Do industries' average firm size, productivity and skill-intensity explain the border effect?*

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Abstract

The border effect literature concludes that border-related trade costs, along with the elasticity of substitution, explain why countries trade more with themselves than with other partners. On its hand, the exporting firm literature shows that larger, more productive and more skilled-labour intensive firms are more able to bear with some of those border-related trade costs. In this paper we combine those findings and test whether a larger average firm size, apparent labour productivity and skill content can reduce the border effect. Using a sample of European countries and an empirical model based on the gravity equation we find that a larger average size, labour-productivity and skill-content reduce the border effect significantly.

JEL classification: F14; F15

Keywords: International trade; Border effect; EU countries; Gravity equation; Exports

* I would like to thank Patricia Canto, Aitor Garmendia, Juanjo Gibaja, Rafael Llorca, Francisco Requena and the participants at the X Encuentro de Economía Aplicada (Logroño, 14-16th June 2007) for their helpful comments.

1. Introduction

In a seminal paper, McCallum (1995) showed that Canadian provinces trade 22 more times among themselves than with US states, once differences in distance and economic size were controlled for. McCallum's extraordinary finding motivated a large number of studies. A line of research has been devoted to analyse whether the large border effect found by McCallum was robust to the use of new data, econometric models and different geographical settings (Wei, 1996; Helliwell, 1998; Nitsch, 2000; Anderson and van Wincoop, 2003; Okubo, 2003; Gil-Pareja, et al. 2005; Heinemeyer, et al. 2008). Another line of research has focused on the reasons that may explain the border effect (Hillberry, 1999; Head and Mayer, 2000 and 2002; Evans, 2003; Chen, 2004; Hillberry and Hummels, 2008; Schulze and Wolf, 2008; Yi, 2009). The present paper belongs to this second line of research.

As explained by Evans (2003), the border effect is a combination of two factors: the elasticity of substitution between domestic and foreign varieties, and border-related trade costs. There are different reasons explaining why firms face higher costs when they sell abroad. First, firms bear sunk costs when they enter a foreign market (Roberts and Tybout, 1997). For example, firms spend money and time to gauge the likely volume of their sales, to analyse the characteristics of their competitors, to study whether the product should be adapted to foreign customers' tastes or to determine the most suitable distribution channel. Second, even when a firm is already exporting, it faces additional costs when dealing with foreign markets, such as transport costs, tariff and non-tariff barriers and costs related to exchange-rate volatility or the enforcement of contracts. In addition to these costs, dealing with foreign markets demand higher managerial competences, which in turn, lead to higher labour costs. For example, managers should be able to speak in different languages, have the skills to co-ordinate teams with different cultures and the experience to adapt to each country's idiosyncrasies.

The exporting firm literature shows, on its hand, that some firms are more able than others bearing with the extra-costs of selling goods in foreign markets than others. In their review of the literature, Bernard et al. (2007) conclude that, across a wide range of countries and industries, larger, more productive, and more skill-intensive firms are more likely to export. Why do those characteristics enhance firms' ability to cope with foreign markets' extra costs? The canonical model developed by Melitz (2003), points out that only the most productive firms can cope with the additional costs imposed by foreign markets and obtain profits. With respect to size, Alonso and Donoso (1994) point out that large firms can amortise more easily the market-entry fixed costs due to their larger sales. Finally, as explained above, since foreign markets demand more managerial skills, firms with more skilled workers will have more chances to succeed abroad.

Our intuition is that if larger, more productive and more skill intensive firms are more able to cope with the extra-cost of selling goods abroad their "firm-level" border effect will be lower. If this intuition is correct, we would expect a lower border effect for larger, more productive and more skill-intensive firms. To test this hypothesis, ideally, we would like to have firm level data on size, productivity and skill content of the labour force for a large sample of countries. Since we do not have firm-level data, we use European Union (EU) countries' industry level-data for our analysis. The contribution of this paper is, therefore, to analyse whether industries' average size of firms, productivity and skill content of the labour force influence the border effect. Our results confirm that a country has a lower border effect in those industries that are characterised by a larger average firm size, by a higher apparent labour productivity and by a more skilled labour force.

The remainder of the paper proceeds as follows. Section 2 explains the model we use in the empirical analysis. Section 3 presents the data used in the empirical analysis. Section 4 discusses the results of the regression analyses. Finally, Section 5 presents the main conclusions of our research.

2. The Model

As previous studies, we use a gravity model to estimate the influence of industries' characteristics on the border effect. In particular, we estimate the following gravity equation:

$$\ln X_{ij,k} = \beta_1 + \beta_2 D_{ij} + \beta_3 Border + \beta_4 Lang + \beta_5 adj_{ij} + \beta_6 P^x_{i,k} + \beta_7 P^m_{j,k} + \sum_a \varphi_a \left(Border\ x\ \alpha^a_{i,k} \right) + \varepsilon_{ij,k} \quad (1)$$

where $X_{ij,k}$ indicates country *i*'s exports of industry *k* to country *j*; D_{ij} denotes the distance between country *i* and country *j*. *Border* is a dummy variable which takes the value of one if *i* and *j* are the same country and zero otherwise; *Lang* is a dummy variable which takes the value of one if country *i* and country *j* speak the same language and zero otherwise; finally, *Adj* is a dummy variable which takes the value of one when country *i* and country *j* are adjacent and zero otherwise.

As explained in Anderson and van Wincoop (2003), in addition to bilateral trade costs, the gravity equation should control for differences in product prices in the exporting and the importing country (multilateral resistances). Following Chen (2004), we include industry-specific origin and destination fixed effects ($P^{x}_{i,k}$ and $P^{m}_{j,k}$) to control for multilateral resistances. These fixed effects prelude the introduction of other variables that also influence the volume of exports, such as production at the exporting country or demand in the partner country, due to perfect multicollinearity. Finally, to analyse the effect of industries' average firm size, apparent labour productivity and skill intensity on the border effect, following Evans (2003) and Chen (2004), we introduce an interaction term between the border variable and the exporting country's industry's characteristic ($\alpha^{a}_{i,k}$). The sign of the interaction term, φ_a, will tell us whether the industrial characteristic increases or reduces the border effect.

3. Data

Most of the data we use in the empirical analyses are obtained in the Eurostat's database (http://epp.eurostat.ec.europa.eu). The Annual detailed enterprise statistics on industry and construction database offers different indicators in the NACE classification for EU countries. From that database we extract data on number of firms per industry, average number of employees per industry, apparent labour productivity (value added per employee) and labour costs per employee. We proxy the average size of firms dividing the number of employees by the amount of firms; on the other hand, we proxy industries' average skill intensity by the labour cost per employee.[1] Distances between countries are taken from CEPII's database. Trade data are obtained in Eurostat's external trade database.[2] Finally, as we do not have real

[1] The educational or the occupational composition of employment are better proxies of the skill content than the labour cost per employee. However, these data were not available for our sample.

[2] Trade data are reported in the 2002 Harmonised System classification (HS2002). To match the HS2002 classification with the NACE industrial classification, we establish a correspondence in three steps. First, we match the HS2002 classification with the CPC1.1 classification. Then, we match the CPC 1.1. classification with the ISIC Rev. 3.1 classification, and finally, the ISIC Rev. 3.1 classification is matched with the NACE classification. These correspondences were obtained in the United Nations Statistical Division web page: http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1

data on the amount of intra-national trade, as previous studies (Wei, 1996; Nitsch, 2000; Evans, 2003; Chen, 2004), we calculate intra-national trade as the difference between production and total exports.[3]

With these data we obtain a balanced sample of ten EU countries and thirteen industries for 2007. The countries are Austria, Finland, France, Germany, Greece, Italy, Poland, Spain, Sweden and the United Kingdom; the industries are: Textiles, Wood and wood products, Paper and paper products, Publishing and printing, Chemicals, Rubber and plastic products, Other non-metallic mineral products, Manufacture of basic metals, Fabricated metal products, Machinery and equipment, Electrical machinery, Communication equipment and apparatus and Other transport equipment. The amount of domestic trade observations is 10 countries x 13 industries = 130; the amount of international trade observations is 10 countries x 9 partners x 13 industries = 1170. Hence, the sample covers the total amount of 1300 observations. The number of observations is, in fact, 1299 because there are no exports of Other transport equipment from Greece to Poland in the year 2007.

4. Results of the empirical analyses

Table 1 presents the results of the empirical analyses. In Column (1) we estimate the border effect with no industry characteristics. As shown in the table, the estimated border coefficient is 0.68. According to this estimate a European Union country trades twice more with itself than with another European Union country (exp 0.68). The rest of the independent variables' coefficients have the expected sign: distance has a large negative effect on trade, whereas to speak the same language and to be adjacent have a positive effect on trade.

[Insert Table 1 around here]

Our border effect estimate is much lower than the one estimated by previous studies. Chen (2004), which also uses industry disaggregated trade data and fixed effects, gets a 1.32 coefficient for 1996 (Table 1 - Column 4). Head and Mayer (2000), who also use disaggregated data, get a 2.54 coefficient for the 1993-1995 period (table 5), which is reduced

[3] Production data are also obtained from Eurostat's Annual detailed enterprise statistics on industry and construction database.

to 1.44 when intra-national distance is better control for (Head and Mayer, 2002; Table 4 - CESD). Finally, using aggregated data, Nitsch (2000) gets a 2.43 coefficient (Table 1 - Column 4).

Columns (2) to (4) analyse the impact of average size of firms, apparent labour productivity and skill-intensity on the border effect. As explained above, these variables are introduced in interaction with the border variable. The interaction terms are introduced one by one due to the high correlation across these variables.[4] As reported in the table, all interaction coefficients are negative and statistically significant. These results confirm our expectation: a country will have a lower border effect in those industries that are characterised by a larger firm size, higher apparent productivity and a more skilled labour force. The remaining coefficient have the correct sign and they are statistically significant.

Differences in industries' characteristics have a very important effect on the border effect. A one standard deviation increase in the (log) average firm size drives the border effect to zero. A one standard deviation increase in the (log) average labour productivity reduces the border effect by 78 per cent and a standard deviation increase in the (log) average labour cost per employee reduces the border effect by 72%.

Robustness tests

To test the robustness of our results, we introduce additional variables that may also influence the border effect. On the one hand, we take into account those variables that may explain differences in the border effect across countries. First, Anderson and van Wincoop (2003) point out that small countries, in terms of GDP, have a larger border effect. In small countries a trade barrier leads to a larger relative reduction in international trade and to a larger relative increase in intra-national trade, generating a larger border effect. Second, Helliwell (1997) and Nitsch (2000) show that high GDP per capita countries report smaller border effects than low GDP per capita countries. As explained by Baldwin (1994) and Frankel and Wei (1995), as countries become richer they increase their level of specialisation, leading to larger international trade levels. Third, Evans (2003) shows that a larger number of links among a country's citizens (national networks) and a higher level of trust among them (social capital)

[4] The correlation between the average size of firms interaction term and the labour productivity interaction term is 0.95. The correlation between the average size of firms interaction term and the labour cost per employee interaction term is also 0.95. The correlation between the labour productivity interaction term and the labour cost interaction term is almost perfect.

facilitate domestic trade and increase the border effect. We proxy the density of national networks with the density of national transport networks (railroad and roadways kilometres per thousand of population) and the density of national informal networks (percentage of the population that belongs to a social, religious, sports or another kind of voluntary organisation); [5] social capital is proxied with an indicator of trust. [6]

On the other hand, different factors can explain the variation of the border effect across industries: the spatial clustering of firms, industries' differentiation level, and tariff and non-tariff barriers. First, Hillberry (1999), Hillberry and Hummels (2002) and Wolf (2000) stress that border effects may arise endogenously, if firms reap advantages from clustering. We proxy the spatial clustering of firms with the Ellison and Glaeser (1997) dispersion index (Table 3: percentage of four-digit sub-industries that fall in the not very localised range). Second, Rauch (1999) argues that it is more costly to obtain information on differentiated products and, hence, those goods have a larger border effect. To determine industries' differentiation level we use Rauch's index, which distinguishes between differentiated products, reference priced products and homogeneous goods in the 4-digit SITC classification. We match this classification with the NACE classification used in our study. To determine the categorisation that corresponds to our 2-digit NACE industries we analyse how many sub-industries are classified as differentiated in Rauch's liberal index. Third, Head and Mayer (2000) and Chen (2004) point out that differences in non-tariff barriers may explain the variation in border effects across industries. Data on the level of non-tariff barriers across industries are obtained from European Commission (1997); we calculate NACE 2-digit industries' non-tariff barriers as a simple average of sub-industries non-tariff barriers.

Table 2 presents the results of the robustness checks for the average size of firms interaction coefficient. We re-estimate equation (1), interacting the border coefficient with each of the control variables described above. We present the estimates when the control interaction terms are introduced one by one (Columns 1 to 9), and when all control interaction terms are introduced together (Column 10). The results of the robustness analyses for the apparent labour-productivity and the labour-cost per employee interaction terms are very similar and

[5] Infrastructure data are obtained from CIA's Word Factbook and informal network data from the World Values Survey, 1999-2004 Wave.
[6] Trust is measured by the percentage of people that answers Yes to the question of whether most people can be trusted. These data are obtained from the World Values Survey, 1999-2004 Wave.

are not reported.[7] As shown in the table, the average size of firms' interaction coefficient is robust to the introduction of other variables that may also influence the border effect. When the control variables are introduced one by one, only three interaction coefficients have the expected sign: GDP, GDP per capita and railroad kilometres per thousand of population. As expected, GDP and GDP per capita interaction coefficient have a negative sign, denoting that larger and richer countries tend to have a lower border effect. Also, the rail per capita coefficient is positive, denoting that more dense transport infrastructure facilitates intra-national trade, leading to a higher border effect. Contrary to expectations, the density of informal networks and social capital have a depressing effect on the border effect; the dispersion of firms has a positive effect on the border effect and more differentiated products do not command a larger border effect. Finally, the interaction coefficient for non-tariff barriers is negative and statistically significant; according to this result, industries that have larger non-tariff barriers have a lower border effect. When we introduce all control variables only two of the interaction coefficients, spatial dispersion and NTBs (both with the non-expected sign), are statistically significant.

[Insert Table 2 around here]

Following previous studies (Hillberry, 1999; Head and Mayer, 2000; Chen, 2004), we perform an additional robustness check regressing country-specific industry border coefficients against the variables that may influence the border effect.[8] As shown in Table 3, in all cases, the average size of firms' interaction coefficient is negative and statistically significant.[9]

[Insert Table 3 around here]

[7] These results can be provided upon request.

[8] The 130 country+industry (10 countries x 13 industries) border coefficients are estimated with equation (1). As explained by Head and Mayer (2000) and Chen (2003), the dependent variables consist of estimated coefficients with different significance level, introducing heteroskedasticity; in order to control for this, weighted-least-squares are applied, where the weights are given by the inverse of the standard errors of the border coefficients.

[9] Similar results are obtained for the apparent labour productivity and labour costs per employee interaction coefficients.

5. Conclusions

This paper analyses whether industries' characteristics such as the average size of firms, apparent labour productivity and the skill content of the labour force may influence the border effect. We test this hypothesis with a sample of ten European Union countries and 13 industries and find that a country has a lower border effect in those industries that are characterised by a larger firm size, by a higher apparent labour productivity and by a more skilled labour force. These results are robust to the introduction of other variables that may also explain the border effect.

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Table 1. Border effects interacted with industries' characteristics

	(1)	(2)	(3)	(4)
Distance	-1.41 (0.13)***	-1.33 (0.21)***	-1.44 (0.13)***	-1.43 (0.13)***
Language	0.40 (0.18)**	0.40 (0.18)**	0.36 (0.18)*	0.36 (0.19)*
Adjacency	0.52 (0.13)***	0.52 (0.13)***	0.51 (0.13)***	0.50 (0.13)***
Border	0.68 (0.26)***	3.76 (0.77)***	3.90 (1.61)**	4.03 (1.20)***
Border x Average size of firms		-0.99 (0.21)***		
Border x Apparent labour productivity			-0.80 (0.40)**	
Border x Labour cost per employee				-0.94 (0.86)***
Number of observations	1299	1299	1299	1299
R square	0.86	0.87	0.86	0.86

Notes: industry-specific origin and destination dummy variables included in all regressions (they are not reported). Distance, average size of firms, apparent labour productivity and labour costs per employee are in logs. Heterocedasticity-robust standard errors in parentheses. ***: statistically significant at 1%; **: statistically significant at 5%; *: statistically significant at 10%.

Table 2. Robustness checks on the average size of firms

	(1)	(2)	(3)	(4)	(5)
Distance	-1.23 (0.13)***	-1.34 (0.12)***	-1.32 (0.13)***	-1.33 (0.12)***	-1.30 (0.13)***
Language	0.49 (0.18)***	0.38 (0.18)**	0.42 (0.19)**	0.39 (0.19)**	0.46 (0.19)**
Adjacency	0.53 (0.13)***	0.52 (0.13)***	0.52 (0.13)***	0.52 (0.13)***	0.52 (0.13)***
Border	7.60 (2.57)***	6.84 (3.47)**	3.66 (0.68)***	3.80 (0.65)***	4.16 (1.18)***
Border * Average size of firms	-0.96 (0.21)***	-0.97 (0.22)***	-1.01 (0.23)***	-1.00 (0.20)***	-0.98 (0.21)***
Border * GDP	-0.28 (0.17)*				
Border * GDP per capita		-0.31 (0.38)			
Border * Railway			0.24 (0.75)		
Border * Roadways				0.00 (0.02)	
Border * Informal network					-0.01 (0.01)
R-square	0.87	0.87	0.87	0.87	0.87
Number of observations	1299	1299	1299	1299	1299

Table 2 (cont.).

	(6)	(7)	(8)	(9)	(10)
Distance	-1.32 (0.13)***	-1.31 (0.12)***	-1.31 (0.12)***	-1.33 (0.12)***	-1.15 (0.13)***
Language	0.42 (0.19)**	0.40 (0.18)**	0.40 (0.18)**	0.40 (0.18)**	0.53 (0.19)***
Adjacency	0.51 (0.13)***	0.53 (0.12)***	0.52 (0.12)***	0.52 (0.13)***	0.55 (0.12)***
Border	3.62 (0.70)***	2.67 (1.04)***	4.52 (0.71)***	4.87 (0.93)***	13.98 (4.35)***
Border * Average size of firms	-1.00 (0.22)***	-0.99 (0.20)***	-1.06 (0.20)***	-0.97 (0.20)***	-0.91 (0.21)***
Border * GDP					-0.28 (0.24)
Border * GDP per capita					-0.48 (0.46)
Border * Railway					-0.81 (1.07)
Border * Roadways					-0.02 (0.02)
Border * Informal network					-0.02 (0.01)
Border * Trust	0.00 (0.02)				0.01 (0.02)
Border * Spatial dispersion		0.02 (0.01)**			0.02 (0.01)*
Border * Differentiated goods			-0.02 (0.00)***		-0.02 (0.00)***
Border * NTBs				-0.68 (0.30)**	-0.20 (0.28)
R-square	0.87	0.87	0.88	0.87	0.88
Number of observations	1299	1299	1299	1299	1299

Notes: industry-specific origin and destination dummy variables included in all regressions (they are not reported). Distance, average size of firms, apparent labour productivity, labour costs per employee, GDP and GDP per capita are in logs. Heterocedasticity-robust standard errors in parentheses. ***: statistically significant at 1%; **: statistically significant at 5%; *: statistically significant at 10%.

Table 3. Additional robustness check for average size of firms. Dependent variable: estimated country specific industry coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
Average size of firms	-0.84 (0.09)***	-0.80 (0.09)***	-0.81 (0.09)***	-0.84 (0.09)***	-0.85 (0.09)***	-0.83 (0.09)***
GDP		-0.24 (0.09)***				
GDP per capita			-0.40 (0.21)*			
Railway				-0.06 (0.28)		
Roadways					-0.01 (0.01)	
Informal network						0.00 (0.00)
R-square	0.19	0.21	0.20	0.19	0.19	0.19
Number of observations	130	130	130	130	130	130

Table 3 (cont.). Additional robustness check for average size of firms. Dependent variable: estimated country specific industry coefficients

	(7)	(8)	(9)	(10)	(11)
Average size of firms	-0.84 (0.09)***	-0.86 (0.09)***	-0.92 (0.09)***	-0.85 (0.09)***	-0.76 (0.10)***
GDP					-0.36 (0.12)***
GDP per capita					-0.40 (0.28)
Railway					-1.41 (0.63)**
Roadways					-0.01 (0.01)
Informal network.					-0.02 (0.01)**
Trust	0.00 (0.01)				0.01 (0.02)
Spatial dispersion		0.02 (0.00)***			0.02 (0.00)***
Differentiation			-0.02 (0.00)**		-0.01 (0.00)***
NTB				-0.65 (0.18)***	-0.27 (0.18)
R-square	0.19	0.23	0.27	0.22	0.32
Number of observations	130	130	130	130	130

Notes: All regressions are estimated with a constant term (not reported). Average size of firms, GDP and GDP per capita are in logs. Standard deviation in parentheses. ***: statistically significant at 1%; **: statistically significant at 5%; *: statistically significant at 10%.