

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

by
Joachim Wagner

University of Lüneburg
Working Paper Series in Economics

No. 310

October 2014

www.leuphana.de/institute/ivwl/publikationen/working-papers.html

ISSN 1860 - 5508

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

Joachim Wagner*

Leuphana University Lueneburg and CESIS, KTH, Stockholm

[This version: October 1, 2014]

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.

JEL classification: F14

Keywords: Exports, R&D, productivity, EFIGE data, France, Italy, Spain

* 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.

Joachim Wagner
Leuphana University Lueneburg
Institute of Economics
PO Box 2440
D-21314 Lueneburg, Germany

e-mail: wagner@leuphana.de

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.

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.

References

Altomonte, Carlo and Tommaso Aquilante (2012), The EU-EFIGE/Bruegel-UniCredit dataset. Bruegel Working Paper, No. 2012/13.

Bustos, Paula (2011), Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms. *American Economic Review* 101 (1), 304-340.

Conover, W. J. (1999), *Practical Nonparametric Statistics*. Third edition. New York etc.: John Wiley.

Delgado, Miguel A., Jose C. Farinas and Sonia Ruano (2002), Firm productivity and export markets: a non-parametric approach. *Journal on International Economics* 57 (2), 397-422.

Dilling-Hansen, Mogens and Valdemar Smith (2014), R&D, exports and productivity: testing the Bustos model on Danish data. *Applied Economics Letters* 21 (11), 733-737.

Hamermesh, Daniel S. (2000). The craft or labormetrics. *Industrial and Labor Relations Review* 53 (3), 363-380.

Levinsohn, James and Amil Petrin (2003), Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies* 70 (2), 317-341.

Melitz, Mark J. (2003), The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica* 71 (6), 1695-1725.

Redding, Stephen J. (2011), Theories of Heterogeneous Firms and Trade. *Annual Review of Economics* 3, 77-105.

Vogel, Alexander and Joachim Wagner (2013), Exports, R&D and Productivity in German Business Services Firms: A Test of the Bustos-Model. *Empirical Economics Letters* 12(1), 1-6.

Wagner, Joachim (2012a), International trade and firm performance: A survey of empirical studies since 2006. *Review of World Economics / Weltwirtschaftliches Archiv* 148 (2), 235-267.

Wagner, Joachim (2012b), Exports, R&D and productivity: a test of the Bustos-model with German enterprise data. *Economics Bulletin* 32 (3), 1942-1948.

Table I: Results of the empirical investigation

	<u>Type 1</u>	<u>Type 2</u>	<u>Type 3</u>
Country	Exports: no, R&D: no	Exports: yes, R&D: no	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
	<u>Type 1 vs. Type 2</u>	<u>Type 1 vs. Type 3</u>	<u>Type 2 vs. Type 3</u>
France			
t-Test for difference in means of TFP (prob-value) ¹	0.003	0.000	0.008
Two-sample Kolmogorov-Smirnov test for stochastic dominance (prob-value) ²	0.005	0.000	0.001
Italy			
t-Test for difference in means of TFP (prob-value) ¹	0.014	0.000	0.000
Two-sample Kolmogorov-Smirnov test for stochastic 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 stochastic 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.

Working Paper Series in Economics

(recent issues)

- No.309: *Thomas Wein*: Preventing Margin Squeeze: An Unsolvable Puzzle for Competition Policy? The Case of the German Gasoline Market, September 2014
- No.308: *Joachim Wagner*: Firm age and the margins of international trade: Comparable evidence from five European countries, September 2014
- No.307: *John P. Weche Gelübcke*: Auslandskontrollierte Industrie- und Dienstleistungsunternehmen in Niedersachsen: Performancedifferentiale und Dynamik in Krisenzeiten, August 2014
- No.306: *Joachim Wagner*: New Data from Official Statistics for Imports and Exports of Goods by German Enterprises, August 2014
- No.305: *Joachim Wagner*: A note on firm age and the margins of imports: First evidence from Germany, August 2014
- No.304: *Jessica Ingenillem, Joachim Merz and Stefan Baumgärtner*: Determinants and interactions of sustainability and risk management of commercial cattle farmers in Namibia, July 2014
- No.303: *Joachim Wagner*: A note on firm age and the margins of exports: First evidence from Germany, July 2014
- No.302: *Joachim Wagner*: A note on quality of a firm's exports and distance to destination countries: First evidence from Germany, July 2014
- No.301: *Ahmed Fayez Abdelgouad*: Determinants of Using Fixed-term Contracts in the Egyptian Labor Market: Empirical Evidence from Manufacturing Firms Using World Bank Firm-Level Data for Egypt, July 2014
- No.300: *Annika Pape*: Liability Rule Failures? Evidence from German Court Decisions, May 2014
- No.299: *Annika Pape*: Law versus Economics? How should insurance intermediaries influence the insurance demand decision, June 2013
- No.298: *Joachim Wagner*: Extensive Margins of Imports and Profitability: First Evidence for Manufacturing Enterprises in Germany, May 2014 [published in: *Economics Bulletin* 34 (2014), 3, 1669-1678]
- No.297: *Joachim Wagner*: Is Export Diversification good for Profitability? First Evidence for Manufacturing Enterprises in Germany, March 2014 [published in: *Applied Economics* 46 (2014), 33, 4083-4090]
- No.296: *Joachim Wagner*: Exports and Firm Profitability: Quality matters!, March 2014 [published in: *Economics Bulletin* 34 (2014), 3, 1644-1652]
- No.295: *Joachim Wagner*: What makes a high-quality exporter? Evidence from Germany, March 2014 [published in: *Economics Bulletin* 34 (2014), 2, 865-874]
- No.294: *Joachim Wagner*: Credit constraints and margins of import: First evidence for German manufacturing enterprises, February 2014
- No.293: *Dirk Oberschachtsiek*: Waiting to start a business venture. Empirical evidence on the determinants., February 2014

- No.292: *Joachim Wagner*: Low-productive exporters are high-quality exporters. Evidence from Germany, February 2014 [published in: *Economics Bulletin* 34 (2014), 2, 745-756]
- No.291: *Institut für Volkswirtschaftslehre*: Forschungsbericht 2013, Januar 2014
- No.290: *Stefan Baumgärtner, Moritz A. Drupp und Martin F. Quaas*: Subsistence and substitutability in consumer preferences, December 2013
- No.289: *Dirk Oberschachtsiek*: Human Capital Diversity and Entrepreneurship. Results from the regional individual skill dispersion nexus on self-employment activity., December 2013
- No.288: *Joachim Wagner and John P. Weche Gelübcke*: Risk or Resilience? The Role of Trade Integration and Foreign Ownership for the Survival of German Enterprises during the Crisis 2008-2010, December 2013
- No.287: *Joachim Wagner*: Credit constraints and exports: A survey of empirical studies using firm level data, December 2013
- No.286: *Toufic M. El Masri*: Competition through Cooperation? The Case of the German Postal Market, October 2013
- No.285: *Toufic M. El Masri*: Are New German Postal Providers Successful? Empirical Evidence Based on Unique Survey Data, October 2013
- No.284: *Andree Ehlert, Dirk Oberschachtsiek, and Stefan Prawda*: Cost Containment and Managed Care: Evidence from German Macro Data, October 2013
- No.283: *Joachim Wagner and John P. Weche Gelübcke*: Credit Constraints, Foreign Ownership, and Foreign Takeovers in Germany, September 2013
- No.282: *Joachim Wagner*: Extensive margins of imports in The Great Import Recovery in Germany, 2009/2010, September 2013 [published in: *Economics Bulletin* 33 (2013), 4, 2732-2743]
- No.281: *Stefan Baumgärtner, Alexandra M. Klein, Denise Thiel, and Klara Winkler*: Ramsey discounting of ecosystem services, August 2013
- No.280: *Antonia Arsova and Deniz Dilan Karamen Örsal*: Likelihood-based panel cointegration test in the presence of a linear time trend and cross-sectional dependence, August 2013
- No.279: *Thomas Huth*: Georg von Charasoff's Theory of Value, Capital and Prices of Production, June 2013
- No.278: *Yama Temouri and Joachim Wagner*: Do outliers and unobserved heterogeneity explain the exporter productivity premium? Evidence from France, Germany and the United Kingdom, June 2013 [published in: *Economics Bulletin*, 33 (2013), 3, 1931-1940]
- No.277: *Horst Raff and Joachim Wagner*: Foreign Ownership and the Extensive Margins of Exports: Evidence for Manufacturing Enterprises in Germany, June 2013
- No.276: *Stephan Humpert*: Gender Differences in Life Satisfaction and Social Participation, May 2013
- No.275: *Sören Enkelmann and Markus Leibrecht*: Political Expenditure Cycles and Election Outcomes Evidence from Disaggregation of Public Expenditures by Economic Functions, May 2013
- No.274: *Sören Enkelmann*: Government Popularity and the Economy First Evidence from German Micro Data, May 2013

- No.273: *Michael Berlemann, Soeren Enkelmann, and Torben Kuhlenskasper: Unraveling the Relationship between Presidential Approval and the Economy – A Multi-Dimensional Semi-Parametric Approach, May 2013*
- No.272: *Michael Berlemann and Sören Enkelmann: The Economic Determinants of U.S. Presidential Approval – A Survey, May 2013*
- No.271: *Soeren Enkelmann: Obama and the Macroeconomy Estimating Social Preferences Between Unemployment and Inflation, May 2013*
- No.270: *Anja Köbrich León: Does Cultural Heritage affect Employment decisions – Empirical Evidence for Second Generation Immigrants in Germany, April 2013*
- No.269: *Anja Köbrich León and Christian Pfeifer: Religious Activity, Risk Taking Preferences, and Financial Behavior, April 2013*
- No.268: *Anja Köbrich León: Religion and Economic Outcomes – Household Savings Behavior in the USA, April 2013*
- No.267: *John P. Weche Gelübcke and Isabella Wedl: Environmental Protection of Foreign Firms in Germany: Does the country of origin matter?, April 2013*
- No.266: *Joachim Wagner: The Role of extensive margins of exports in *The Great Export Recovery* in Germany, 2009/2010, March 2013 [published in: Jahrbücher für Nationalökonomie und Statistik 234 (2014), 4, 519-526]*
- No.265: *John-Oliver Engler and Stefan Baumgärtner: Model choice and size distribution: a Bayequentist approach, February 2013*
- No.264: *Chiara Franco and John P. Weche Gelübcke: The death of German firms: What role for foreign direct investment?, February 2013*
- No.263: *Joachim Wagner: Are low-productive exporters marginal exporters? Evidence from Germany, February 2013 [published in Economics Bulletin 33 (2013), 1, 467-481]*
- No.262: *Sanne Hiller, Philipp J. H. Schröder, and Allan Sørensen: Export market exit and firm survival: theory and first evidence, January 2013*
- No.261: *Institut für Volkswirtschaftslehre: Forschungsbericht 2012, Januar 2013*
- No.260: *Alexander Vogel and Joachim Wagner: The Impact of R&D Activities on Exports of German Business Services Enterprises : First Evidence from a continuous treatment approach, December 2012*
- No.259: *Christian Pfeifer: Base Salaries, Bonus Payments, and Work Absence among Managers in a German Company, December 2012*
- No.258: *Daniel Fackler, Claus Schnabel, and Joachim Wagner: Lingerin illness or sudden death? Pre-exit employment developments in German establishments, December 2012 [published in: Industrial and Corporate Change 23 (2014), 4, 1121-1140]*
- No.257: *Horst Raff and Joachim Wagner: Productivity and the Product Scope of Multi-product Firms: A Test of Feenstra-Ma, December 2012 [published in: Economics Bulletin, 33 (2013), 1, 415-419]*
- No.256: *Christian Pfeifer and Joachim Wagner: Is innovative firm behavior correlated with age and gender composition of the workforce? Evidence from a new type of data for German enterprises, December 2012 [published in: Journal of Labour Market Research 47 (2014), 3, 223-231]*

(see www.leuphana.de/institute/ivwl/publikationen/working-papers.html for a complete list)

Leuphana Universität Lüneburg
Institut für Volkswirtschaftslehre
Postfach 2440
D-21314 Lüneburg
Tel.: ++49 4131 677 2321
email: brodt@leuphana.de

www.leuphana.de/institute/ivwl/publikationen/working-papers.html