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Empirical link between firm-level indicators and target variables of competitiveness: Bayesian Model Averaging approach

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Introduction

Research topic

1. What is the empirical link between firm-level indicators and competitiveness outcomes on a macro level?
2. What can we learn from firm-level distributions?
3. How important are firm-level indicators above and beyond macroeconomic variables in explaining competitiveness outcomes?

Empirical approach

- Panel model for 9 EU-countries over the period 2003 to 2011 (Belgium, Estonia, Finland, France, Germany, Italy, Lithuania, Slovenia, Spain)
- Novel CompNet dataset bridging the macro and micro dimension
- Econometric approach: Bayesian model averaging (BMA)

Motivation to incorporate firm level information

- Di Giovanni and Levchenko (2010): aggregate competitiveness outcomes driven by the largest and most productive firms, not by the average firm
  - Focusing on average/representative firm may yield biased policy conclusions
- Melitz and Redding (2013): firms at opposite tails of the distribution react differently to policy intervention
  - Firm heterogeneity may explain cross-country differences in policy outcomes
- Di Mauro and Pappada (2014): real exchange rate movements are underestimated when cross-country differences in productivity distributions are ignored
- Berman et al. (2012): firm heterogeneity affects the response to exchange rate movements

Dataset

Three dependent variables

- Target variables of Competitiveness: *Real GDP/capita growth, TFP growth, Export market share growth*

Independent variables

1. CompNet firm-level indicators
   - Inter-quartile range (IQR) and skewness for firm size (# of employees), TFP growth, labour productivity growth, capital intensity
   - Share of credit constrained firms (SAFE Index)
2. CompNet macroeconomic indicators
   - Global value chains (GVC), revealed comparative advantage (RCA) in high-tech industries, competitive pressures from China
3. Traditional indicators
   - Macroeconomic environment, labour market, institutional and legal framework, human capital, demographics

Econometric Approach

Panel regression wit country- and time-fixed effects

$$y_{it} = \alpha + x'_{i,t-1}\beta + \gamma_i + \delta_t + \varepsilon_{i,t}$$

- Problem of model uncertainty arises due to large set of candidate regressors

BMA approach

- Estimate models for all possible covariate combinations
- Posterior model probabilities conditional on the data for a given model yield
  - Posterior inclusion probability (PIP) for a given variable
  - Model-weighted posterior mean coefficient and standard deviation
- Two criteria to confirm statistical significance of our indicators:
  1. PIP > prior inclusion probability
  2. Posterior mean is different from zero at 10% significance level

Key results: benchmark regression

	Real GDP per capita growth		TFP (Solow residual) growth		Export market shares growth	
	PIP	Posterior Mean	PIP	Posterior Mean	PIP	Posterior Mean
Exogenous variables (first lag):						
HCI (ULC based)	**0.936**	**-0.283*****	**0.887**	**-0.324*****	**0.962**	**-0.416*****
Change in GVC position	**0.332**	**0.180***	0.153	0.136	**0.907**	**0.408*****
Existent overlap with China	**0.790**	**-0.776*****	**0.341**	**-0.473****	0.216	-0.006
Labour productivity, skewness	**0.578**	**0.196*****	**0.348**	**0.179****	0.287	0.126
Labour with tertiary education	0.291	0.174	**0.450**	**-0.313*****	0.227	0.093
Part-time employment	**0.571**	**0.238****	0.162	0.151	0.182	-0.002
SAFE index	**0.606**	**-0.278****	0.069	-0.014	0.222	-0.099
New overlap with China	**0.462**	**0.391****	0.076	0.023	0.297	0.275
Labour with secondary education	0.203	0.030	0.175	0.138	**0.452**	**0.237****
RCA in high-tech industries	**0.562**	**0.158****	0.065	0.022	0.186	0.002
GVC position	**0.452**	**-0.260***	0.094	-0.086	0.251	-0.087
Labour productivity, IQR	0.183	0.051	**0.219**	**0.135****	0.250	0.115
Temporary employees	**0.314**	**0.140***	0.088	0.070	0.178	0.011
Legal system and property rights	**0.271**	**-0.113***	0.091	-0.073	0.185	-0.020
Time dummies:						
2004	**0.620**	**-0.230****	0.116	-0.103	**0.369**	**-0.208***
2005	0.225	0.084	0.073	-0.049	0.243	-0.106
2006	**0.744**	**0.281*****	0.195	0.213	**0.392**	**0.161****
2007	0.425	-0.050	**0.828**	**-0.359*****	0.225	-0.026
2008	**0.805**	**-0.335****	**0.961**	**-0.576*****	0.335	0.232
2009	**0.668**	**0.446****	**0.701**	**0.299*****	**0.868**	**-0.510*****
2010	0.410	0.403	0.172	0.091	0.305	0.174
2011	0.437	0.244	**0.374**	**-0.125***	**0.719**	**-0.268*****
Summary statistics:						
Mean number of regressors		13.752		7.920		11.9023
Model space		2.70E+11		2.70E+11		2.70E+11
Number of models visited		2907114		2154804		4433389
Percent of model space visited		0.0011		0.00078		0.0016
Percent of total PMP covered by top 10,000 models		19		56		18
Correlation between analytical and sample PMP		0.9973		0.9999		0.9989
Average posterior shrinkage factor		0.9566		0.9646		0.8235
Number of observations		75		75		75

Key results: regression with HCI interaction terms

	Real GDP per capita growth		TFP (Solow residual) growth		Export market shares growth	
	PIP	Posterior Mean	PIP	Posterior Mean	PIP	Posterior Mean
Exogenous variables (first lag):						
HCI (ULC based)	**0.478**	**-0.214****	**0.720**	**-0.297*****	**0.830**	**-0.355*****
x Labour productivity, skewness	**0.289**	**0.147****	**0.196**	**0.152***	0.336	0.183
x TFP, IQR	**0.840**	**0.223*****	**0.441**	**0.173****	**0.503**	**0.204****
x Capital intensity, IQR	**0.219**	**-0.125***	0.059	-0.046	0.174	-0.037
Change in GVC position	0.154	0.126	0.132	0.135	**0.862**	**0.401*****
New overlap with China	**0.700**	**0.518*****	0.075	0.082	0.288	0.268
Labour with tertiary education	**0.184**	**-0.080***	**0.449**	**-0.314*****	0.224	0.124
Labour productivity, skewness	**0.361**	**0.174****	**0.204**	**0.156****	0.225	0.089
Existent overlap with China	0.343	-0.449	**0.216**	**-0.367***	0.211	0.085
Labour with secondary education	**0.175**	**0.093****	0.144	0.131	**0.413**	**0.233****
TFP, IQR	0.144	0.070	**0.258**	**0.157***	**0.320**	**0.160***
SAFE index	**0.427**	**-0.203****	0.063	-0.032	0.204	-0.093
Part-time employment	**0.317**	**0.185****	0.114	0.133	0.175	-0.011
GVC position	**0.253**	**-0.177***	0.097	-0.111	0.253	-0.132
RCA in high-tech industries	**0.325**	**0.135****	0.058	0.023	0.173	-0.013
Labour productivity, IQR	0.141	0.084*	**0.180**	**0.131****	0.218	0.104
Legal system and property rights	**0.230**	**-0.124****	0.096	-0.092	0.169	-0.034
Time dummies:						
2004	**0.578**	**-0.242*****	0.083	-0.087	**0.311**	**-0.186***
2005	0.205	0.108	0.056	-0.012	0.207	-0.068
2006	**0.535**	**0.214****	0.128	0.156	**0.381**	**0.163****
2007	**0.515**	**-0.177*****	**0.866**	**-0.262*****	0.205	-0.021
2008	**0.957**	**-0.427*****	**0.988**	**-0.597*****	**0.303**	**0.216***
2009	**0.696**	**0.337*****	**0.657**	**0.283*****	**0.849**	**-0.585*****
2010	0.178	0.130	0.129	-0.022	0.275	0.158
2011	0.262	-0.065	**0.388**	**-0.198****	**0.698**	**-0.278*****
Summary statistics:						
Mean number of regressors		11.740		8.2515		13.067
Model space		7.00E+13		7.00E+13		7.00E+13
Number of models visited		2679302		2149411		44326723
Percent of model space visited		0.0000038		0.0000030		0.0000063
Percent of total PMP covered by top 10,000 models		18		45		12
Correlation between analytical and sample PMP		0.9939		0.9996		0.9901
Average posterior shrinkage factor		0.9590		0.9640		0.8120
Number of observations		75		75		75

Conclusions

Conclusions

- Firm-level information has significant explanatory power above and beyond traditional macroeconomic variables
- Real GDP/capita and TFP growth are driven by the most productive firms in the economy
  - Skewness of labour productivity is one of the most important indicators in the BMA analysis
- Tighter financial constraints of firms tend to dampen real GDP/capita growth
- Real effective exchange rate is the single most important driver for all three target variables of competitiveness
- Response to exchange-rate movements depends crucially on distribution of firm size and productivity
  - Fatter right tale of the productivity distribution is associated with a smaller impact of HCI, i.e. highly productive firms are less vulnerable to changes in relative costs.
- Results are robust across different Bayesian prior assumptions