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Share of exports to low-income countries, productivity, and innovation: A replication study with firm-level data from six European countries*

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Abstract:

Crinò and Epifani (2012) report and discuss two empirical regularities they find in a representative sample of Italian manufacturing firms. First, there is a negative correlation between firms' productivity and their export share to low-income destinations. Second, there is a negative correlation between firms' innovation activity and their export share to low-income destinations. This note uses recently available comparable high quality firm level data for six European countries (including Italy) and similarly specified empirical models in an attempt to replicate these results. Replication failed completely. The link found between the share of exports to low-income countries and either productivity or R&D intensity is never in line with the results from Crinò and Epifani (2012).

Keywords: Exports, low-income destinations, productivity, innovation, EFIGE data

JEL classification: F14

* The firm level data used in this study are available from www.efige.org. To facilitate replication and extensions the Stata do-file used is available from the author on request.

1. Motivation

In a paper published in the *Economic Journal* Crinò and Epifani (2012) report and discuss two empirical regularities they find in a representative sample of Italian manufacturing firms:

R1: There is a negative correlation between firms' productivity and their export share to low-income destinations.

R2: There is a negative correlation between firms' innovation activity and their export share to low-income destinations.

The authors conjecture that more productive firms tend to concentrate their sales in high-income markets because they produce higher-quality products (where product quality is closely related to innovation), for which relative demand is higher in high-income destination countries. Crinò and Epifani (2012, p. 1237) argue that this finding can shed light on the important but not yet fully understood issue of the determinants of the popularity of foreign destinations from the standpoint of domestic exporters. However, they point out that it is not known as yet "whether the empirical regularities documented …, although strong and plausible, hold elsewhere. Testing whether our results extend beyond Italian manufacturing is therefore a promising avenue for future research." (Crinò and Epifani 2012, p. 1237)

This note walks down that avenue. It uses recently available comparable high quality firm level data for six European countries (including Italy) and similarly specified empirical models in an attempt to replicate the results found by Crinò and Epifani (2012), keeping in mind that "the credibility of a new finding that is based on carefully analyzing two data sets is far more than twice that of a result based only on one" (Hamermesh, 2000, p. 376).

To anticipate the most important finding, replication failed completely. The link found between the share of exports to low-income countries and either productivity or innovation activity is never in line with the results from Crinò and Epifani (2012).

The rest of the paper is organized as follows. Section 2 introduces the data used, discusses the definition of the variables and the specification of the empirical models, and comments on the econometric methods applied to estimate the models. Section 3 presents the results of the econometric investigation. Section 4 concludes.

2. Data and empirical strategy

The empirical investigation in this paper uses the EU-EFIGE/Bruegel-UniCredit dataset (the EFIGE data from now on). This database has recently been collected within the project *European Firms in a Global Economy: internal policies for external competitiveness*. It combines measures of firms' international activities with information on firm characteristics for representative samples of manufacturing firms in seven European Economies (Germany, France, Italy, Spain, United Kingdom, Austria, and Hungary). Data were collected in 2010 and refer (mainly) to 2008. A detailed description of the EFIGE data is given in Altomonte and Aquilante (2012). An anonymized version of the EFIGE data is publicly available at www.efige.org.

In their empirical models Crinò and Epifani (2012) regress the share of exports of a firm to low-income countries on productivity and on innovation activities while controlling for industry affiliation. Using the EFIGE data these variables are defined as follows:

Share of exports to low-income countries is defined as the sum of the shares of exports of a firm that goes to countries from the group of "Other EU countries" (that do not belong to the EU15 countries, and that comprise Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, Czech Republic, Romania, Slovakia, Slovenia, and

Hungary), to China and India, and to Central and South America. In the EFIGE questionnaire other areas listed in the respective question are the “EU15 countries” and “USA and Canada” (which are high-income countries) and areas that comprise both high-income and low-income countries (“Other European countries not EU” include Switzerland and Norway, and Russia and the Ukraine; “Other Asian Countries” include Japan and Afghanistan; and “Other Areas” include Australia and Angola). Note that the definition of low-income countries used here differs in detail from the definition used by Crinò and Epifani (2012, p. 1209) who include Africa (but not India) due to different areas used in the respective questionnaires.

Productivity is measured as Total Factor Productivity (TFP) and is defined as the Solow residual of a Cobb-Douglas production function estimated following the semi-parametric algorithm suggested by Levinsohn and Petrin (2003). This measure of productivity is a similar (but not identical) to the various measures used by Crinò and Epifani (2012, p. 1212), and it is the only one available in the version of the EFIGE data that is used in this study.

Innovation activity is measured by two variables. One is the average percentage of turnover from innovative products sales over the last three years (2007-2009). The other is the average percentage of total turnover the firm invested in R&D in the last three years (2007-2009). Crinò and Epifani (2012, p. 1230) use identical variables plus a dummy-variable for process innovation (and the principal component from these three proxy variables for firms’ innovative activities).

Industry controls are dummy variables for 11 industries according to the NACE-Clio categories; these are the only industry variables included in the EFIGE data used in this study (see Altomonte and Aquilante 2012, p. 18).

Crinò and Epifani (2012, p. 2014) apply two econometric methods to estimate their empirical models, Ordinary Least Squares (OLS) and an outlier-robust

procedure that uses the `rreg` command in Stata. The latter command implements the M-estimator proposed by Huber (1964). However, as pointed out by Verardi and Croux (2009, p. 442), this estimator can only identify isolated outliers and is inappropriate when clusters of outliers exist where one outlier can mask the presence of another, and the initial values for the algorithm is not robust to bad leverage points. Full robustness can be achieved by using the so-called MM-estimator that can resist contamination of the data set of up to 50% of outliers (i.e., that has a breakdown point[1] of 50 % compared to zero percent for OLS). Here we report results based on OLS estimates plus results estimated using the Huber M-estimator and the MM-estimator.[2]

In this paper we use data for six of the seven countries included in the EFIGE study, namely Germany, France, Italy, Spain, United Kingdom, and Hungary.[3]

3. Results of the econometric investigation

To test for the presence or not of the two empirical regularities reported by Crinò and Epifani (2012) - a negative correlation between firms' productivity and their export share to low-income destinations; and a negative correlation between firms' innovation activity and their export share to low-income destinations – three empirical models are estimated that regress the share of a firm's exports to low-income countries on (1) total factor productivity, (2) the share of innovative products in total sales, and (3) the share of R&D expenditures in total sales, controlling for industry

[1] The breakdown point of an estimator is the highest fraction of outliers that an estimator can withstand, and it is a popular measure of robustness.

[2] Computations were done using the ado-files provided by Verardi and Croux (2009) with the efficiency parameter set at 0.7 as suggested there based on a simulation study.

[3] Austria is not included because the number of firms with complete information on the variables used in the empirical models is tiny; details are available on request.

affiliation of a firm by a complete set of industry dummy variables. Each empirical model is estimates by (1) OLS, (2) the Huber-M-estimator, and (3) the fully robust MM-estimator. All nine models are estimated for each of the six countries included in this study. Results for the 54 models are reported by country in Table 1 to Table 6.

[Table 1 – Table 6 near here]

Of the 54 estimated regression coefficients none is negative and statistically significantly different from zero at an error level of 10 percent or better, and only 8 have a negative sign. From the remaining 48 positive coefficients 21 are statistically significantly different from zero at an error level of 10 percent or better. These results are not at all in line with the two empirical regularities reported by Crinò and Epifani (2012).

4. Concluding remarks

Crinò and Epifani (2012) report and discuss two empirical regularities they find in a representative sample of Italian manufacturing firms. First, there is a negative correlation between firms' productivity and their export share to low-income destinations. Second, there is a negative correlation between firms' innovation activity and their export share to low-income destinations. This note uses recently available comparable high quality firm level data for six European countries (including Italy) and similarly specified empirical models in an attempt to replicate these results. Replication failed completely. The link found between the share of exports to low-income countries and either productivity or R&D intensity is never in line with the results from Crinò and Epifani (2012).

The results reported here cast doubts on the general validity of the empirical findings reported by Crinò and Epifani (2012). If these findings were valid in general they should show up in similarly (but not identically) specified empirical models estimated using different data from similar countries (or even the same country).

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Table 1: Share of exports to low-income countries, productivity, and innovation: Regression results for Germany

Method		OLS	RREG	MMREGESS
Dependent variable: Share of exports to low-income countries in total exports (percent)				
Total factor productivity	ß	0.251	0.965	2.001
	p	0.892	0.618	0.334
Share of innovative products in total sales (percent)	ß	0.126	0.102	-0.007
	p	0.048	0.035	0.873
Share of R&D expenditures In total sales (percent)	ß	0.022	0.030	0.065
	p	0.869	0.794	0.730
Industry controls		yes	yes	yes
Number of firms		318	318	318

Note: For description of data, definition of variables and discussion of methods see text. ß is the estimated regression coefficient, p is the prob-value. All models include a constant.

Descriptive statistics

	Mean	sd	min	p25	p50	p75	max
Share of exports to low-income countries in total exports (percent)	18.40	17.63	0	5	15	25	100
Total factor productivity	0.19	0.47	-1.42	-0.07	0.19	0.40	2.82
Share if innovative products in total sales (percent)	15.29	18.58	0	0	10	20	100
Share of R&D expenditures in total sales (percent)	6.11	7.84	0	1	3	10	50

Table 2: Share of exports to low-income countries, productivity, and innovation: Regression results for France

Method		OLS	RREG	MMREGESS
Dependent variable: Share of exports to low-income countries in total exports (percent)				
Total factor productivity	ß	2.351	0.143	0.021
	P	0.015	0.376	0.395
Share of innovative products in total sales (percent)	ß	-0.009	0.009	-0.0002
	p	0.736	0.096	0.710
Share of R&D expenditures In total sales (percent)	ß	0.187	0.113	-0.003
	p	0.009	0.000	#####
Industry controls		yes	yes	yes
Number of firms		1,091	1,091	1,091

Note: For description of data, definition of variables and discussion of methods see text. ß is the estimated regression coefficient, p is the prob-value. All models include a constant. ##### indicates that the variance matrix in nonsymmetric or highly singular; standard errors cannot be computed.

Descriptive statistics

	Mean	sd	min	p25	p50	p75	max
Share of exports to low-income countries in total exports (percent)	11.97	19.26	0	0	1	19	100
Total factor productivity	-0.065	0.62	-2.27	-0.41	-0.12	0.22	1.88
Share if innovative products in total sales (percent)	11.99	20.25	0	0	3	15	100
Share of R&D expenditures in total sales (percent)	4.51	8.48	0	0	2	5	100

Table 3: Share of exports to low-income countries, productivity, and innovation: Regression results for Hungary

Method		OLS	RREG	MMREGESS
Dependent variable: Share of exports to low-income countries in total exports (percent)				
Total factor productivity	ß	-6.016	1.510	0.890
	p	0.212	0.033	0.051
Share of innovative products in total sales (percent)	ß	-0.015	0.073	0.003
	p	0.902	0.035	0.808
Share of R&D expenditures In total sales (percent)	ß	0.725	-0.001	-0.031
	p	0.273	0.988	0.905
Industry controls		yes	yes	yes
Number of firms		190	190	190

Note: For description of data, definition of variables and discussion of methods see text. ß is the estimated regression coefficient, p is the prob-value. All models include a constant.

Descriptive statistics

	Mean	sd	min	p25	p50	p75	max
Share of exports to low-income countries in total exports (percent)	26.67	36.75	0	0	5	50	100
Total factor productivity	0.013	0.65	-2.77	-0.35	-0.004	0.39	1.54
Share if innovative products in total sales (percent)	9.47	18.97	0	0	0	10	100
Share of R&D expenditures in total sales (percent)	1.85	4.70	0	0	0	1	30

Table 4: Share of exports to low-income countries, productivity, and innovation: Regression results for Italy

Method		OLS	RREG	MMREGESS
Dependent variable: Share of exports to low-income countries in total exports (percent)				
Total factor productivity	ß	0.667	3.021	2.035
	p	0.660	0.000	0.000
Share of innovative products in total sales (percent)	ß	0.065	0.031	0.012
	p	0.050	0.030	0.158
Share of R&D expenditures In total sales (percent)	ß	0.260	0.120	0.033
	p	0.009	0.003	0.367
Industry controls		yes	yes	yes
Number of firms		1,338	1,338	1,338

Note: For description of data, definition of variables and discussion of methods see text. ß is the estimated regression coefficient, p is the prob-value. All models include a constant.

Descriptive statistics

	Mean	sd	min	p25	p50	p75	max
Share of exports to low-income countries in total exports (percent)	16.00	23.62	0	0	5	20	100
Total factor productivity	-0.27	0.50	-3.07	-0.54	-0.27	0.004	1.42
Share if innovative products in total sales (percent)	16.44	22.27	0	0	10	20	100
Share of R&D expenditures in total sales (percent)	4.79	7.88	0	0	2	5	100

Table 5: Share of exports to low-income countries, productivity, and innovation: Regression results for Spain

Method		OLS	RREG	MMREGESS
Dependent variable: Share of exports to low-income countries in total exports (percent)				
Total factor productivity	ß	-2.145	1.538	1.984
	p	0.436	0.404	0.190
Share of innovative products in total sales (percent)	ß	0.034	0.087	0.036
	p	0.629	0.097	0.274
Share of R&D expenditures In total sales (percent)	ß	0.016	0.149	0.017
	p	0.904	0.137	0.845
Industry controls		yes	yes	yes
Number of firms		279	279	279

Note: For description of data, definition of variables and discussion of methods see text. ß is the estimated regression coefficient, p is the prob-value. All models include a constant.

Descriptive statistics

	Mean	sd	min	p25	p50	p75	max
Share of exports to low-income countries in total exports (percent)	18.21	24.35	0	0	10	25	100
Total factor productivity	-0.087	0.54	-3.26	-0.39	-0.12	0.25	1.79
Share if innovative products in total sales (percent)	15.03	19.16	0	0	10	20	100
Share of R&D expenditures in total sales (percent)	5.16	9.99	0	0	1	5	80

Table 6: Share of exports to low-income countries, productivity, and innovation: Regression results for the United Kingdom

Method		OLS	RREG	MMREGESS
Dependent variable: Share of exports to low-income countries in total exports (percent)				
Total factor productivity	ß	1.100	2.367	1.377
	p	0.616	0.020	0.027
Share of innovative products in total sales (percent)	ß	0.090	0.079	0.024
	p	0.126	0.001	0.289
Share of R&D expenditures In total sales (percent)	ß	0.096	0.168	0.095
	p	0.350	0.001	0.028
Industry controls		yes	yes	yes
Number of firms		274	274	274

Note: For description of data, definition of variables and discussion of methods see text. ß is the estimated regression coefficient, p is the prob-value. All models include a constant.

Descriptive statistics

	Mean	sd	min	p25	p50	p75	max
Share of exports to low-income countries in total exports (percent)	11.92	18.63	0	0	5	15	90
Total factor productivity	-0.116	0.49	-1.83	-0.44	-0.15	0.11	1.98
Share if innovative products in total sales (percent)	14.74	21.52	0	0	9	20	100
Share of R&D expenditures in total sales (percent)	4.29	9.45	0	0	1	5	100

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