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Exports, R&D and Productivity: A test of the Bustos-model with enterprise data from France, Italy and Spain

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Abstract

This paper uses comparable firm level data from France, Italy and Spain to test a hypothesis derived by Bustos (AER 2011) in a model that explains the decision of heterogeneous firms to export and to engage in R&D. Using a non-parametric test for first order stochastic dominance it is shown that, in line with this hypothesis, the productivity distribution of firms with exports and R&D dominates that of exporters without R&D, which in turn dominates that of firms that neither export nor engage in R&D. These results are in line with findings for Argentina reported by Bustos, and with findings for Germany and Denmark. The model, therefore, seems to be useful to guide empirical work on the relation between exports, R&D and productivity.

The data used in this study are available from the web; see www.efige.org and section 2 of the paper. To facilitate replication the Stata do-file is available from the author on request.
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1. Motivation

Over the past decade a huge literature emerged that theoretically analyzes the role of heterogeneous firms in international trade. Most of these models build on the seminal paper by Melitz (2003). At the core of this theoretical literature (that is surveyed by Redding (2011)) and the closely related micro-econometric literature on firm performance and international firm activities (that is surveyed in Wagner (2012a)) is the relation between firm productivity and exports. In a recent paper Bustos (2011) makes an important extension to this literature by introducing technology choice in a model of trade with heterogeneous firms. In her model, more productive firms gain higher revenues and therefore are the only ones that find paying the fixed costs that are needed to start exporting profitable (as in the Melitz (2003) model). In addition, only the most productive firms adopt the most advanced technology, because the benefit of adoption is proportional to revenues, while its cost is fixed.

As is proved in detail in Bustos (2011) in the model the underlying productivity differences produce a sorting of firms in three groups: the most productive firms both export and use the advanced technology, the intermediate group exports but still uses the old technology and the least productive firms use the old technology and serve only the domestic market only. In an empirical application the use of advanced technology is represented by spending on research and development (R&D). This leads to the following empirically testable hypothesis:

In a given industry productivity is highest in firms that export and engage in R&D, followed by firms that export and do not engage in R&D and by firms that do neither export nor engage in R&D.

Bustos (2011) finds support for this implication of her model with data from Argentina. Corroborative evidence is reported for German manufacturing firms by Wagner (2012b) and for German services firms by Vogel and Wagner (2013). Results reported for Denmark by Dilling-Hansen and Smith (2014) are also in line with this.

This note uses comparable firm level data from France, Italy and Spain for a further empirical test of these implications, 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, results are in line with the theoretical hypothesis for all three countries, too.

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). In this paper we focus on three of these countries (France, Italy and Spain) that have a sufficient number of firms from all three types, namely firms that export and engage in R&D, firms that export and do not engage in R&D and firms that do neither export nor engage in R&D.The cross-section data were collected in 2010 and mainly refer 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.

A firm is classified as an exporter if it sold abroad some or all of its own products directly from home country. A firm is considered to be engaged in R&D if it employed at least one employee in R&D. 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).

In a first step of the empirical investigation the hypotheses from the Bustos (2011) model are tested using t-tests for differences in the means of productivity between the three groups of firms. In a second step, non-parametric tests for first order stochastic dominance of the productivity distribution of one group of firms over the productivity distribution of another group of firms are applied. This test strategy was introduced into the empirical literature on exports by Delgado, Farinas and Ruano (2002). Let F and G denote the cumulative distribution functions of productivity for two groups of firms (say, exporters with and without R&D activities). First order stochastic dominance of F relative to G is given if $F(z) - G(z)$ is less or equal zero for all z with strict inequality for some z. Given two independent random samples of plants from each group, the hypothesis that F is to the right of G can be tested by the Kolmogorov-Smirnov test based on the empirical distribution functions for F and G in the samples (for details, see Conover 1999, p. 456ff.). Note that this tests not only for differences in the mean productivity of both groups (like in almost all other papers in the literature on trade and productivity) but for differences in all moments of the distribution.

3. Results

Results for empirical tests of the hypotheses from the Bustos (2011) model are reported in Table I. In all three countries the ranking of the mean values for TFP is in line with the Bustos hypothesis: Type 3 firms (that export and engage in R&D) have the highest average productivity, followed by Type 2 firms (that export but are not active in R&D), and Type 1 firms (that neither export nor do R&D) come last. A t-test for differences in the means of TFP reveals that this ranking is statistically significant at a conventional error level. Results of the two-sample Kolmogorov-Smirnov tests show that not only the means of the productivity distributions are ranked in this way. Using a conventional error level of five percent, we find that in line with the Bustos (2011) hypothesis the productivity distribution of firms with exports and R&D dominates that of exporters without R&D, which in turn dominates that of firms that neither export nor engage in R&D.

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4. Conclusions

This paper empirically tests a hypothesis derived by Bustos (2011) in a model that explains the decision of heterogeneous firms to export and to engage in R&D. Using comparable data for firms from France, Italy and Spain and a non-parametric test for first order stochastic dominance it is shown that, in line with this hypothesis, the productivity distribution of firms with exports and R&D dominates that of exporters without R&D, which in turn dominates that of firms that neither export nor engage in R&D. These results are in line with findings from for Argentina, Germany and Denmark. The model introduced in Bustos (2011), therefore, seems to be useful to guide empirical work on the relation between exports, R&D and productivity.

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Table I: Results of the empirical investigation

Country		Type 1 **E**xports: no, R&D: no	Type 2 Exports: yes, R&D: no	Type 3 Exports: yes, R&D: yes
France				
Number of enterprises		747	357	936
TFP	mean	-0.226	-0.132	-0.045
	sd	0.450	0.548	0.641
Italy				
Number of enterprises		529	592	1,002
TFP	mean	-0.408	-0.348	-0.206
	sd	0.445	0.475	0.497
Spain				
Number of enterprises		620	355	906
TFP	mean	-0.311	-0.213	-0.131
	sd	0.409	0.469	0.476

	Type 1 vs. Type 2	Type 1 vs. Type 3	Type 2 vs. Type 3
France			
t-Test for difference in means of TFP (prob-value)[1]	0.003	0.000	0.008
Two-sample Kolmogorov-Smirnov test for stochastical dominance (prob-value)[2]	0.005	0.000	0.001
Italy			
t-Test for difference in means of TFP (prob-value)[1]	0.014	0000	0.000
Two-sample Kolmogorov-Smirnov test for stochastical dominance (prob-value)[2]	0.025	0.000	0.000
Spain			
t-Test for difference in means of TFP (prob-value)[1]	0.001	0.000	0.003
Two-sample Kolmogorov-Smirnov test for stochastical dominance (prob-value)[2]	0.008	0.000	0.000

Note: TFP is total factor productivity; for details, see text.

[1] Test of H_0: mean of first group equal to mean of second group against H_1: mean of first group smaller than mean of second group. The t-test is a two-sample test with unequal variances.
[2] Test of H_0: distributions are equal against H_1: distribution of TFP of the second group stochastically dominates distribution of TFP of the first group.