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# Exports, R&D Activities, and Labour Productivity of SMEs

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# Motivation

- Strong interest of policy makers about drivers of the internationalization of SMEs
- SMEs face a significant productivity gap relative to large firms
- SMEs, micro enterprises, young companies and service SMEs exhibit face a significant disadvantage in exporting and exhibit lower export shares
- Little is known about the export relations for microenterprises, young firms and service SMEs etc

# Research questions

Primary:

What are the relationships between exports, R&D and labour productivity in SMEs?

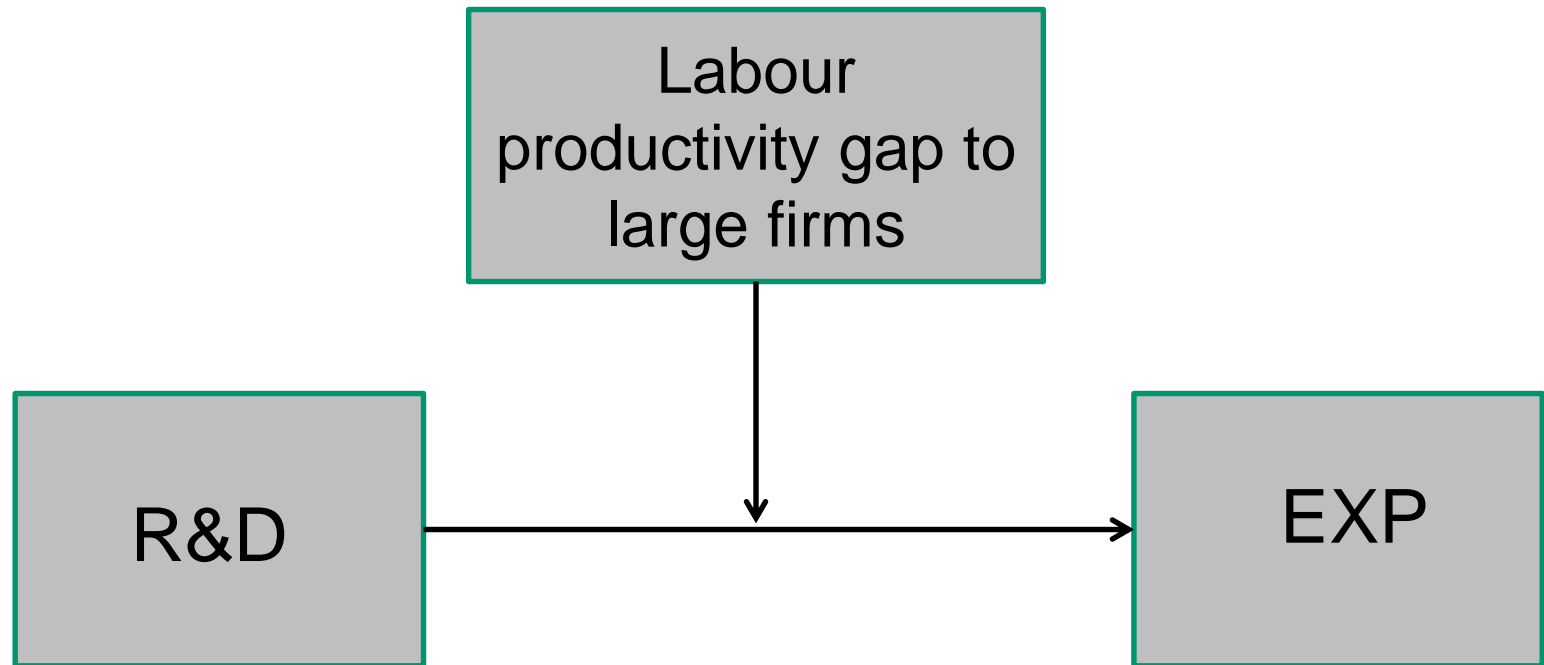
Secondary:

How these relationships vary with firms' characteristics?

# Theoretical Background

- Innovation activities are the main factors for export performance  
(Katsikeas, Leonidou & Samiee, 2008)
- Firms with superior performance become exporters  
(Dunning, 1970; Melitz, 2003)
- Empirical literature show that exporting is significantly related to (Johanson & Vahlne, 1977; Bilkey & Tesar, 1977)
  - firm size
  - age
  - productivity
  - R&D and innovation activities

# Conceptual Model



# Empirical model

Probability that firm  $i$  exports:

$$Pr( EX_{it} = 1 ) = \Phi \left( \begin{aligned} & \alpha_1 + \alpha_2 \ln L_{it-1} + \alpha_3 young_{it} + \alpha_4 ( R \& D_{it} / Y_{it} ) + \alpha_5 YL_{it} / \overline{YL}_{is}^{large} \\ & + \alpha_6 ( R \& D_{it} / Y_{it} ) \cdot YL_{it} / \overline{YL}_{is}^{large} + \sum_{s=1} b_{is} DSEC_{is} \\ & + \sum_{r=1} b_{ir} DREG_{ir} + \sum_{j=1} c_{ij} year_{ij} + \varepsilon_{it} \end{aligned} \right)$$

EX: exports of goods or services =1, zero otherwise

L: employment (full time equivalents)

Young: 1 for one to five years old, 0 otherwise

R&D/Y : R&D intensity

YL: Labour productivity

YL<sup>large</sup>: Av. labour productivity of large firms given sector, year

DSEC, DREG, year

$\alpha_6$  Interaction term between R&D and the productivity gap

# Empirical model

Export share equation:

$$X/Y_{it} = \beta_1 + \beta_2 \ln L_{it-1} + \beta_3 \text{young}_t + \beta_4 (R\&D_{it}/Y_{it}) + \beta_5 YL_{it} / \overline{YL}_{is}^{\text{large}} \\ + \beta_6 (R\&D_{it}/Y_{it}) * YL_{it} / \overline{YL}_{is}^{\text{large}} + \sum_{s=1} b_{is} DSEC_{is} + \sum_{r=1} b_{ir} DREG_{ir} + \sum_{j=1} c_{ij} \text{year}_{ij} + \varepsilon_{it}$$

- $X/Y$ : export to sales ratio in percent
- Extensions:
  - Quadratic terms for the R&D to sales ratio
  - Alternative measure of R&D intensity: ratio of R&D employees to total workers

# Empirical model

- Dependent variable is bounded between 0 and 1
- Estimation method:
  - fractional response model (Papke and Wooldridge 1996, 2008)
  - Heckman selection models
  - Two-part models are more general than fractional response models (Oberhofer and Pfaffermayr 2012)
- Two-part models with time means (Mundlak 1978; Lejarraga, Oberhofer 2015)
- First stage: probit or logit model

$$\Pr(y > 0 \mid \mathbf{x}) = f(\mathbf{x}\boldsymbol{\delta})$$

- Second stage: continuous part

$$E(y \mid y > 0, \mathbf{x}) = g(\mathbf{x}\boldsymbol{\lambda})$$

- Or using the GLM approach

$$E(y \mid y > 0, \mathbf{x}) = g^{-1}(\mathbf{x}\boldsymbol{\lambda})$$

- Error distribution: binomial



# Empirical model

- Estimations performed using the TPM command in STATA with time means for the continuous variables and robust option
- Margin command for the marginal effects
- Separate estimates for
  - micro enterprises
  - young SMEs
  - service SMEs
  - manufacturing SMEs
  - high-tech manufacturing SMEs

# Data

- Time period: 1995-2011, # of obs 18000
- Representative data set for firms with R&D activities
  - Coverage is more than 70 % in the size class 10-250 employees
  - Information is available for funded firms and non funded firms
- Variables
  - Total sales
  - R&D expenditures (frascati definition)
  - Employees
  - Number of R&D personal (full-time equivalents)
  - Exports in % of sales
  - Cashflow
  - University-firm R&D cooperation
  - Firms have to deliver their annual report (firmenbuchnummerauszug)

Source: Austrian Research Funding Agency (FFG)

# Descriptive statistics

		total	micro	young	manufact	services
		SMEs	enterprises		uring	
	# obs	18254	6048	5889	8225	10029
export status	% of firms	0.78	0.63	0.69	0.91	0.67
export to sales ratio in %	mean	0.37	0.26	0.33	0.51	0.26
young (0-5 yrs)	% of firms	0.32	0.56		0.23	0.40
R&D to sales ratio in %	median	0.04	0.11	0.10	0.03	0.07
	mean	0.19	0.33	0.35	0.11	0.26
employment	median	19	4	7	48	10
relative productivity level	mean	0.78	0.76	0.71	0.82	0.75

## Two part model for the total sample

	Probit estimates					
	TPM with firm effects			Pooled TPM		
	coeff		z	coeff		z
R&D sales ratio	-0.17 <sup>***</sup>		-2.72	-0.11 <sup>**</sup>		-2.53
R&D sales ratio X relative labour productivity	0.87 <sup>***</sup>		4.56	0.86 <sup>***</sup>		4.57
In employment	0.40 <sup>***</sup>		13.16	0.25 <sup>***</sup>		24.39
In relative labour productivity	0.22 <sup>***</sup>		8.75	0.20 <sup>***</sup>		8.36
young (0-5 yrs)	-0.04		-1.54	-0.04		-1.64
mean of R&D sales ratio	0.08		1.11			
mean of In employment	-0.16 <sup>***</sup>		-5.01			
mean of rel labour productivity	0.00		-0.17			
constant	-0.90 <sup>***</sup>		-3.61			
Log pseudo likelihood	-7437			-7451		
# of observations	17686			17686		

## Two part model for the total sample

	GLM estimates					
	TPM with firm effects			Pooled TPM		
	coeff		z	coeff		z
R&D sales ratio	-0.06		-0.77	0.56	***	10.63
R&D sales ratio X relative labour productivity	0.45	***	3.42	0.57	***	4.28
In employment	0.22	***	6.50	0.18	***	16.41
In relative labour productivity	0.37	***	15.63	0.35	***	15.07
young (0-5 yrs)	0.14	***	4.64	0.16	***	5.37
mean of R&D sales ratio	0.92	***	10.21			
mean of In employment	-0.04		-1.19			
mean of rel labour productivity	0.00		0.41			
constant	0.71	**	2.08	0.83	**	2.24
Log pseudo likelihood	-7066			-7094		
# of observations	17686			17686		
combined marginal effect R&D sales ratio	0.10	***	4.23	0.23	***	12.17
combined marginal effect labour productivity	0.12	**	18.09	0.12	***	18.03

# Results for micro enterprises and young SMEs

	Probit estimates					
	Micro enterprises			Young SMEs		
	coeff.		z	coeff.		z
R&D sales ratio	-0.16	**	-2.20	-0.08		-1.02
R&D sales ratio X relative Labour productivity	0.62	***	3.14	0.65	***	2.89
In employment	0.42	***	9.37	0.34	***	8.18
In relative labour productivity	0.24	***	7.05	0.25	***	6.64
young (0-5 yrs)	0.03		0.66			
mean of R&D sales ratio	0.05		0.67	0.01		0.08
mean of In employment	-0.07		-1.49	-0.08	*	-1.73
mean of rel labour productivity	-0.01	***	-2.66	-0.01		-1.12
constant	-1.07	***	-2.80	-0.57		-1.29
Log pseudolikelihood	-5255			-2926		
# of observations	5790			5654		

# Results for micro enterprises and young SMEs

	GLM estimates					
	Micro enterprises			Young SMEs		
	coeff.		z	coeff.		z
R&D sales ratio	-0.01		-0.09	-0.07		-0.68
R&D sales ratio X relative labour productivity	0.18		1.33	0.26	*	1.77
In employment	0.06		1.02	-0.05		-0.95
In relative labour productivity	0.20	***	4.64	0.23	***	2.62
young (0-5 yrs)	0.17	***	3.44			
mean of R&D sales ratio	0.62	***	5.49	0.70	***	5.92
mean of In employment	-0.02		-0.34	0.21	***	3.63
mean of rel labour productivity	0.02		1.40	0.07		0.74
constant	1.64	***	2.64	1.86	***	3.22
Log pseudo likelihood	-1913			-2043		
# of observations	3705			3964		
combined marginal effect of R&D sales ratio	0.06	**	2.31	0.06	**	2.36
combined marginal effect of labour productivity	0.10	**	8.26	0.12	**	6.41

## Results for Manufacturing and service SMEs

	probit estimates					
	Manuf. SMEs			Service SMEs		
	coeff		z	coeff		z
R&D sales ratio	-0.31 **		-2.34	-0.14 **		-2.14
R&D sales ratio x relative labour productivity	1.95 ***		4.06	0.74 ***		3.99
In employment	0.46 ***		7.87	0.37 ***		10.61
In relative labour productivity	0.25 ***		4.33	0.20 ***		7.34
young (0-5 yrs)	-0.12 **		-2.32	-0.01		-0.43
mean of R&D sales ratio	-0.09		-0.54	0.14 *		1.84
mean of In employment	-0.15 ***		-2.56	-0.17 ***		-4.67
mean of rel labour productivity	0.01		0.56	0.00		-0.13
constant	0.35		1.34	-0.88 ***		-3.47
Log pseudolikelihood	-243			-8605		
# of observations	8157			9529		



# Results for Manufacturing and service SMEs

GLM estimates

	Manuf. SMEs			Service SMEs		
	coeff		z	coeff		z
R&D sales ratio	-0.48	***	-2.97	-0.03		-0.32
R&D sales ratio X relative labour productivity	2.54	***	5.83	0.23	*	1.88
In employment	0.21	***	4.13	0.25	***	5.28
In relative labour productivity	0.35	***	9.23	0.34	***	9.98
young (0-5 yrs)	0.02		0.52	0.22	***	5.51
mean of R&D sales ratio	1.18	***	6.39	0.84	***	7.98
mean of In employment	0.03		0.54	-0.12	**	-2.44
mean of relative labour productivity	0.03	*	1.90	0.00		-0.18
constant	-1.04	***	-5.63	0.53		1.53
Log pseudolikelihood	-3743			-5318		
# of observations	7419			6411		
combined marginal effect R&D sales ratio	0.40	***	5.19	0.07	***	3.02
combined marginal effect labour productivity	0.16	***	15.13	0.11	***	12.53

# Results

- R&D to sales ratio is significantly and positively related to both the probability of exporting and the export share
- Robust and significant when individual firm effects are taken into account (m.e. decreases from 0.23 to 0.10)
- Interaction term between the R&D-sales ratio and relative labour productivity of SMEs is positive and significant

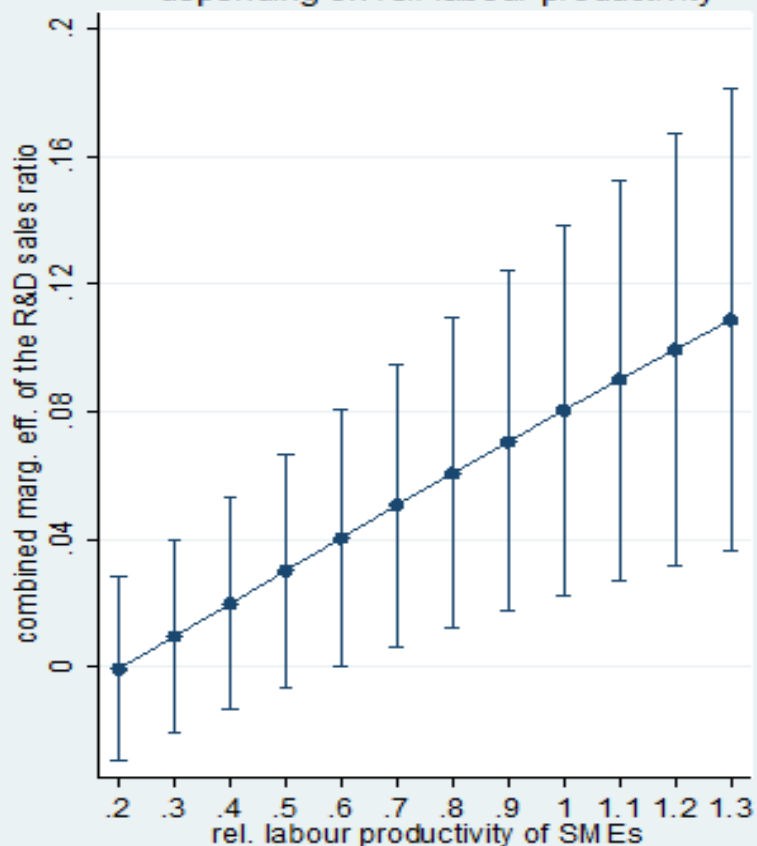
## **=> relationship between exporting and R&D activities**

increases with the ratio of SMEs' labour productivity to that of large firms

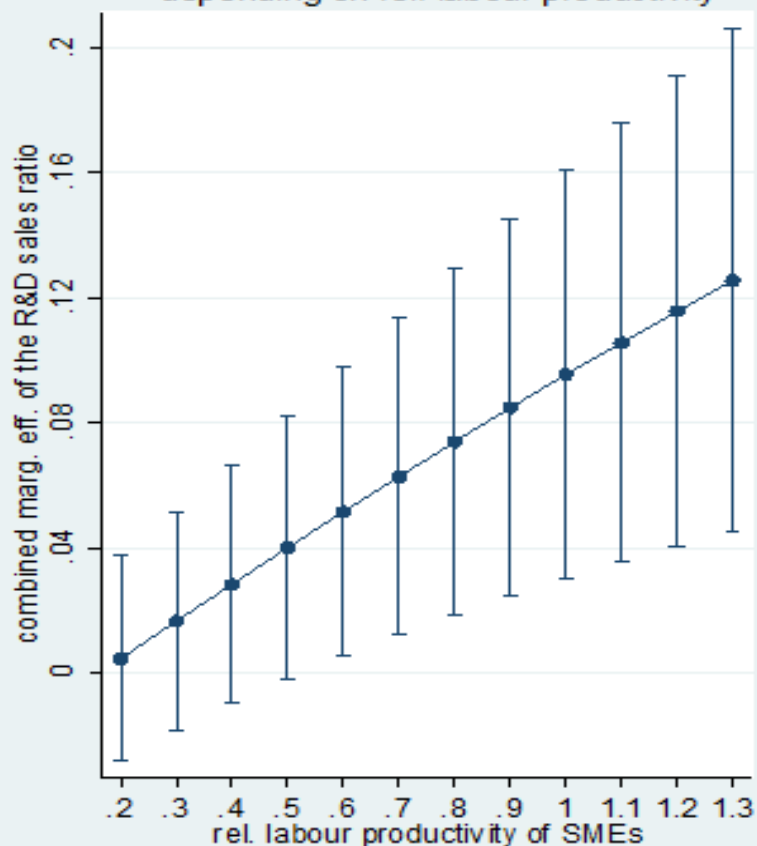
- Results holds true for all subsamples (young, micro, manufacturing, non-manufacturing, high tech)
- Relative labour productivity and size are positive and significant

# Marginal effect of R&D on exporting depending on labour productivity

marg. eff. R&D/Y for micro enterprises depending on rel. labour productivity

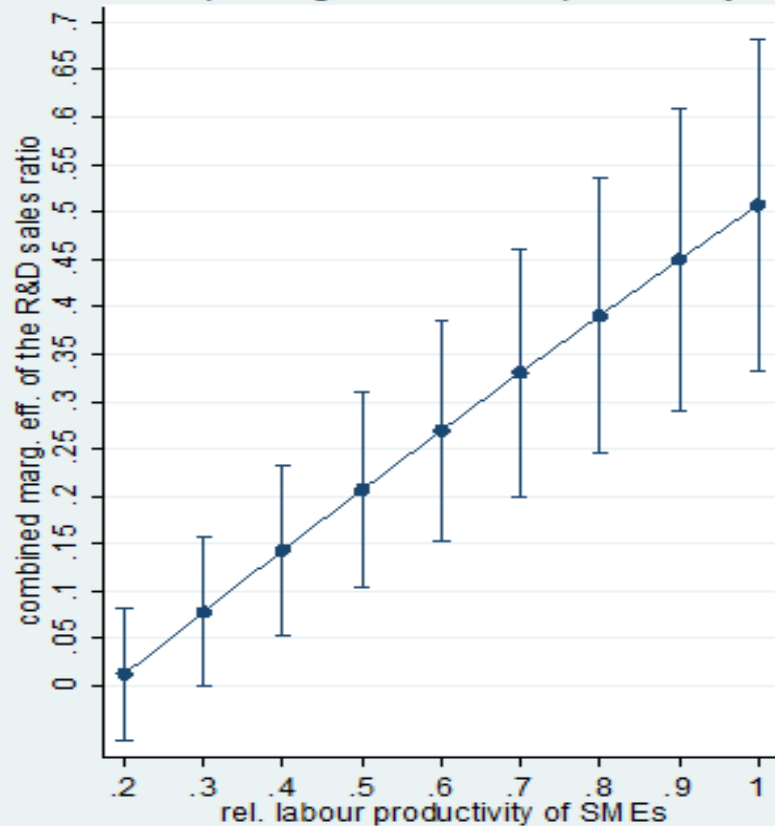


marg. eff. R&D/Y for young SMEs depending on rel. labour productivity

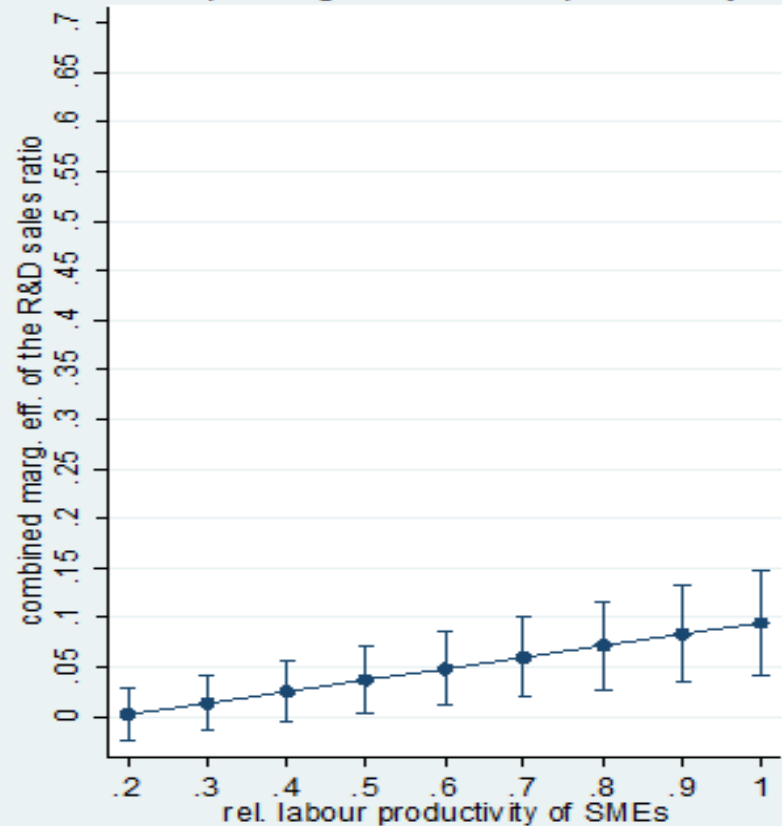


# Marginal effect of R&D on exporting depending on labour productivity

marg. eff. R&D/Y for manufacturing SMEs depending on rel. labour productivity



marg. eff. R&D/Y for non-manufacturing SMEs depending on rel. labour productivity



# Contributions

- New evidence on the links using panel data methods (“much SME research still relies on cross-sectional data” Love and Roper 2015)
- Coverage of micro enterprises
- Inclusion of service SMEs and service exports
- No minimum thresholds on exporting unlike in the trade statistics

# Conclusions

- High R&D spending and high productivity are primary drivers of exporting of SMEs
- R&D activities are only significant when the labour productivity gap of SMEs to that of large firms is not too large
- Link is lower for young SMEs, microenterprises, services SMEs
- Implications for policy
  - R&D is an important factor to be successful in foreign markets
  - Export promotion measures vs. R&D subsidies?
  - Policies aiming to increase the level of R&D indirectly affects export activities of SMEs

Thank you for your attention!

Questions?  
Comments?