

Export diversification and output volatility: comparative firm-level evidence

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Frankfurt
16.12.2014

- 1 - Bank of Slovenia
- 2 - National Bank of Romania
- 3 - The Central Bank of Hungary
- 4 - National Bank of Slovakia
- 5 - Bank of Estonia and University of Tartu

Motivation

Macro-level regularities:

- ☹️ The negative relationship between volatility and growth (Ramey and Ramey (1995) etc)
- ☹️ Openness to trade is related to higher volatility (Rodrick (1997, 1998) etc)
- 😊 Countries with high openness to trade face higher volatility but not lower long-term growth (Kose *et al.* (2006))
- 😊 Openness to trade does not increase growth volatility if the export basket is diversified (Bejan (2006) and Haddad *et al.* (2013))

What about micro-level?

Address aggregation bias and policies for heterogeneous firms

Aim

- .. to estimate the link between the diversification of export markets or goods and the volatility of output at the firm-level
- Comparative evidence from Estonia, Hungary, Romania, Slovenia and Slovakia
- Estimate the effect of pre-recession diversification, in 2008, on the volatility over the great recession in 2008-2011
- The portfolio diversification idea from finance
 - If demand in different markets or for different products is not perfectly positively correlated -> more diversified firms should have lower sales volatility
 - Do not test for the relative correlation of markets in this paper

Literature – theoretical models

- Melitz (2003) – heterogeneous firms exporting to many markets
 - Heterogeneous firms exporting to one or more markets with market entry costs -> more productive firms export to many markets and drain resources from purely domestic firms
- Rodrik (1998) – exposure to external risk and aggregate risk
 - World market is less volatile than a single economy -> exporting reduces aggregate risks
 - Openness to trade increases specialisation -> concentration of products increases and aggregate risks increase
- Vannoorenberghe (2012) – exporting and volatility
 - Firms do not choose markets independently
 - Sales growth in domestic market is negatively correlated with sales growth in export markets -> exporters have lower volatility
- Vannoorenberghe *et al.* (2014) – export diversification and volatility
 - Diversification effect – reduces volatility
 - Composition effect – large markets are more volatile
 - > the net effect depends on which effect dominates

Literature – empirical regularities

Country-level

- Rodrik (1998)
 - Terms of trade volatility and product concentration is positively correlated with growth volatility
- Haddad *et al.* (2013)
 - Trade diversification alters the relationship between openness and output growth volatility
-> very open economies have lower volatility if their export is diversified
 - Diversification of products has stronger effect than diversification of markets

Firm-level

- Di Giovanni *et al.* (2014)
 - 69% of the standard deviation of aggregate sales growth is explained by a firm-specific component in manufacturing
- Vannoorenberghe (2012)
 - The relationship between firm export *share* and volatility of global sales is convex, firms exporting less than 10% have lower volatility than non-exporters
- Vannoorenberghe *et al.* (2014)
 - Small firms: more diversified exporters have higher export volatility
 - Large firms: more diversified exporters have lower export volatility
 - Explanation: small firms more likely occasional exporters

Methodology

- Estimate endogenous binary-variable model or endogenous treatment-regression:

$$volatility_{i,t...t+3} = \beta_0 + \delta \exp_div_{i,t} + \beta_1 \log(age_{i,t}) + \beta_2 \log(size_{i,t}) + \beta_3 \log(lprod_{i,t}) \\ + \beta_4 foreign_{i,t} + \beta_5 \log(capital_int_{i,t}) + \beta_6 \exp_share_{i,t} + \gamma_{s,t} + \varepsilon_i$$

$$\exp_div^*_{i,t} = \gamma_0 + \gamma_1 \log(age_{i,t}) + \gamma_2 \log(size_{i,t}) + \gamma_3 \log(lprod_{i,t}) \\ + \gamma_4 \exp_share_{i,t} + u_i$$

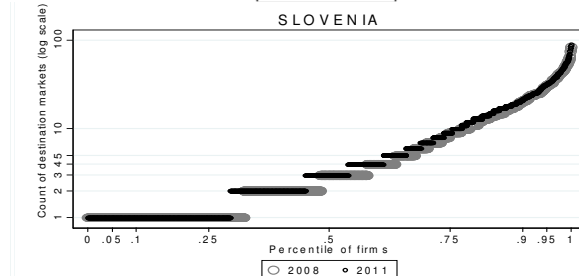
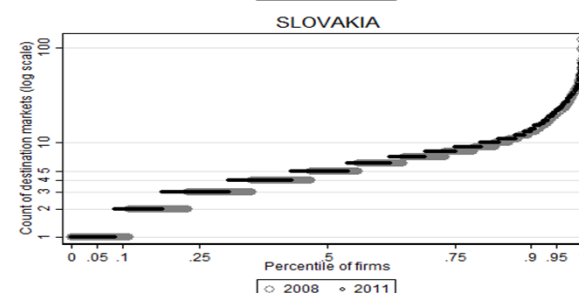
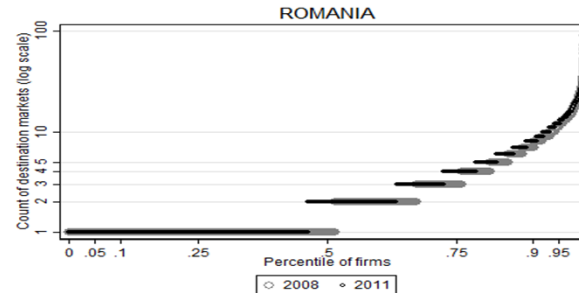
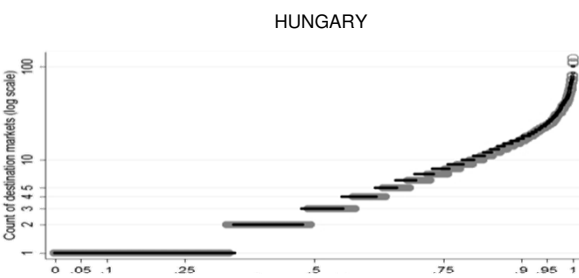
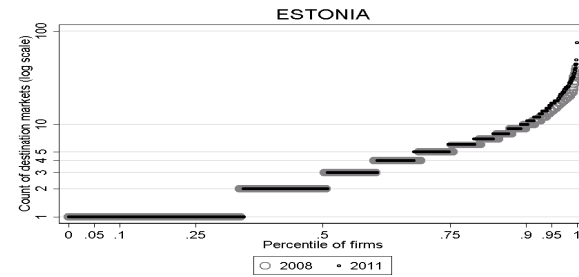
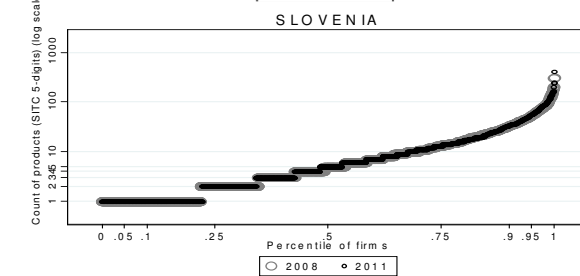
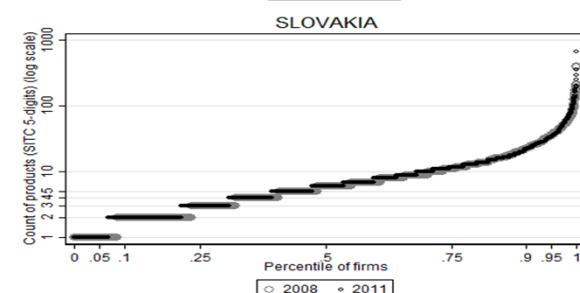
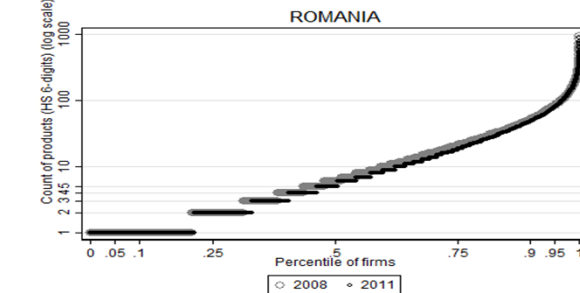
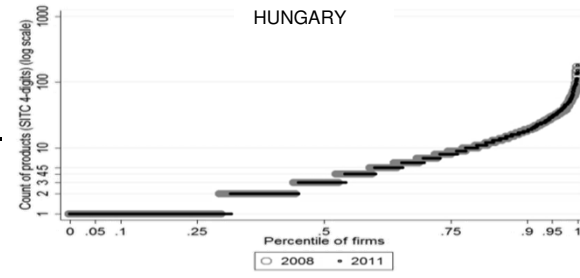
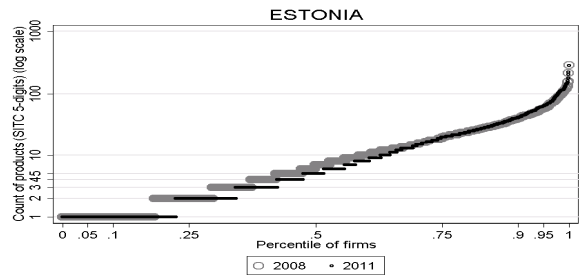
- where $cov(\varepsilon_i, u_i) \neq 0$ and $\exp_div_{i,t} = \begin{cases} 1, & \text{if } \exp_div^*_{i,t} > 0 \\ 0, & \text{otherwise} \end{cases}$
- Use no extra exogenous instruments, identification is purely from the functional form, non-linear probit for diversification and linear for volatility
- Estimate simultaneously with maximum likelihood
- Dependent variable: volatility in 2008-2011 measured as coefficient of variation in real value added
- Explanatory variables: in 2008

Data

- Trade data:
 - Customs data of export flows by:
 - Destination markets
 - Goods at 5-digit SITC or 6-digit HS
 - Examples of 5-digit SITC Rev. 4
 - 022.1 - Milk (including skimmed milk) and cream, not concentrated or sweetened
 - 022.11 - Milk of a fat content, by weight, not exceeding 1%
 - 022.12 - Milk and cream, of a fat content, by weight, exceeding 1% but not exceeding 6%
 - 022.13 - Cream of a fat content, by weight, exceeding 6%
 - 775.2 - Household-type refrigerators and food freezers (electrical and other)
 - 775.21 - Refrigerators, household-type (electric or other), whether or not containing a deep-freeze compartment
 - 775.22 - Deep-freezes, household-type (electric or other)
- Balance sheet and profit-loss statements:
 - Employ the same definition of variables and outlier trimming as in the CompNet project + dummy for majority of foreign ownership
- Coverage:
 - Manufacturing firms
 - Volatility over the great recession in 2008-2011
 - Whole population data for EE, HU, RO, SI; for SK only firms larger than 20 employees

Left panel:
**Difersification
of goods**

20-30% of
firms export
only one
good, except
SK



Right panel:
**Difersification
of markets**

30% of firms
export only to
one market,
except RO, SK

Diversification and unconditional volatility

	Below median diversified (above median Herfindahl)			Above median diversified (below median Herfindahl)		
	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median
Coefficient of variation of real value added by diversification of goods						
Estonia (SITC at 5 digits)	0.354	0.228	0.307	0.349	0.209	0.307
Hungary (SITC at 4 digits)	0.320	0.259	0.570	0.340	0.263	0.266
Romania (HS at 6 digits)	0.415	0.289	0.343	0.402	0.282	0.326
Slovakia (SITC at 5 digits)	0.344	0.252	0.278	0.353	0.258	0.285
Slovenia (SITC at 5 digits)	0.260	0.177	0.220	0.249	0.162	0.205
Coefficient of variation of real value added by diversification of destination markets						
Estonia	0.351	0.230	0.305	0.353	0.207	0.315
Hungary	0.340	0.260	0.260	0.326	0.270	0.256
Romania	0.423	0.297	0.341	0.394	0.272	0.329
Slovakia	0.353	0.255	0.291	0.343	0.255	0.276
Slovenia	0.259	0.171	0.219	0.250	0.169	0.209

Results (1)

Diversification of *products*

	Estonia	Hungary	Romania	Slovakia	Slovenia
Outcome equation: coefficient of variation of real value added					
Log(age)	-0.011	-0.033	-0.0001	-0.024	-0.032***
Log(employment)	-0.006	-0.0002	-0.022***	-0.017**	-0.028***
Log(labour productivity)	-0.072***	-0.043***	-0.024***	-0.150***	-0.031**
Foreign owned (base domestic)	-0.024	0.024*	-0.005	0.021	0.0004
Log(capital per employee)	0.018***	0.026***	0.021***	0.078***	0.006
Share of export in sales	0.020	0.022	0.063***	-0.087***	0.010
Diversification of goods (binary)	-0.197***	-0.291***	-0.349***	-0.261***	0.202***
Secors (2-digit NACE2008)	Yes	Yes	Yes	Yes	Yes
Treatment equation: diversification of destination markets					
Log(age)	0.272***	0.127	0.151***	0.167*	0.053
Log(employment)	0.183***	0.538***	0.124***	0.021	0.164***
Log(labour productivity)	0.022	0.066**	0.112***	-0.027	0.112***
Share of export in sales	0.408**	0.232***	0.328***	-0.627***	0.116
athrho	0.717***	0.723***	0.878***	0.688***	-0.750***
No of obs	628	2386	3962	1490	1743

- Strong negative diversification effect: diversified firms have by one standard deviation lower volatility in real value added
 - The opposite effect in SI
- More productive and less capital intensive firms have also lower volatility
- In general: older, larger, more productive and more export intense firms have higher diversification propensities

Results (2)

Diversification of *markets*

	Estonia	Hungary	Romania	Slovakia	Slovenia
Outcome equation: coefficient of variation of real value added					
Log(age)	-0.021	-0.049***	-0.002	-0.049**	-0.028***
Log(employment)	-0.003	-0.069**	-0.014**	-0.0002	-0.016
Log(labour productivity)	-0.071***	-0.0609***	-0.028***	-0.141***	-0.024
Foreign owned (base domestic)	-0.023	0.027**	-0.005	0.021	0.002
Log(capital per employee)	0.017***	0.025***	0.021***	0.078***	0.006
Share of export in sales	-0.012	-0.004	0.063***	-0.056**	0.018
Diversification of markets (binary)	-0.114*	0.089	-0.283***	-0.273***	0.009
Secors (2-digit NACE2008)	Yes	Yes	Yes	Yes	Yes
Treatment equation: diversification of markets					
Log(age)	0.195**	0.127	0.157***	-0.065	0.0004
Log(employment)	0.392***	0.304***	0.278***	0.166***	0.363***
Log(labour productivity)	0.046	0.354***	0.117***	0.074*	0.256***
Share of export in sales	0.005	-0.083	0.387***	-0.324***	0.825***
athrho	0.394*	-0.156	0.642***	0.750***	-0.004
No of obs	628	2386	3962	1490	1743

- The diversification effect is still strong, but smaller than for diversification of goods: smaller for EE and RO, slightly bigger for SK and insignificant for HU and SI
- In general: firm size and productivity have stronger effect on market entrance than on goods entrance (Melitz (2003) model of market entry costs)

Robustness tests

Pairwise correlation coefficients	Estonia			Hungary			Romania			Slovakia			Slovenia		
	Volatility	Herf. goods	Herf. markets	Volatility	Herf. goods	Herf. markets	Volatility	Herf. goods	Herf. markets	Volatility	Herf. goods	Herf. markets	Volatility	Herf. goods	Herf. markets
Herf. goods	0.045	1		0.058*	1		0.033*	1		0.029	1		0.068*	1	
Herf. markets	-0.004	0.206*	1	0.045*	0.350*	1	0.053*	0.241*	1	-0.019	0.289*	1	0.068*	0.347*	1
Log(age)	-0.108*	-0.173*	-0.181*	-0.094*	-0.036*	-0.064*	-0.162*	-0.060*	-0.161*	-0.124*	-0.071*	-0.008	-0.167*	-0.117*	-0.189*
Log(empl.)	-0.149*	-0.243*	-0.378*	-0.174*	-0.139*	-0.327*	-0.245*	-0.216*	-0.386*	-0.002	-0.0003	-0.148*	-0.135*	-0.253*	-0.547*
Log(lprod)	-0.124*	-0.042	-0.078*	-0.160*	-0.151*	-0.409*	-0.102*	-0.085*	-0.075*	-0.035	-0.003	-0.054*	-0.070*	-0.061*	-0.129*
Exp_share	-0.041	-0.160*	-0.079*	-0.030	-0.137*	-0.145*	0.039*	-0.100*	-0.059*	0.025	0.211*	0.112*	0.071*	-0.134*	-0.388*
Foreign	-0.065	-0.112*	0.038*	-0.033	-0.108*	-0.101*	-0.039*	-0.077*	0.025*	0.066*	0.105*	0.067*	0.038*	-0.039	-0.100*
Log(capempl)	0.019	0.053	-0.247*	-0.055*	-0.084*	-0.344*	-0.020*	0.037*	-0.207*	0.100*	0.044	-0.213*	-0.031	-0.011	-0.120*

- Use IV estimation where continuous Herfindahl index is a measure of diversification
- Look for the exogenous instruments that are excluded from the volatility equation
 - Use firm size, ownership and export share as instruments and estimate the following by 2SLS:

$$volatility_{i,t...t+3} = \beta_0 + \delta \exp_div_{i,t} + \beta_1 \log(age_{i,t}) + \beta_2 \log(lprod_{i,t}) + \beta_3 \log(capital_int_{i,t}) + \gamma_{s,t} + \varepsilon_i$$

$$\exp_div_{i,t} = \gamma_0 + \gamma_1 \log(size_{i,t}) + \gamma_2 foreign_{i,t} + \gamma_3 \exp_share_{i,t} + u_i$$

Results (3)

Diversification of *products*, IV estimation with herfindahl index

	Estonia	Hungary	Romania	Slovakia	Slovenia
IV regression, dependent: coefficient of variation of real value added					
Diversification of goods, Herfindahl	0.393***	0.385*	0.812***	-0.048	0.259***
Log(age)	-0.011	-0.035*	0.001	-0.051***	-0.026***
Log(labour productivity)	-0.077***	-0.040***	-0.009	-0.144***	-0.015
Log(capital per employee)	0.020**	0.021***	0.028***	0.074***	0.007
Secors (2-digit NACE2008)	Yes	Yes	Yes	Yes	Yes
First-stage regression, dependent: diversification of goods, Herfindahl					
Log(employment)	-0.044***	-0.091***	-0.033***	-0.022***	-0.045***
Foreign owned (base domestic)	-0.038	-0.046***	-0.013	0.004	0.023
Share of export in sales	-0.063*	-0.031	-0.054***	0.214***	-0.039*
Log(age)	-0.047***	0.010**	-0.038***	-0.038**	-0.011
Log(labour productivity)	-0.009	-0.017	-0.025***	0.040***	-0.030***
Log(capital per employee)	-0.007	-0.024***	-0.010***	-0.015	-0.001
Secors (2-digit NACE2008)	Yes	Yes	Yes	Yes	Yes
R ² (diversification equation)	0.255	0.058	0.185	0.131	0.131
Durbin-Wu-Hausman test of endogeneity	9.07***	3.55*	103.37***	0.821	16.23***
No of obs	628	2386	3962	1490	1743

- Strong negative diversification effect: highly diversified firms, concentration index close to 0, have by one and a half standard deviation lower volatility in real value added than firms exporting only one good
 - No effect in SK

Results (4)

Diversification of *markets*, IV estimation with herfindahl index

	Estonia	Hungary	Romania	Slovakia	Slovenia
IV regression, dependent: coefficient of variation of real value added					
Diversification of markets, Herfindahl	0.202**	0.388**	0.455***	0.222*	0.088***
Log(age)	-0.025*	-0.047**	-0.001	-0.040**	-0.030***
Log(labour productivity)	-0.071***	-0.028*	-0.016**	-0.154***	-0.015
Log(capital per employee)	0.024***	0.036***	0.028***	0.090***	0.007
Secors (2-digit NACE2008)	Yes	Yes	Yes	Yes	Yes
First-stage regression, dependent: diversification of goods, Herfindahl					
Log(employment)	-0.081***	-0.049**	-0.075***	-0.049***	-0.096***
Foreign owned (base domestic)	0.066**	-0.006	0.052***	0.074***	0.094***
Share of export in sales	-0.081**	-0.037**	-0.049***	0.070***	-0.235***
Log(age)	-0.021	-0.030***	-0.025***	-0.010	0.002
Log(labour productivity)	-0.019**	0.067***	-0.043***	0.033**	-0.064***
Log(capital per employee)	-0.029***	-0.073***	-0.018***	-0.070***	-0.008
Secors (2-digit NACE2008)	Yes	Yes	Yes	Yes	Yes
R2 (diversification equation)	0.245	0.225	0.243	0.122	0.416
Durbin-Wu-Hausman test of endogeneity	6.32**	6.31**	94.722***	3.096*	11.38***
No of obs	628	2386	3962	1490	1743

- The diversification effect is smaller than for diversification of goods in EE, RO, SI; roughly the same in HU and much stronger in SK
- Instruments have strong effect in diversification equation: larger and more export oriented firms have higher diversification, foreign companies more concentrated in markets (GVA)

Summary

- Confirm the negative effect of diversification on volatility at the firm level
- Diversification of products has usually stronger effect than diversification of markets
 - Similar finding to macro-level estimations by Haddad et al. (2013)
- The effect of export diversification on output volatility is large:
 - Above median diversified firms have by one standard deviation lower volatility in value added
- There are strong diversification patterns:
 - Older, larger and more productive firms export many products and into many markets
- Further developments: robustness tests on growth volatility

THANK YOU!

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SOME ADDITIONAL SLIDES

Volatility in export markets: sales growth vs value added CI EE, RO, SK

