8,164	9,202

Predictors of the dispersion of MRPK and MRPL (4/6)

	log(MRPK)	log(MRPL)
Obstacles to investment (omitted category: not an obstacle at all)		
Labor market regulations		
Major	-0.053	-0.098***
	(0.036)	(0.014)
Minor	0.024	-0.050***
	(0.032)	(0.013)
Business regulations and taxation		
Major	-0.087**	0.005
	(0.037)	(0.014)
Minor	-0.017	-0.005
	(0.034)	(0.015)
Availability of adequate transport infrastructure		
Major	0.007	0.070***
	(0.037)	(0.016)
Minor	0.028	0.015
	(0.032)	(0.013)
Availability of finance		
Major	-0.008	-0.047***
	(0.035)	(0.015)
Minor	-0.034	-0.023
	(0.033)	(0.014)
Uncertainty about future		
Major	0.024	0.024*
	(0.035)	(0.014)
Minor	-0.004	0.004
	(0.034)	(0.015)
Sample size	8,164	9,202

Predictors of the dispersion of MRPK and MRPL (5/6)

	log(MRPK)	log(MRPL)
Adjustment		
Investment, log(1 + investment)	-0.058***	0.030***
	(0.005)	(0.002)
% change in employment in last three years	0.072***	-0.075***
	(0.023)	(0.009)
Investment over last three years (omitted category: about the right amount)		
too much	-0.283***	-0.083***
	(0.060)	(0.024)
too little	-0.111***	-0.024*
	(0.031)	(0.013)
company did not exist three years ago	-0.996**	-0.601***
	(0.451)	(0.159)
Investment priority in next three years (omitted category: no investment planned)		
replacing capacity	-0.108**	0.007
	(0.047)	(0.019)
capacity expansion for existing products or services	-0.126***	0.001
	(0.049)	(0.021)
developing new products, processes or services	-0.030	0.038*
	(0.050)	(0.021)
Sample size	8,164	9,202

Predictors of the dispersion of MRPK and MRPL (6/6)

	log(MRPK)	log(MRPL)
Source of funds (omitted category: external finance)		
internal funds or retained earnings	0.152***	0.055***
	(0.038)	(0.016)
intra-group funding	-0.160	0.135***
	(0.113)	(0.051)
Credit constrained	-0.104**	-0.083***
	(0.045)	(0.019)
Sample size	8,164	9,202
R^2	0.477	0.777
Memorandum:		
R^2 with country $\times$ industry fixed effects and no X	0.430	0.746
R^2 with X and no fixed effects	0.112	0.271
R^2 with X and country fixed effects	0.176	0.674
R^2 with X and industry fixed effects	0.209	0.313
R^2 with X and country and industry fixed effects	0.275	0.699
R^2 with X and slopes varying by country	0.538	0.731
R^2 with X and slopes varying by industry	0.545	0.600

Compensating differentials vs. distortions

- Variables measuring firm demographics, dynamic adjustment of inputs, and source of funds have robust predictive power
- The contribution of "obstacles" variables is more modest: many coefficients not statistically significant
- The group of variables "quality of capital", "capacity utilization" and "adjustment" could reflect compensating differentials and firm policies
- The group of variables "demographics", "obstacles to investment" and "source of funds" could reflect constraints, distortions and the business environment
- Predictive power is similar for the two groups of variables

Quantify the magnitude of eliminating distortions (1/6)

To quantify the magnitudes of gains that one could obtain by eliminating constraints and distortions, we use the Hsieh-Klenow insight that (log) productivity losses due to misallocation of resources may be approximated with

$$\frac{\sigma}{2} var\left(\alpha_i \log\left(MRPK_i\right) + \beta_i \log\left(MRPL_i\right)\right)$$

Hsieh and Klenow (2009) assume that there are no distortions in inputs other than capital, while we allow for distortions in the utilization of labor (but we assume that there are no distortions in the allocation of material inputs)

Quantify the magnitude of eliminating distortions (2/6)

Assuming constant elasticities in the production function ($\alpha_i = \alpha$ and $\beta_i = \beta$ for all firms) and using $s^K \propto \alpha$ and $s^L \propto \beta$

$$\sigma/2 var\left(\alpha \log\left(MRPK_i\right) + \beta \log\left(MRPL_i\right)\right) \approx$$
$$\sigma/2\left[\left(s^K\right)^2 var\left(\log\left(MRPK_i\right)\right) + \left(s^L\right)^2 var\left(\log\left(MRPL_i\right)\right)\right]$$
$$+\sigma s^K s^L \rho_{KL} \sqrt{var\left(\log\left(MRPK_i\right)\right) var\left(\log\left(MRPL_i\right)\right)}$$

In our data, $\rho_{KL} = \rho\left(MRPK_i, MRPL_i\right) \approx 0.21$, $\bar{s}^K = 0.28$, and $\bar{s}^L = 0.24$

Since we do not have an estimate of the elasticity of demand, we set $\sigma = 3$ as in Hsieh and Klenow (2009)

Quantify the magnitude of eliminating distortions (3/6)

Using the incremental R^2 for the "distortion" group of variables

$$\sigma/2\left(s^K\right)^2 var\left(\log\left(MRPK_i\right)\right) \times \left(\text{incremental } R^2\right)$$
$$=1.5 \times 0.28^2 \times 1.44^2 \times 0.063 = 0.015$$

Similar calculation for MRPL

$$\sigma/2\left(s^L\right)^2 var\left(\log\left(MRPL_i\right)\right) \times \left(\text{incremental } R^2\right)$$
$$=1.5 \times 0.24^2 \times 0.93^2 \times 0.106 = 0.008$$

Capital and labor distortions can reinforce each other

$$\sigma s^K s^L \rho_{KL} \sqrt{var\left(\log\left(MRPK_i\right)\right) var\left(\log\left(MRPL_i\right)\right)}$$

the additional gain is 0.049 and total productivity gain is approximately 7 log percentage points

Quantify the magnitude of eliminating distortions (4/6)

- Estimated gain smaller than what Hsieh and Klenow (2009) provide when they compare the US to developing countries
- We compare countries with more similar levels of development
- Perhaps more importantly, we compute gains from removing specific and measurable distortions (collected in X)
- We do not treat the entire raw dispersion as a source of potential distortions and possible productivity gains

Quantify the magnitude of eliminating distortions (5/6)

- With the Hsieh-Klenow framework and the incremental R^2 relative to the specification with X, removing inequality in average marginal revenue products across countries (i.e. making the country fixed effects be all identical) would raise productivity by at least 9 percentage log points
- Removing barriers between countries and industries i.e. making the country $\times$ industry fixed effects all identical) would raise productivity by at least 18 percentage log points

Quantify the magnitude of eliminating distortions (6/6)

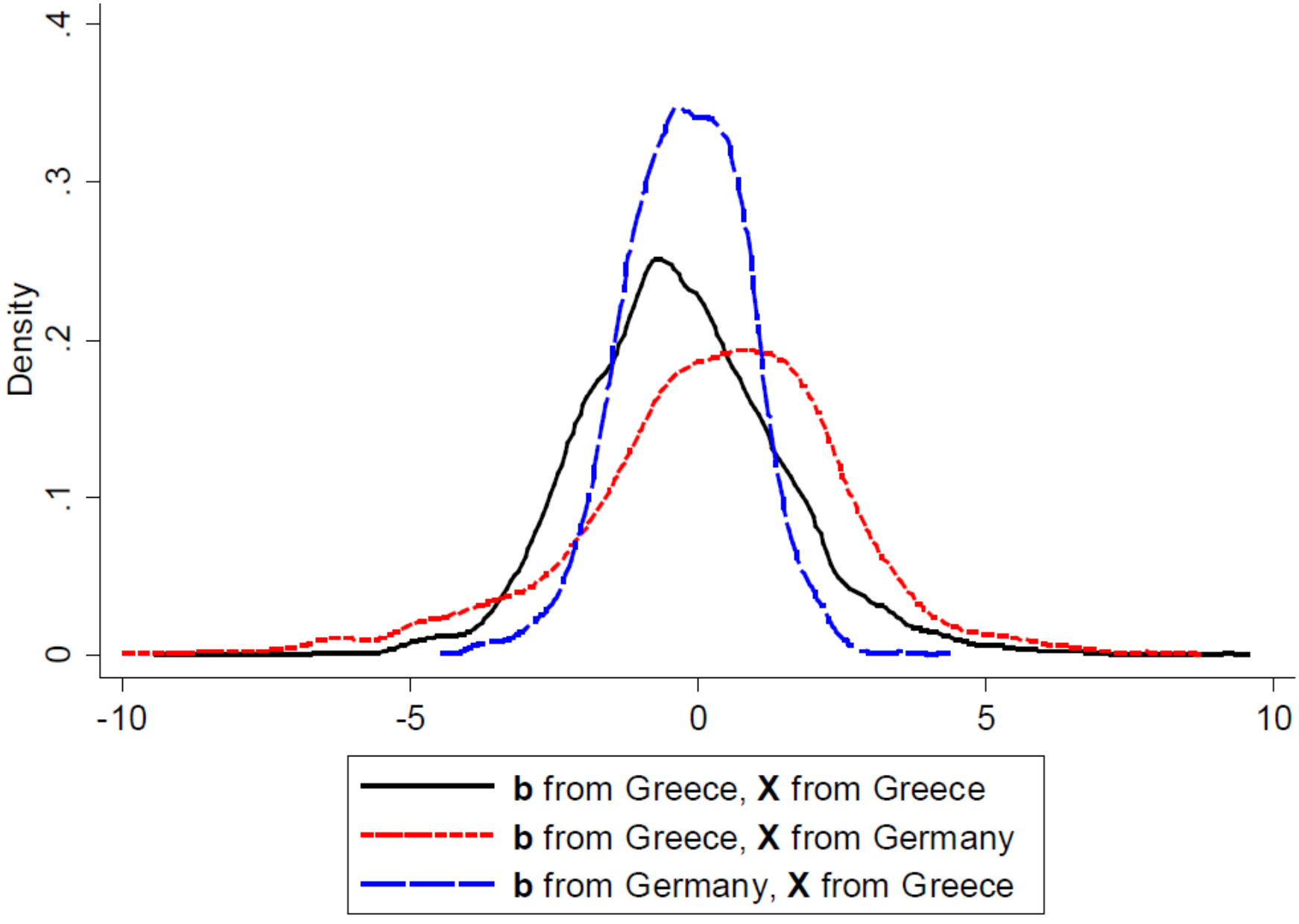
- Raw dispersion across firms in the EU 28 is 1.44 for MRPK and 0.93 for MRPL
  - Estimate of MRPK for the US in Asker et al. (2014, JPE, Table 2): 0.98
  - Estimate of MRPL for the US in Bartelsman et al. (2013, AER, Table 1): 0.58
- $3/2 \times 0.28^2 \times \left((1.44)^2 - (0.98)^2\right) + 3/2 \times 0.24^2 \times \left((0.93)^2 - (0.52)^2\right) + 3 \times 0.28 \times 0.24 \times 0.21 \times (1.44 \times 0.93 - 0.98 \times 0.52) = 0.22$
- Reducing the EU dispersion to the level of the US would increase EU productivity by more than 20 percent

Machado-Mata decomposition

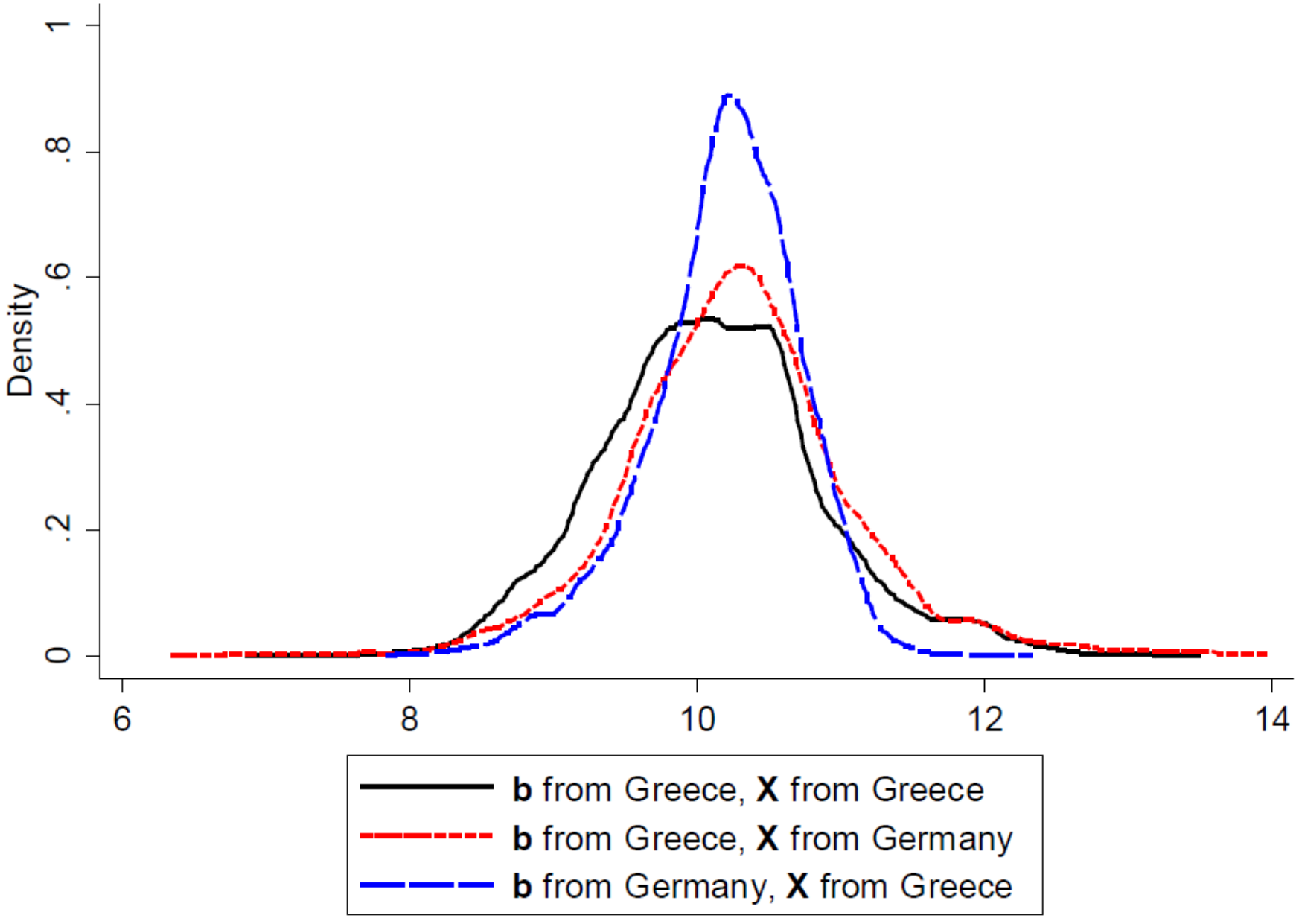
Firm characteristics X	Prices β	St. dev. log(MRPK)	St. dev. log(MRPL)
Germany	Germany	0.98	0.46
Greece	Greece	1.81	0.77
Germany	Greece	2.37	0.86
Greece	Germany	1.08	0.52

- German business, institutional and policy environment help improve the equalization of returns across firms
- Using German X and Greek β, the distribution of MRPK
  - shifts to the right: consistent with German firms having characteristics associated with high levels of productivity
  - more dispersed: the variation of firm characteristics in Germany is greater than in Greece; when combined with the Greek "prices", the dispersion of marginal products is wider than the one actually observed in Greece

Machado-Mata decomposition of MRPK for Greece



Machado-Mata decomposition of MRPL for Greece



Conclusion (1/2)

- This paper contributes to the growing literature measuring misallocation of resources
  - new insights on sources of observed dispersion in marginal products
  - marginal revenue products associated with firm demographics, quality of inputs, utilization of resources, and dynamic adjustment of inputs
  - contribution of perceived constraints (or barriers) to investment more modest

Conclusion (2/2)

- Differences in the levels of MRPL are higher across countries than across industries
  - opposite for MRPK
  - national regulations and language barriers play an important part in the efficiency of resource allocation within the EU
- Machado-Mata decomposition suggests that cross-country variation in the within-country dispersion of marginal revenue products is largely brought about by
  - differences in how a country's business, institutional and policy environment translates firm characteristics into outcomes
  - rather than by differences in firm characteristics *per se*

Thank you!

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Additional slides

Dynamic model of profit maximizing firm (1/7)

With a Cobb-Douglass production function, isoelastic demand function, and additively separable quadratic adjustment costs, profit for firm i at time t is given by

$$\pi_{it} = G_{it}\left[\left(U_{it}K_{it}\right)^{\alpha_i}\left(E_{it}L_{it}\right)^{\beta_i}\right]^{\left(1-\frac{1}{\sigma_i}\right)} - R_{it}\left(U_{it}\right)K_{it} - W_{it}\left(E_{it}\right)L_{it}$$
$$- \frac{\phi_K}{2}\left(\frac{K_{it}}{K_{i,t-1}} - 1\right)^2 R_{it}\left(U_{it}\right)K_{i,t-1} - \frac{\phi_L}{2}\left(\frac{L_{it}}{L_{i,t-1}} - 1\right)^2 W_{it}\left(E_{it}\right)L_{i,t-1}$$

where $\gamma_i = \alpha_i + \beta_i$ reflects returns to scale in production, U_{it} is a measure of capital utilization (or quality), E_{it} is a measure of labor effort (can also capture efficiency wages or labor quality), $R_{it}\left(U_{it}\right)$ is the price schedule for the price of capital K_{it} as a function of capital utilization, $W_{it}\left(E_{it}\right)$ is the price schedule for the price of labor L_{it} as a function of labor effort, ϕ_K and ϕ_L capture the size of adjustment costs (could be stochastic and firm specific), G_{it} is a combination of productivity and demand shifters, σ_i is the elasticity of demand

Dynamic model of profit maximizing firm (2/7)

Firms are assumed to maximize the present value of their profits

$$\Pi_{it} = \sum_{\tau=t}^{\infty} \left(\prod_{s=t}^{\tau} (1 + r_s) \right) \pi_{i\tau}$$

where r_s is the market interest rate which we assume to be constant across firms, e.g. the marginal or representative investor is the same across firms

Dynamic model of profit maximizing firm (3/7)

Let $Y_{it} \equiv G_{it}\left[\left(U_{it}K_{it}\right)^{\alpha_i}\left(E_{it}L_{it}\right)^{\beta_i}\right]^{\left(1-\frac{1}{\sigma_i}\right)}$ be the firm revenue

Then the optimality conditions for capital and labor are

$$MRPK_{it} \equiv \left(1-\frac{1}{\sigma_i}\right)\alpha_i\frac{Y_{it}}{K_{it}}$$
$$\approx R_{it}\left(U_{it}\right)\left[1+\phi_K\left(\frac{K_{it}}{K_{i,t-1}}-1\right)-\frac{\phi_K}{1+r_{t+1}}\times\left(\frac{K_{i,t+1}}{K_{it}}-1\right)\right]$$

$$MRPL_{it} \equiv \left(1-\frac{1}{\sigma_i}\right)\beta_i\frac{Y_{it}}{L_{it}}$$
$$\approx W_{it}\left(E_{it}\right)\left[1+\phi_L\left(\frac{L_{it}}{L_{i,t-1}}-1\right)-\frac{\phi_L}{1+r_{t+1}}\times\left(\frac{L_{i,t+1}}{L_{it}}-1\right)\right]$$

Dynamic model of profit maximizing firm (4/7)

- The marginal revenue products are defined in terms of physical units of capital and labor
- Their variation across firms may reflect differences in adjustment costs, as well as input quality, utilization rates, and taxes or regulation
- However, if quality of inputs or adjustment costs were accounted for and if the price schedules were the same across firms, then marginal revenue products for effective units of capital ($U_{it}K_{it}$) and labor ($E_{it}L_{it}$) should be equalized across firms: cross-sectional dispersion should be 0
- The optimality conditions show that marginal revenue products (LHS in equations on previous slide) are functions of distortions and compensating differentials (RHS)

Dynamic model of profit maximizing firm (5/7)

In a steady state when adjustment costs are zero, the costs of capital and labor are given by

$$R_i\left(U_i\right) K_i = \left[\left(1-\frac{1}{\sigma_i}\right) \alpha_i \frac{Y_i}{K_i}\right] K_i = \left(1-\frac{1}{\sigma_i}\right) \alpha_i Y_i$$

$$W_i\left(E_i\right) L_i = \left[\left(1-\frac{1}{\sigma_i}\right) \beta_i \frac{Y_i}{L_i}\right] L_i = \left(1-\frac{1}{\sigma_i}\right) \beta_i Y_i$$

where we drop the time index t to underscore that this is a steady state

Dynamic model of profit maximizing firm (6/7)

The steady state cost shares are

$$s_i^K = \frac{R_i\left(U_i\right) K_i}{R_i\left(U_i\right) K_i + W_i\left(E_i\right) L_i} = \frac{\alpha_i}{\alpha_i + \beta_i} = \frac{\alpha_i}{\gamma_i}$$

$$s_i^L = \frac{W_i\left(E_i\right) L_i}{R_i\left(U_i\right) K_i + W_i\left(E_i\right) L_i} = \frac{\beta_i}{\alpha_i + \beta_i} = \frac{\beta_i}{\gamma_i}$$

and this can be rewritten as

$$\alpha_i = \gamma_i s_i^K$$
$$\beta_i = \gamma_i s_i^L$$

Dynamic model of profit maximizing firm (7/7)

Using the expressions for α_i and β_i in MRPK and MRPL

$$MRPK_{it} = \left(1 - \frac{1}{\sigma_i}\right) \gamma_i s_i^K \frac{Y_{it}}{K_{it}}$$

$$MRPK_{it} = \left(1 - \frac{1}{\sigma_i}\right) \gamma_i s_i^L \frac{Y_{it}}{L_{it}}$$

With markup $\mu_i = \frac{\sigma_i - 1}{\sigma_i}$, then $\left(1 - \frac{1}{\sigma_i}\right) \gamma_i = \frac{1}{\mu_i} \gamma_i = (1 - s_{\pi,i})$. If the share of pure economic profits $s_\pi \approx 0$ (e.g. Basu and Fernald, 1997, JPE), then $(1 - s_{\pi,i}) \approx 1$ and this yields

$$MRPK_{it} \approx s_i^K \frac{Y_{it}}{K_{it}}$$

$$MRPK_{it} \approx s_i^L \frac{Y_{it}}{L_{it}}$$