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The impact of exporting on firm productivity: a meta-analysis of the learning-by-exporting hypothesis

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Abstract We conduct a meta-analysis of more than 30 papers that study the causal relationship between exporting and firm productivity. Our main result, robust to different specifications and to different weights for each observation, indicates that the impact of exporting upon productivity is higher for developing than developed economies. We also find that the export effect tends to be higher (1) in the first year that firms start exporting (compared to later years); and (2) when the sample used in the paper is not restricted to matched firms. Moreover, we find no evidence of publication bias.

Keywords Productivity · Globalisation · Publication bias

JEL Classification F15 · F20

1 Introduction

Exporting can be an important source of information, competitive pressures and other productivity advantages for firms, leading to significant performance

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improvements (Krugman 1980; Bernard et al. 2003). Given its potential relevance, this learning-by-exporting hypothesis spurred a large number of empirical studies that seek to assess the causal effect of exporting at the firm level. However, there is no consensus on whether such effect exists or what specific factors may be behind it. In fact, a recent survey (Wagner 2007) indicates that the evidence on this learning effect is 'mixed and unclear', while it is well established that, on average, firms that export are more productive than firms that do not export and that there is self-selection in the exporting process (more productive firms are the ones that tend to become exporters).

Given the large amount of heterogeneity across the many studies that examine the causal impact of exporting, our paper adopts a meta-analysis approach (Card and Krueger 1995; Ashenfelter et al. 1999; Görg and Strobl 2001; Pereira and Martins 2004). Under this approach, we try to understand if there are any systematic relationships between the characteristics of each study and its results. In fact, there are several dimensions in which a specific paper can be different from other studies, such as the range of country coverage, the type of dependent variable, the characteristics of the sample, and the estimation methods.[1]

A related question that we are also interested in concerns the possibility of publication bias. Indeed, it has been suggested that journal editors may favour studies that reach significant results to the detriment of papers which find no significant relationships. Such selection process would result in a non-representative set of evidence, thus biasing one's inference about the magnitude of the effect of interest.

Surveying more than 30 papers and conducting different robustness tests, we are able to find some clear patterns concerning the study features that can systematically predict study outcomes. In particular, we find that the impact of exporting upon productivity is higher at developing than at developed economies, an important result from the point of views of the economic analysis of globalisation and economic policy in general. We also find evidence that the impact of exporting upon productivity (1) is higher in the first year that firms start exporting than at later years; and (2) is lower when only matched firms are considered. Moreover, we do not find evidence of publication bias.

The next section describes in more detail the econometric approach undertaken in the studies that we analyse and then explains our own econometric methodology. Section 3 describes the studies that we examine, while Sect. 4 presents the results and the robustness analysis. Finally, Sect. 5 concludes.

2 Methodology

As we are interested primarily in firm-level panel-data studies that examine the causal impact of exports in terms of firm performance, we consider only papers that estimate equations of the following type:

[1] See also the meta-analysis results presented in ISGEP (The International Study Group on Exports and Productivity) (2007).

$$dY_{it} = \beta \text{Export}_i + \lambda X_{it} + \gamma_t + e_{it}, \quad (1)$$

in which dY_{it} is a measure of the (percentual) change in the performance of firm i for a given base period up to period t; and Export_i is an indicator variable taking value one if firm i became an exporter over period t or value zero if the firm remained a non-exporter over the same period. The equation may also include other control variables, such as firm characteristics (X_{it}) and/or controls for business cycle effects (γ_t.) The key parameter that we are interested in is β, which indicates the average change in performance for firms that become exporters with respect to firms that remain non-exporters. We then relate the estimates of β to the characteristics of each respective study.

It is important to emphasise that there are other methods that have been employed in the literature about the relationship between exporting and firm performance. For instance, some studies conduct Kolmogorov–Smirnov analyses, in order to consider the entire distribution of firm performance. Another group of studies also adopt equations similar to Eq. 1 but are interested instead in other dependent variables than performance, such as employment, wages, costs, investment or innovations. A third group of studies addresses different but related issues, such as the determinants of exporting behaviour, comparisons between domestic firms and multinationals or comparisons between the exiting behaviour of exporting and non-exporting firms. However, in order to focus our analysis on comparable studies, we consider only those that estimate equations as in Eq. 1 and that take the change in firm performance as their dependent variable. We therefore do not consider studies that measure performance in levels rather than in growth rates or that analyse the effects of different export intensities.[2]

Another important point to mention is that even panel-data studies that adopt a difference-in-differences approach do not necessarily estimate the causal effect of exporting upon firm productivity or any other dependent variable of interest. If assignment to 'treatment' (to become an exporter) is not random and, in particular, if such assignment varies with unobserved characteristics that also affect the outcome of interest, then the estimate obtained in studies such as those we consider here will also capture other effects than simply the effect of exporting. However, we also believe that by restricting our coverage to papers that use firm-level panel data to estimate Eq. 1, we will be examining less biased estimates of the causal effect of exporting than if we were to consider the wider set of estimates available in the literature.

Once the set of studies considered is defined, our next step is to characterise them in terms of several dimensions that we regard as of particular interest and that can be obtained from the information available in the papers. The variables that we consider can be grouped into the following categories:

1. *Economic development*. Differences in the level of development of a country may tend to be systematically related to the impact of exporting upon performance. For instance, firms from developing countries may benefit from a

[2] There is a small number of studies that do implement analysis as those of Eq. 1 but are not considered in our paper because they do not make available enough information about the data and methods used.

stronger performance effect when entering the export market, to the extent that those firms are likely to be further away from the frontier of technological knowledge. Therefore, such firms from developing economies are perhaps likely to learn more from overseas clients or competitors than 'similar' firms based in developed countries. We examine the role of this factor by considering a dummy variable taking value one for firms based in developed countries and value zero for firms based in developing countries. We consider the UN definition of a developed economy but our results below are robust to alternative definitions.

2. *Estimation method*. While the most standard approach to the estimation of Eq. 1 is ordinary least squares (OLS)/fixed effects (FE), several papers adopt alternative methods. Some papers implement propensity score matching (PSM), some conduct different version of the generalised method of moments (GMM), while others use full information maximum likelihood (FIML) approaches. To the extent that the assumptions made in OLS/FE lead to upward biased estimates of the impact of exporting upon firm performance (because high-performance firms are more likely to select into exporting than low-performance firms), then one may expect that non-OLS methods would lead to lower estimates. We implement this analysis by lumping into a non-OLS dummy variable all estimation methods other than OLS or FE.
3. *Performance measurement timing*. The effects of exports upon performance do not need to be constant over time. For instance, firms may learn considerably when they start exporting but not much more after they have exported for some time. Alternatively, the effects from exports may take some time to materialise, possibly if the distance to the technological frontier is considerable. Again, we create a dummy variable that flags those estimates that are based on a 'long-run' analysis, which here we define as more than two periods after the firm began exporting.
4. *Sample heterogeneity*. The comparability of firms in the 'treatment' and 'control' groups is a crucial aspect of most empirical studies. Recently some researchers have suggested that (propensity score) matching methods can be more effective than traditional OLS and other methods in terms of generating an adequate 'like-for-like' comparison between the two groups (Rosenbaum and Rubin 1983). To the extent that non-matched samples are more diverse and less comparable than matched samples (when the sample is restricted to firms with similar matching values), the measured effects of the relationship between exports and performance may be higher than when a matched sample is used. As before, we address this hypothesis by considering a dummy variable taking value one for estimates based on matched samples.
5. *Measurement of productivity*. There are different ways of measuring productivity. The most common one—but perhaps also the most difficult to compute, given its data requirement—is total factor productivity (TFP). Perhaps due to such potential problems in correctly estimating TFP, measurement error in that variable can introduce an attenuation bias and lead to lower estimates of the impact of exporting upon performance. We test this hypothesis by considering a dummy variable that captures all estimates based in other variables than TFP.

6. *Time period*. The effect of exports may also be changing over time, particularly as globalisation affects more profoundly a wider set of countries. This process of widening globalisation may mean that exporters become an increasingly more common group of firms, thus eroding the performance advantage that is presumably generated by exporting. We test this hypothesis by including a control variable indicating the average year of the data sample underpinning each estimate.

Finally, our main results from our meta-analysis are obtained from estimating an equation of the following type:

$$\hat{\beta}_j = \alpha_0 + \sum_{k=1}^{K} \alpha_k Z_{jk} + e_j, \tag{2}$$

in which $\hat{\beta}_j$ is the reported estimate of the jth study and Z_{jk} are the variables that measure the characteristics of that same estimate and that were described above.

Although meta-analyses typically weight each study equally, one may also argue that papers published in journals that stand higher in comparative rankings are likely to be of greater importance and thus also deserve a greater weighting in meta-analysis studies. Under that assumption, we also consider in our estimation different weights for each estimate, depending on the ranking of the journal in which the paper and the estimate appear. In particular, we consider three different rankings: those computed by Axarloglou and Theoharakis (2003) and Kalaitzidakis et al. (2001) and a third ranking based on the simple average of twelve different rankings[3]. However, our benchmark results are based on an unweighted analysis of the estimates.

Another important aspect to be taken into account is that some papers present more estimates than others. In order not to let a few papers that may include large numbers of estimates dominate our findings in a disproportionate way, we divide the weight of the ranking (if we are using one) by the number of estimates in the paper. In the benchmark case in which we do not use any journal weight, we use a weight defined by the inverse of the number of estimates in the paper.

3 Descriptive statistics

We were able to find 57 studies that address the causal effect of exporting on firm performance. After restricting the studies to those that consider productivity effects, we are left with 33 studies that we include in our analysis. 27 papers are published in academic journals and six are working papers.

Table 1 presents the list of those 33 papers that we use in the meta-analysis, along with some of their main characteristics, such as their (average) estimate (as mentioned above, many papers present more than one estimate of the relationship between exports and productivity). Other variables described in the table are if the

[3] CEMPRE (Centre for Macroeconomic and Forecasting Studies) and NIPE (Economic Policies Research Unit) (2006).

Table 1 List of all studies and their main characteristics

Reference	Countries	Coeff.	Sig.	M.	N.O.	Dev.	*N*	W.
Bernard and Jensen (1999)	US	0.00	0	0	0.0	1.0	3	42.2
Kraay (1999)	China	0.71	++	0	1.0	0.0	2	
Aw et al. (2000)	Asian (1)	0.02	0	0	0.0	0.0	20	20.9
Castellani (2002)	Italy	−0.00	0	0	0.0	1.0	1	15.5
Isgut (2001)	Colombia	0.06	+	0	0.0	0.0	10	14.7
Hallward-Driemeier et al. (2002)	Asian (2)	0.12	+	0	0.0	0.0	10	
Wagner (2002)	Germany	0.04	0	1	1.0	1.0	1	26.4
Baldwin and Gu (2003)	Canada	0.04	++	0	0.3	1.0	6	25.7
Hansson and Lundin (2004)	Sweden	0.03	+	0	0.0	1.0	6	15.5
Bernard and Jensen (2004)	USA	0.00	0	0	0.0	1.0	1	8.9
Bigsten et al. (2004)	African (3)	0.06	0	0	1.0	0.0	6	14.7
Blalock and Gertler (2004)	Indonesia	0.04	++	0	0.0	0.0	4	32.8
Damijan et al. (2004)	Slovenia	0.03	0	0	0.0	1.0	5	
Girma et al. (2004)	UK	0.05	+	1	1.0	1.0	8	11.1
Greenaway and Yu (2004)	UK	0.33	+	0	1.0	1.0	2	15.5
Greenaway and Kneller (2004)	UK	0.05	+	1	0.5	1.0	6	8.9
Hahn (2004)	S. Korea	0.90	0	0	0.0	0.0	1	
Mengistae and Pattillo (2004)	African (4)	0.08	+	0	0.0	0.0	2	8.0
Alvarez and Lopez (2005)	Chile	0.23	+	0	0.0	0.0	3	25.7
Arnold and Hussinger (2005)	Germany	−0.01	0	1	1.0	1.0	2	15.5
Fernandes and Isgut (2005)	Colombia	0.05	++	1	0.8	0.0	8	
Greenaway et al. (2005)	Sweden	0.19	0	1	1.0	1.0	26	15.5
Requena Silvente (2005)	UK	0.01	+	0	0.0	1.0	4	3.1
Van Biesebroeck (2005)	African (5)	0.25	++	0	0.3	0.0	12	42.2
Yasar and Rejesus (2005)	Turkey	0.16	+	1	1.0	0.0	9	26.4
Yasar et al. (2006)	Turkey	0.21	++	0	0.0	0.0	12	15.5
Damijan and Kostevc (2007)	Slovenia	0.20	0	1	1.0	1.0	5	15.5
De Loecker (2007)	Slovenia	0.01	0	1	1.0	1.0	5	42.2
Farinas and Martin-Marcos (2007)	Spain	0.04	+	0	0.5	1.0	16	15.9
Greenaway and Kneller (2007)	UK	0.01	0	1	1.0	1.0	3	15.5
ISGEP (2007)	13 countries (6)	0.02	0	0	0.0	0.8	57	
Crespi et al. (2008)	UK	0.21	++	0	0.3	1.0	4	25.7
Greenaway and Kneller (2008)	UK	0.04	0	1	1.0	1.0	15	36.9

All variables are averaged by paper. 'Coeff.' is the coefficient of each paper. 'Sig.' describes the significance of the estimates reported in each paper (++: at least 75% of the estimates significantly positive at the 10% level; +: at least 50% of the estimates significantly positive at the 10% level; 0: less than 50% of the estimates significantly positive at the 10% level and less than 50% of the estimates significantly negative at the 10% level); 'M.' is a dummy variable equal to one if the paper adopts a matching method. 'N.O.' is a dummy variable if the paper adopts a different econometric method that OLS (or fixed effects). 'Dev.' is a dummy variable equal to one if the country is classified as developed. 'N' indicates the number of estimates used from the paper. 'W.' is an indication of the total weight assigned to the paper. The weight used here draws on CEMPRE and NIPE (2006); alternative weights are also used in the paper. Country groups: (1): Taiwan and South Korea; (2): Malaysia, Indonesia, Thailand, S. Korea and Philippines; (3): Cameroon, Kenya, Ghana and Zimbabwe; (4): Ghana, Kenya and Ethiopia; (5): Ethiopia, Tanzania, Burundi, Zambia, Kenya, Ghana, Cote d'Ivoire, Cameroon and Zimbabwe; (6): Austria, Belgium, Chile, China, Colombia, France, Germany, Italy, Ireland, Slovenia, Spain, Sweden and United Kingdom (Denmark is also analysed in the paper but not in terms of the learning-by-exporting hypothesis)

Table 2 Descriptive statistics

Variable	Mean	Std. dev.	N
Coefficient	0.09	0.19	275
St. error	0.09	0.21	275
t-Value	1.99	3.2	275
Developed	0.60	0.49	275
Non-OLS	0.39	0.49	275
Matched sample	0.32	0.47	275
Long effect	0.68	0.47	275
Survey year	1994.21	4.99	275
No. observations	13,303.2	55,786.54	275
Weight 1	0.91	1.29	151
Weight 2	0.76	1.58	168
Weight 3	2.9	3.26	192

'Developed' is a dummy variable equal to one when the estimate refers to developed economies (UN definition). 'Non-OLS' is equal to one if the estimate is based on other econometric methods than OLS or fixed effects. 'Matched sample' is a dummy variable equal to one if the estimate is based on a matching approach. 'Long effect' is a dummy variable equal to one if the estimate is based on the exporting effect after entrant year. 'Plant' is a dummy variable equal to one if the estimate is based on plant-level data. (Journal) Weight 1 corresponds to Kalaitzidakis et al. (2001), Weight 2 corresponds to Axarloglou and Theoharakis (2003), and Weight 3 corresponds to CEMPRE and NIPE (2006)

paper carries out a matching analysis, if the paper adopts other methods than OLS or FE, if the country upon which the estimates are based is developed or not, and the number of estimates reported in the paper. Finally, we also indicate the weight carried by each paper (which, in some specifications, is then divided by the number of estimates to generate the weight of each estimate). The paper weight can be derived from one of three different rankings (the one displayed in the table is from CEMPRE and NIPE (2006)).

The next table summarizes the main features of our data set. In Table 2 we describe the 275 estimates included in our analysis, of which 60% refer to developed countries; 39% of all estimates implement non-OLS econometric techniques; and 32% involve PSM. The average number of observations in each sample is 13,303 (although this large number is driven to a large extent by an outlier in this respect (Hahn 2004)).

4 Results

Our main results, based on the estimation of Eq. 2 are presented in Tables 3 and 4. In both tables, the first column does not assign any weight to each estimate, while the remaining three columns consider each a separate weight to different papers based on the ranking of the journal in which the paper was published.

As documented in Table 3, we find that, on the one hand, developed countries tend to exhibit lower effects from exporting in terms of the performance of their

Table 3 Meta-analysis regression

	No weight (1)	Weight 1 (2)	Weight 2 (3)	Weight 3 (4)
Developed	−0.059 (0.041)	−0.077*** (0.029)	−0.083*** (0.030)	−0.059** (0.025)
Non-TFP	−0.024 (0.032)	0.012 (0.026)	0.039* (0.021)	0.023 (0.023)
Non-OLS	0.104** (0.050)	0.029 (0.049)	0.062 (0.039)	0.051 (0.050)
Matched sample	−0.045 (0.041)	−0.075* (0.042)	−0.076** (0.034)	−0.064 (0.049)
Long term	−0.043* (0.026)	−0.058* (0.034)	−0.061** (0.025)	−0.072** (0.030)
Survey year	0.0001 (0.004)	0.0008 (0.001)	0.002** (0.0009)	0.002 (0.002)
$\sqrt{\text{No. observations}}$	0.0003 (0.0003)	−0.0003*** (0.0001)	−0.0002* (0.00008)	−0.0002** (0.00007)
Intercept	−0.079 (8.808)	−1.443 (2.433)	−3.545** (1.771)	−4.146 (3.683)
Obs.	218	151	168	192
R^2	0.053	0.3	0.285	0.181
F-statistic	3.238	7.44	10.227	6.185

The dependent variable for each regression is an estimate of the relationship between exports and firm productivity from the studies considered in this paper. The explanatory variables are different characteristics of each study. 'Developed' is a dummy variable equal to one when the estimate refers to developed economies (UN definition). 'Non-OLS' is equal to one if the estimate is based on other econometric methods than OLS or fixed effects. 'Matched sample' is a dummy variable equal to one if the estimate is based on a matching approach. 'Long effect' is a dummy variable equal to one if the estimate is based on the exporting effect after entrant year. (Journal) Weight 1 corresponds to Kalaitzidakis et al. (2001), Weight 2 corresponds to Axarloglou and Theoharakis (2003), and Weight 3 corresponds to CEMPRE and NIPE (2006). Significance levels: *: 0.10; **: 0.05; ***: 0.01

firms, the effect ranging between −0.059 and −0.083. On the other hand, non-OLS estimators tend to generate higher estimates of the role of exports (although the difference is only significant in one column), while long-term effects tend to result in weaker effects upon performance. We also find that matched samples tend to produce lower estimates, although in two specifications the coefficient is not significant.[4]

We complement this main analysis by extending our specification with a control for the standard error of the estimate under analysis. In fact, bigger point estimates are not necessarily as significant as smaller estimates, so that our previous results may be misleading in terms of the effects of different characteristics of the studies. By controlling for the standard error, we address this possibility. Once we do this (see Table 4), we find that more covariates are significantly related to the estimates of the impact of exports on productivity. In particular, in the case of the model without weights, we find that non-TFP dependent variables and more recent data now lead to bigger (more positive) impacts.

In general, we find that the results are very robust across the two tables. In particular, the result about the role of development is generally unchanged across the different weights, at least in qualitative terms. Across virtually all columns of the two tables, developed countries display lower estimates of the relationship between exports and productivity. In fact, the role of development ranges between

[4] Moreover, studies with more observations tend to lead to smaller effects; and there is some evidence that more recent studies lead to bigger effects, although in only one case the coefficient is significant.

Table 4 Meta-analysis regression (including standard errors)

	No Weight (1)	Weight 1 (2)	Weight 2 (3)	Weight 3 (4)
Developed	−0.121*** (0.029)	−0.065** (0.027)	−0.056** (0.028)	−0.059*** (0.022)
Non-TFP	0.057** (0.023)	0.024 (0.024)	0.042** (0.020)	0.039** (0.019)
Non-OLS	0.063* (0.038)	−0.003 (0.036)	0.024 (0.029)	0.018 (0.032)
Matched sample	−0.064** (0.033)	−0.063** (0.027)	−0.058*** (0.021)	−0.058* (0.031)
Long term	−0.045** (0.022)	−0.050 (0.030)	−0.058** (0.023)	−0.068*** (0.025)
Survey year	0.007*** (0.002)	0.001 (0.001)	0.002* (0.001)	0.003 (0.002)
$\sqrt{\text{No. observations}}$	0.0003** (0.0001)	−0.0002** (0.00009)	−0.0001 (0.00007)	−0.00008 (0.00007)
St. error	0.593*** (0.106)	0.653*** (0.121)	0.705*** (0.127)	0.557*** (0.111)
Intercept	−14.566*** (4.345)	−2.373 (2.715)	−3.075 (1.927)	−6.444 (4.164)
Obs.	218	151	168	192
R^2	0.441	0.465	0.426	0.424
F-statistic	9.062	11.443	15.658	8.882

The dependent variable for each regression is an estimate of the relationship between exports and firm productivity from the studies considered in this paper. The explanatory variables are different characteristics of each study. 'Developed' is a dummy variable equal to one when the estimate refers to developed economies (UN definition). 'Non-OLS' is equal to one if the estimate is based on other econometric methods than OLS or fixed effects. 'Matched sample' is a dummy variable equal to one if the estimate is based on a matching approach. 'Long effect' is a dummy variable equal to one if the estimate is based on the exporting effect after entrant year. (Journal) Weight 1 corresponds to Kalaitzidakis et al. (2001), Weight 2 corresponds to Axarloglou and Theoharakis (2003), and Weight 3 corresponds to CEMPRE and NIPE (2006). Significance levels: *: 0.10; **: 0.05; ***: 0.01

−0.056 and −0.121 and, except for one case out of eight, all coefficients are significant, at least at the 5% level. Given that the average level across all studies of the role of exporting upon productivity is around 9% (see Table 2), it is clear from our findings that a country development level can be a particularly important dimension in these studies.

However, there are two other results that also suggest a relatively clear relationship between the respective study characteristic and the ensuing estimate of the role of exports. These additional variables are the short-/long-run dimension and the matched/unmatched sample. In the first case, the estimates in columns (1), (3) and (4) (Table 4) indicate that long-run studies systematically display lower relationships between exporting and productivity. The three coefficients are also particularly similar, ranging between −0.045 and −0.068, each significant at least at the 5% level.

The second case concerns the role of matched samples. Across all columns, we find that the coefficients are, again, almost identical. Moreover, only one of the four coefficients is significant at only 10% while the others are significant at least at the 5% level. Taken at face value, the size of the estimates (about −0.06) is again considerable, when compared to the average coefficient across all studies (0.09).

Finally, for the benefit of robustness, we also re-estimate our results considering only the subset of significant estimates. Moreover, we also consider the possible role

Table 5 Meta-analysis Regression (only significant estimates; including plant control)

	No Weight (1)	Weight 1 (2)	Weight 2 (3)	Weight 3 (4)
Developed	−0.266*** (0.095)	−0.195*** (0.064)	−0.217*** (0.059)	−0.160** (0.069)
Non-TFP	0.055 (0.041)	0.041 (0.035)	0.047* (0.027)	0.031 (0.035)
Non-OLS	0.028 (0.051)	−0.048 (0.037)	−0.081** (0.037)	−0.057 (0.041)
Matched sample	0.003 (0.033)	0.008 (0.042)	0.049 (0.038)	0.052 (0.038)
Long term	0.005 (0.030)	0.045 (0.034)	0.054** (0.026)	0.019 (0.034)
Survey year	0.015*** (0.003)	0.013*** (0.003)	0.011*** (0.003)	0.013*** (0.004)
$\sqrt{\text{No. observations}}$	−0.0004** (0.0002)	−0.002*** (0.0002)	−0.001*** (0.0002)	−0.001*** (0.0002)
Plant	−0.088 (0.079)	0.011 (0.079)	−0.036 (0.069)	0.025 (0.082)
Intercept	−29.234*** (5.802)	−26.034*** (5.516)	−21.938*** (6.872)	−26.395*** (8.144)
Obs.	102	72	72	82
R^2	0.312	0.65	0.668	0.525
F-statistic	10.811	26.655	29.695	8.972

The dependent variable for each regression is an estimate of the relationship between exports and firm productivity from the studies considered in this paper. The explanatory variables are different characteristics of each study. 'Developed' is a dummy variable equal to one when the estimate refers to developed economies (UN definition). 'Non-OLS' is equal to one if the estimate is based on other econometric methods than OLS or fixed effects. 'Matched sample' is a dummy variable equal to one if the estimate is based on a matching approach. 'Long effect' is a dummy variable equal to one if the estimate is based on the exporting effect after entrant year. 'Plant' is a dummy variable equal to one if the estimate is based on plant-level data. (Journal) Weight 1 corresponds to Kalaitzidakis et al. (2001), Weight 2 corresponds to Axarloglou and Theoharakis (2003), and Weight 3 corresponds to CEMPRE and NIPE (2006). Significance levels: *: 0.10; **: 0.05; ***: 0.01

of the level of the data (firm- or plant/establishment-level), another dimension that may affect the size of the estimates reported in different studies.[5] These new findings are presented in Table 5. The results again indicate a (very) significant negative relationship between development and the export effect on firm productivity. The coefficients range between −0.16 and −0.27 and are all significant at the 5% level or less.[6]

On the one hand, we also find that most of the other dimensions of the studies for which we document significant relationships (short-/long-run dimension and matched/unmatched sample) are now insignificant (and sometimes of the 'wrong' sign). We believe this can be explained by the smaller number of observations under this subsample. Another explanation is the smaller amount of variation across observations, given the restriction that only significant estimates are to be considered, which would reduce the precision of the coefficients of the meta-analysis results. On the other hand, it is noteworthy that even these restrictive conditions do not lead to the erosion of the main result of the paper, that of a

[5] This is achieved by including a dummy variable that takes value one only if the estimate is based on plant-level data. We found that 43% of the 275 estimates are based on such data.

[6] We have also conducted this robustness analysis separately—i.e. including only the significant estimates or including only the plant-level dummy variable and the quantitative and qualitative results are generally unchanged.

Table 6 Publication bias

	No Weight (1)	Weight 1 (2)	Weight 2 (3)	Weight 3 (4)
$\sqrt{\text{No. observations}}$	0.002 (0.003)	−0.005 (0.003)	−0.002 (0.003)	−0.001 (0.003)
Developed	−0.773 (0.533)	−0.983 (0.766)	−0.051 (0.616)	−1.100 (0.703)
Non-TFP	1.289*** (0.424)	1.609*** (0.479)	1.816*** (0.460)	1.889*** (0.463)
Non-OLS	−2.156** (0.867)	−2.104** (1.046)	−2.697** (1.267)	−2.368*** (0.890)
Matched sample	1.090 (0.859)	−0.872 (0.620)	0.377 (1.067)	0.523 (0.729)
Long effect	−1.289*** (0.497)	−0.321 (0.669)	−1.349** (0.528)	−1.186** (0.546)
Survey year	0.044 (0.050)	0.016 (0.041)	0.046* (0.025)	0.076 (0.051)
Intercept	−83.347 (98.832)	−26.707 (82.829)	−88.296* (49.832)	−146.568 (100.692)
Obs.	218	151	168	192
R^2	0.173	0.34	0.256	0.263
F-statistic	8.196	7.47	6.507	9.224

The dependent variable for each regression is the *t*-ratio from the studies considered in this paper. The explanatory variables are different characteristics of each study. 'Developed' is a dummy variable equal to one when the estimate refers to developed economies (UN definition). 'Non-OLS' is equal to one if the estimate is based on other econometric methods than OLS or fixed effects. 'Matched sample' is a dummy variable equal to one if the estimate is based on a matching approach. 'Long effect' is a dummy variable equal to one if the estimate is based on the exporting effect after entrant year. (Journal) Weight 1 corresponds to Kalaitzidakis et al. (2001), Weight 2 corresponds to Axarloglou and Theoharakis (2003), and Weight 3 corresponds to CEMPRE and NIPE (2006). Significance levels: *: 0.10; **: 0.05; ***: 0.01

negative relationship between development and the export effect on firm productivity.

4.1 Publication bias

Following the meta-analysis literature (Card and Krueger 1995), our paper also tests whether there is a publication bias in the research about the causal effects of exporting on performance. Indeed, one may expect that studies on this or any other topic will be more likely to be published if they obtain significant effects. In this case, the evidence one would obtain from studying the literature could be severely biased.

We search for evidence about publication bias in our sample by regressing the *t*-ratio of each estimate on the same set of controls as in Eq. 2 plus a control for the square root of the number of observations used for that same estimate. The rationale for this analysis is that in the absence of publication bias, the studies with relatively small number of observations are more likely to be published if they have a high *t*-value. As Card and Krueger (1995) put it, "If studies are only published if they achieve a *t*-ratio of 2 or more, and if researchers choose their specification in part to achieve statistically significant results, then the early studies [in the minimum-wage literature examined by the author] may tend to have high *t*-ratios despite their small samples" (p. 239).

Our results about this issue are presented in Table 6. We find that, consistent with the publication bias case, the results of some specifications do suggest that estimates based on more observations have lower *t*-ratios. However, as Fig. 1 indicates, this

Table 7 Publication bias (excluding outliers)

	No Weight (1)	Weight 1 (2)	Weight 2 (3)	Weight3 (4)
$\sqrt{\text{No. observations}}$	0.022*** (0.005)	0.018*** (0.004)	0.021*** (0.004)	0.020*** (0.004)
Developed	0.554 (0.548)	0.636 (0.730)	0.825 (0.556)	0.470 (0.716)
Non-TFP	−0.145 (0.398)	0.473 (0.439)	0.895** (0.410)	0.764 (0.470)
Non-OLS	−0.848 (0.670)	−1.412 (0.959)	−1.678 (1.054)	−1.324* (0.801)
Matched sample	−0.033 (0.696)	−1.920*** (0.560)	−0.961 (0.850)	−1.014 (0.617)
Long effect	−1.819*** (0.466)	−0.821 (0.584)	−1.440*** (0.452)	−1.287** (0.519)
Survey year	−0.097* (0.053)	−0.095* (0.053)	−0.050 (0.033)	−0.019 (0.047)
Intercept	195.659* (105.175)	193.356* (105.885)	102.002 (65.272)	40.566 (93.997)
Obs.	255	135	151	174
R^2	0.244	0.455	0.395	0.351
F-statistic	10.256	15.827	14.294	19.774

The dependent variable for each regression is the *t*-ratio from the studies considered in this paper. The explanatory variables are different characteristics of each study. ‘Developed’ is a dummy variable equal to one when the estimate refers to developed economies (UN definition). ‘Non-OLS’ is equal to one if the estimate is based on other econometric methods than OLS or fixed effects. ‘Matching sample’ is a dummy variable equal to one if the estimate is based on a matching approach. ‘Long effect’ is a dummy variable equal to one if the estimate is based on the exporting effect after entrant year. (Journal) Weight 1 corresponds to Kalaitzidakis et al. (2001), Weight 2 corresponds to Axarloglou and Theoharakis (2003), and Weight 3 corresponds to CEMPRE and NIPE (2006). Significance levels: *: 0.10; **: 0.05; ***: 0.01

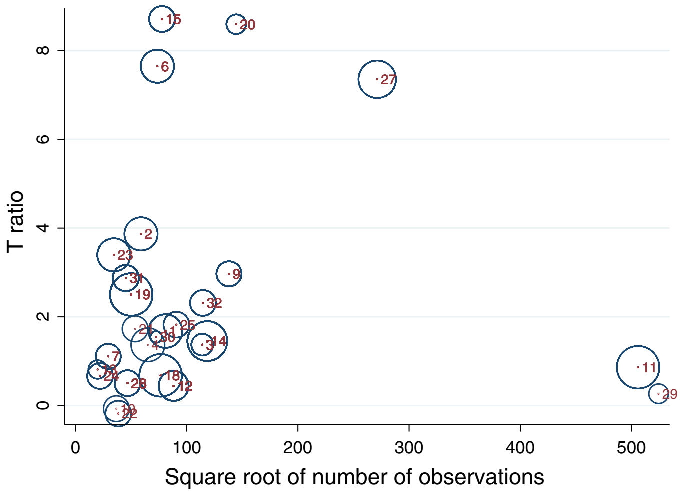

Fig. 1 *t*-Ratios and the square root of number of observations. *Size of circle* proportional to the weight of the journal in which the paper was published. Weight used from CEMPRE and NIPE (2006). See text for more details

result may be related to the two observations in its right-hand-side corner, which can be interpreted as outliers. Once these two observations are removed from the analysis, we actually find a typically very significant and positive relationship between sample size and the *t*-ratio (see Table 7). We therefore conclude that there is no evidence of publication bias in the literature about the effects of exporting upon firm performance.

5 Conclusions

We conduct a meta-analysis of more than 30 papers and almost 300 estimates of the causal relationship between exporting and productivity. Meta-analysis techniques are useful in this context as the many studies available tend to have different characteristics, making it difficult to discern clear patterns in their findings. Indeed, in a recent survey, Wagner (2007) concludes that the effects of exporting on productivity are 'mixed and unclear'.

Our results indicate that the impact of exporting upon productivity is higher at developing than at developed economies, a finding robust to a large set of different specifications. Moreover, we also find that this learning-by-exporting effect (1) is higher in the first year that firms start exporting than at later years; and (2) is lower when only matched firms are considered in the study. These latter findings are also shown to be generally robust to different specifications and to different weights, based on different rankings of the journals in which the estimates are published. Finally, we also find no evidence of publication bias across the estimates considered.

Overall, our results emphasise the importance of access to international markets for the performance of firms in developing countries, perhaps due to the greater distance to the technological frontier that tends to characterise such firms. Our results also support learning-by-exporting models, in that they tend to suggest that the greater impact from exports will arise precisely when firms begin their internationalisation process. Furthermore, the present state of knowledge does not allow one to disentangle other specific characteristics of developing countries from their level of development—longitudinal studies that relate the learning effect across firms and their country's level of development will be useful in this respect.

On a more technical level, the findings presented in our paper suggest that one should be careful when comparing estimates from papers that adopt different methodologies: OLS/FE estimates and/or estimates based on matched samples are likely to indicate lower effects of exporting when compared to estimates based on different methodologies and/or non-matched samples.

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