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Trade, Tariffs and Total Factor Productivity: The Case of Spanish Firms

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1. INTRODUCTION

DO we know everything about the link between openness and productivity at the micro level? A possible source of productivity gains comes from the exploitation of scale economies. Krugman (1979) and Helpman and Krugman (1985) underlined the pro-competitive effects in a context of homogeneous firms. Bernard et al. (2003), Melitz (2003) and Yeaple (2005) explained that a decrease in trade costs increases productivity at the industry level due to a market-share effect, that is, the reallocation of resources among firms in favour of the most productive ones.[1] Learning-by-doing and externalities, technical innovation through imports of intermediate goods and managerial efforts are other possible sources of productivity improvements that have been evidenced by different theoretical models (Ethier, 1982; Markusen, 1989; Grossman and Helpman, 1991; Stokey, 1991; Young, 1991; Xie, 1999). In sum, theoretical models that consider firm heterogeneity do not contemplate the effect of a decrease in trade costs on

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[1] Bernard et al. (2006) provide empirical support for these conclusions. Using US firm-level data, they find, *inter alia*, that falling trade costs increase the probability that low-productivity plants will fail and raise the probability that higher-productivity plants will expand by entering export markets or increasing their sales to foreign countries.

intra-firm productivity, while models that contemplate the effect of trade on intra-firm productivity do not consider firm heterogeneity.[2] As pointed out by Tybout (2000), a mix of these three mechanisms will probably describe the relation between openness and intra-firm productivity more realistically. This empirical issue can now be investigated thanks to firm-level data.

In recent years, widespread effort has been made to investigate the channels through which trade liberalisation affects firm productivity in developing countries.[3] Good examples are the studies of Pavcnik (2002), Schor (2004), Topalova (2004), Amiti and Konings (2007) and Fernandes (2007) for Chile, Brazil, India, Indonesia and Colombia, respectively. As pointed out by Trefler (2004), there are fewer studies focusing on industrialised countries and on countries involved in regional trade agreements, except his own study on the Canada–US Free Trade Agreement. However, as demonstrated by Eaton and Kortum (2002), the diffusion of technology and knowledge through the acquisition of intermediate and/or capital goods can take place more easily among countries with similar endowments, geographic proximity and flexible markets. This provides another motivation to focus on industrialised countries or transition economies. Finally, in line with the debate on regionalism versus multilateralism, it is important to check the sensitivity of trading bloc members to external tariffs. Indeed, if a large amount of trade takes place among FTA partners, the detrimental effect of external tariffs may not be so obvious since the intra-bloc market is large.[4]

In this paper, we focus on the effect of tariffs and foreign competition on the TFP of Spanish manufacturing firms[5] over the 1991–2002 period. This period is characterised by Spain's increasing openness to trade, particularly towards the European Union. The last significant phase of trade liberalisation occurred during

[2] One important exception is the dynamic model with firm heterogeneity of Costantini and Melitz (2007). They assume that innovation and export decisions depend on the future evolution of trade costs and on sunk exporting costs. Therefore, they demonstrate that the timing and anticipation of trade liberalisation affect intra-firm productivity adjustments and export participation.

[3] To focus on an ongoing trade liberalisation period offers an opportunity to check some, but not all, the proposals concerning the microeconomic effects of trade liberalisation. For instance, Cuñat and Maffezzoli (2007) demonstrate that trade liberalisation is likely to affect the long-run comparative advantages of countries through effects on factor prices and accumulation, while Costantini and Melitz (2007) argue that productivity adjustments respond to trade liberalisation announcements.

[4] The articles of Frankel et al. (1996), Wei and Frankel (1996) and Panagariya and Krishna (2002) illustrate this debate.

[5] For Spain, the link between trade and productivity has not been studied at the firm level. Most studies have focused on the relationship between productivity and exports, where productivity is estimated using the index method or the stochastic frontier method or approximated by value added per worker (Merino and Salas, 2002; Barrios et al., 2003; Barrios and Strobl, 2004; Campa, 2004; Huergo and Jaumandreu, 2004; Mañez et al., 2004; Salomon and Shaver, 2005; Fariñas and Martin-Marcos, 2007). Delgado et al. (2002) and Fariñas and Ruano (2004, 2005) study productivity distributions.

the 1980s, while the process to dismantle trade barriers in the framework of adhesion to the European Economic Community (EEC) concluded in 1992. Political reforms and the dismantling of restrictions on capital flows marked the 1980s along with a massive reallocation process among industries and labour markets. After the 1992 ERM crisis, Spain left the ERM. Following the devaluation of the peseta, Spain's openness ratio experienced an exceptional growth without large imbalances over the period. The country's trade with the EU, and especially intra-industry trade, increased sharply.

Like several recent studies, we follow a two-step strategy. First, we use the Olley and Pakes (1996) method to obtain a measure of the total factor productivity (TFP) of firms. Our results confirm that during the 1990s, Spain's increasing openness to trade was contemporaneous with a large increase in productivity in manufacturing industries, a fact that can largely be explained by intra-firm productivity growth. In a second step, we estimate an equation where TFP is explained by a set of firm characteristics and trade policy indicators. We use the System-GMM method proposed by Blundell and Bond (1998) to deal with the possible endogeneity of observable firm characteristics. In a consistent manner we also control for unobservable characteristics that may explain current intra-firm productivity by taking into account the lagged value of productivity.

We use two different measures for openness for each industry: EU most favoured nation (MFN) tariffs and Spanish import penetration rate (IPR). Another important distinctive feature of our study is that these two measures are not substitutes due to the characteristics of the country under study. The first measure is the result of EU negotiations with GATT members. It is a direct component of third-country prices while EU countries are granted duty-free access in the EU market. Thus, IPR provides some additional information since it measures the degree of foreign competition in the Spanish market taking into account growing import flows from third countries but also from the EU.

We address three questions. First, do trade policy indicators have a direct effect on the productivity of Spanish firms? We find that TFP is negatively impacted by European tariffs, but positively benefits from the increased presence of foreign products. Moreover, these two effects are complementary. Second, is there any evidence of TFP gains via imports of inputs? We find evidence of additional productivity gains for importing firms. Third, are there some asymmetries among firms regarding the sensitivity to these trade openness indicators? We find that the impact of exposure to trade and sensitivity to tariffs differ sharply among firms depending on their size and involvement in foreign markets.

The paper is organised as follows. Section 2 presents some important stylised facts concerning Spanish trade liberalisation that serve to understand the effect of the country's trade growth in the 1990s. Section 3 presents the data and the empirical methodology. The results are presented in Section 4, while conclusions are provided in Section 5.

2. STYLISED FACTS

According to the agreement between Spain and the EEC, the dismantling of trade barriers among members began in 1986. For products for which the difference between Spanish tariff rates and the Common External Tariff (CET) rate was lower than 15 per cent, the CET was applied in a straightforward manner. For the rest of the products, dismantling was a progressive process that ended in 1993. Spain's average tariff for non-agricultural products was 12.33 per cent for products from the EEC and 16.44 per cent for products from third countries. The dismantling of tariff barriers was accompanied by the dismantling of quantitative restrictions, a new value-added tax (VAT) and the suppression of the ICGI (an internal compensatory tax that consisted of imposing a lower tax on the sale of locally produced products). The effective rate, that is, the amount of import tax revenue relative to the value of imports, was estimated at 5.44 per cent in 1985. The suppression of the ICGI also had an important dismantling effect (Cañada and Carmena, 1991) since it represented 7.81 per cent of the value of imports.

Quantitative restrictions applied to EEC members were generally eliminated and Spain had to maintain the same barriers as the EEC for third countries. However, there was a large list of exceptions for 'sensitive products'. Among others, Spain was allowed to maintain quantitative restrictions for three additional years for cars, metal, ships, TV, textiles and apparel (see Tamames, 1986).

Although Spanish tariffs were completely adapted to EEC norms by the end of 1992, dismantling was just the starting point for Spanish trade to take off. Concerning the sectors covered by our data, the average export-to-output ratio increased from 27 per cent to 39 per cent between 1991 and 2002, whereas the average import-to-output ratio rose from 18 per cent to 32 per cent. Amazingly, the trade deficit has remained stable over the period (5.8 per cent GDP), a fact which underlines the success of this integration experience. The substantial increase in openness indicates that the period 1991–2002 in Spain is interesting to consider from an econometric point of view.

Import competition and exports increased sharply in a variety of markets including electrical products, leather and leather products, vehicles, plastic and rubber products and other transport equipment. While trade has also intensified in the basic metal sector, chiefly as a result of imports, the intensification of trade in the food and tobacco sector has been mainly due to exports. The chemical, wood, paper, textile and textile products and other manufactured products sectors have increased their exports and their imports, albeit not in a marked manner. For other sectors, trade has remained stable.

For the period under study, 1991–2002, Spanish tariffs were already adapted to the CET rate. Owing to the application of the different cycles of the GATT (Tokyo Round, Uruguay Round), the EU tariff rate (we use MFN tariffs) slightly

TABLE 1
MFN Tariffs, EU

	1991	*1996*	*2002*
1 Food and tobacco	42.28	37.77	33.81
2 Textiles and textile products	10.81	10.14	9.20
3 Leather and leather products	8.34	7.35	6.52
4 Wood	5.52	4.25	3.45
5 Paper	7.97	5.46	1.50
6 Printing products	4.79	3.73	1.47
7 Chemical products	7.12	4.85	4.64
8 Rubber and plastic products	7.23	6.13	4.87
9 Other non-metallic mineral products	5.53	4.32	3.42
10 Basic metals	5.18	3.83	5.38
11 Manufactured metal products	5.48	4.03	2.89
12 Machinery and equipment n.e.c.	4.29	2.81	1.85
13 Office equipment and precision	5.39	3.58	1.54
14 Electrical and optical equipment	6.21	4.78	2.68
15 Motor vehicles	8.40	7.08	6.34
16 Other transport equipment	4.67	3.23	2.32
17 Other manufactured products	5.73	4.02	2.72

Source: TRAINS, UNCTAD.

diminished over the entire period. Tariffs for 1991 and 2002 by industry are displayed in Table 1. EU tariffs remain higher in food products despite an important decrease (from 42 per cent to 33 per cent). In the remaining industries, tariffs ranged from 4 per cent to 10 per cent in 1991 and were pushed down substantially in all industries except for textiles, leather and vehicles for which the decrease was more moderate.

3. EMPIRICAL STRATEGY

We follow a two-step strategy that has become relatively standard in the literature (see Pavcnik, 2002; Schor, 2004; Topalova, 2004; Amiti and Konings, 2007; Fernandes, 2007). In a first step, we use the Olley and Pakes (1996) method to measure the total factor productivity of firms. In a second step, we estimate an equation where TFP is explained by a set of firm characteristics, lagged firm productivity and trade policy indicators using the System-GMM method.

We use data on Spanish manufacturing firms drawn from the *Encuesta sobre Estrategias Empresariales* (Survey on Enterprise Strategies; ESEE), an annual survey conducted by the SEPI Ministry of Industry. The ESEE is representative

of Spanish manufacturing firms classified by industrial sector and size categories[6] and includes exhaustive information at the firm level. The ESEE offers detailed data, for example, on balance sheets, sales, inventories and materials, volume of exports and imports. For each firm, we know the region where it is located and its sector affiliation in the NACE-93 classification. We cleaned the data in order to correct or eliminate problems due to missing data or misreporting. We dropped observations for 1990 that were too incomplete and observations with missing values for capital stocks. The total number of firms in the database is 3,462. At the end of our cleaning process, the sample consisted of 3,107 firms and 20,882 observations for the 1991–2002 period (see Table 2 for some summary statistics). Details about the cleaning process are provided in Appendix A.

In this section, we explain the method used to measure TFP at the firm level and discuss the results of the decompositions of TFP growth by industry, which shed some light on the characteristics of the case under study. We then present the empirical model we estimated and the estimation method.

a. Productivity Measurement

The link between trade and productivity at the firm level has been studied using a wide range of methodologies concerning measures of productivity. A first generation of studies using various measures of efficiency obtained mixed results.[7] In the most recent studies, firm-level TFP is calculated following the Olley and Pakes (1996) method. This method corrects the simultaneity bias arising from the fact that firms choose their level of input once they know their level of productivity. It also corrects the selection bias arising from the fact that producers choose to stay or leave the market depending on their productivity level, which in turn depends on the level of their fixed factor, namely capital stock. To this end, investment is considered as a proxy[8] for unobserved productivity shocks.

[6] The survey participation rate was about 70 per cent for firms with more than 200 employees. Firms that employed between 10 and 200 workers (small firms) were randomly sampled by industry and size strata, accounting for 5 per cent of the population.

[7] Tybout et al. (1991) find little evidence of intra-firm productivity improvements after the Chilean liberalisation. For the Ivory Coast, Harrison (1994) finds that foreign competition forces down mark-ups among firms. Using the same methodology, Krishna and Mitra (1998) find more weak evidence for India. Tybout and Westbrook (1995) find that increases in openness are associated with relatively small-scale efficiency but significant 'residual' gains in Mexico. Driffield and Kambhampati (2003) show that the increase in firms' import intensities did not raise efficiency in the case of Indian firms.

[8] Levinsohn and Petrin (2003) propose an estimation methodology that corrects the simultaneity bias using intermediate input expenditures. This is especially useful when the sample displays many non-positive values of investment and thus the Olley and Pakes method cannot be used. This is not the case for our sample since there are fewer observations with zero investment values. Moreover, production function coefficient estimates obtained without zero investment values are close to the estimates obtained with zero investment values.

TABLE 2
Summary Statistics

Panel A: Exporter* versus non-exporter

Variables	*All*		*Small Firms*		*Large Firms*	
	Export.	*Non-exp.*	*Export.*	*Non-exp.*	*Export.*	*Non-exp.*
Production	9,316,340	508,732	404,155	181,479	15,300,000	3,059,179
Number of employees	327	38	27	20	526	174
Intermediate consumption	5,431,087	245,136	226,445	96,640	8,897,566	1,402,444
Capital	4,166,867	255,124	120,067	60,243	6,862,182	1,773,935
Export share	22.5		13.5		28.6	
Import share	11.3	1.9	5.8	1.6	15.1	3.8
Foreign capital share	24.6	1.3	4.4	0.4	38.0	8.3

Notes:
Production, intermediate consumption and capital in 1,000 pesetas. Small firms refer to firms included in the database with less than 50 employees.
* Exporter: Firms that have exported for at least one year during the period under study.

Source: ESEE.

Panel B: Importer* versus non-importer

Variables	*All*		*Small Firms*		*Large Firms*	
	Import.	*Non-imp.*	*Import.*	*Non-imp.*	*Import.*	*Non-imp.*
Production	9,222,062	257,821	430,983	147,004	14,900,000	1,730,882
Number of employees	324	28	28	19	517	139
Intermediate consumption	5,366,680	122,751	245,867	71,969	8,702,912	797,783
Capital	4,134,707	116,008	128,204	49,857	6,744,961	995,333
Export share	21.2	2.4	11.8	2.0	27.4	8.9
Import share	11.8		7.1		14.9	
Foreign capital share	24.3	0.6	4.6	0.2	37.2	6.7

Notes:
Production, intermediate consumption and capital in 1,000 pesetas. Small firms refer to firms included in the database with less than 50 employees.
* Importer: Firms that have imported for at least one year during the period under study.

Source: ESEE.

This method infers TFP at the firm level as the difference between the observed output and the predicted output function, assuming the technology of firm i is well described by a Cobb–Douglas production function:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it}, \quad (1)$$

where y_{it} is the output, l_{it} the labour, m_{it} the intermediate materials and k_{it} is the capital (all expressed in logarithms). The error term has two components: the

plant-specific productivity component given as ω_{it}, and η_{it} an error term that is uncorrelated with input choices. Assuming that investment function i_{it} is monotonically increasing in ω_{it}, as in Pakes (1994), it can be inverted to express the productivity shock ω_{it} as a function h of i_{it} and k_{it}.

The estimation procedure is performed in three stages. In a first stage we estimate the coefficients of the variable inputs (labour and intermediate materials) and in the second stage we evaluate the survival probability of the firm. The third stage of the routine identifies the coefficient of the fixed factor (capital) where productivity is assumed to evolve according to a first-order Markov process. Following Olley and Pakes (1996) and Pavcnik (2002), we build an index of firms' TFP that allows for comparisons across industries. It is obtained as the difference between the productivity of a reference plant in 1991 and the current productivity of firm i.[9] Coefficients are reported in Table 3 for 17 industries. Coefficients are significant at the 1 per cent level in most cases and have a similar range to other studies.

Before explaining intra-firm productivity, we examine the data and calculate the contribution of intra-firm productivity to industry-level productivity growth over the period 1991–2002. We calculate the aggregate growth of intra-firm productivity by industry using initial market shares as weights, as in Foster et al. (1998). This component of industry productivity growth is therefore based on data for firms that answer the survey throughout the period. The higher the initial market shares of the firms that increase their productivity, the higher this effect will be. We also report total productivity growth by industries, which is partly explained by intra-firm productivity growth but also by other factors such as changes in market shares and the entry and exit of firms from the survey.[10] Results are presented in Table 4.

Aggregate productivity increased from 1991 to 2002 in all industries, except food and tobacco. For most industries, the productivity increases experienced over the period are higher than 15 per cent, representing a moderate increase of 1.3 per cent per year. Rubber and plastic products and electrical and optical equipment are the industries that experienced the highest increases in productivity (3.3 per cent per year). Intra-firm productivity (weighted by market share) grew in every industry except for the leather products industry. This growth explains most of the TFP growth in most sectors (textile, wood, paper, printing products, other non-metallic mineral products, basic metals, machinery and equipment and other manufactured products).

[9] This index is transitive and insensitive to the units of measurement.

[10] Studying all of the factors that explain TFP growth, as in Foster et al. (1998), is beyond the scope of this study. The entry and exit contributions of industry productivity growth are only the entry and exit points from the survey.

TABLE 3
Production Estimates with the Olley and Pakes (1996) Method

Industry	*l*	*k*	*m*	*N*
1 Food and tobacco	0.280***	0.163***	0.505***	2,460
	(0.011)	(0.019)	(0.006)	
2 Textiles and textile products	0.401***	0.043**	0.433***	1,619
	(0.012)	(0.018)	(0.006)	
3 Leather and leather products	0.273***	0.136***	0.488***	445
	(0.023)	(0.011)	(0.012)	
4 Wood	0.389***	0.278***	0.360***	411
	(0.029)	(0.022)	(0.017)	
5 Paper	0.292***	0.092***	0.577***	539
	(0.020)	(0.012)	(0.016)	
6 Printing products	0.472***	0.105***	0.500***	896
	(0.020)	(0.009)	(0.011)	
7 Chemical products	0.334***	0.184***	0.499***	1,375
	(0.014)	(0.010)	(0.009)	
8 Rubber and plastic products	0.394***	0.115***	0.469***	1,013
	(0.014)	(0.011)	(0.009)	
9 Other non-metallic mineral products	0.415***	0.199***	0.449***	1,220
	(0.014)	(0.007)	(0.010)	
10 Basic metals	0.224***	0.092***	0.626***	626
	(0.016)	(0.021)	(0.009)	
11 Manufactured metal products	0.329***	0.096***	0.523***	1,556
	(0.013)	(0.018)	(0.007)	
12 Machinery and equipment n.e.c.	0.416***	0.037***	0.513***	1,271
	(0.016)	(0.021)	(0.008)	
13 Office equipment and precision	0.416***	0.079***	0.523***	311
	(0.036)	(0.017)	(0.016)	
14 Electrical and optical equipment	0.383***	0.103*	0.565***	1,303
	(0.014)	(0.009)	(0.008)	
15 Motor vehicles	0.365***	0.100***	0.532***	893
	(0.017)	(0.004)	(0.009)	
16 Other transport equipment	0.300***	0.119***	0.559***	288
	(0.032)	(0.011)	(0.016)	
17 Other manufactured products	0.393***	0.068***	0.517***	1,122
	(0.015)	(0.024)	(0.009)	

Notes:
Standard errors are in parentheses. * Significant at 10%, ** at 5%, *** at 1%.

Source: Authors' calculations.

b. Estimation Strategy

The next step consists of estimating the effect of trade policy measures on TFP. Unlike most studies, except Fernandes (2007), we control for lagged productivity since we believe that TFP determinants are highly persistent. In contrast to Fernandes (2007), who runs ordinary least squares (OLS) and plant fixed effects

TABLE 4
Intra-firm Productivity Growth and Total Productivity Growth by Industry (1991–2002)

Industry	*Intra-firm Productivity Growth Weighted by Initial Market Share*	*Total Productivity Growth*
1 Food and tobacco	0.024	–0.059
2 Textiles and textile products	0.091	0.242
3 Leather and leather products	–0.004	0.157
4 Wood	0.242	0.308
5 Paper	0.133	0.288
6 Printing products	0.126	0.166
7 Chemical products	0.077	0.276
8 Rubber and plastic products	0.084	0.334
9 Other non-metallic mineral products	0.104	0.243
10 Basic metals	0.093	0.171
11 Manufactured metal products	0.029	0.023
12 Machinery and equipment n.e.c.	0.098	0.223
13 Office equipment and precision	0.016	0.083
14 Electrical and optical equipment	0.052	0.329
15 Motor vehicles	0.027	0.195
16 Other transport equipment	0.020	0.147
17 Other manufactured products	0.160	0.051

Source: Authors' calculations.

estimations of this equation, we prefer to use a generalised method of moments (GMM) framework.[11] Indeed, our dataset allows us to take into account other crucial and observable firm characteristics such as import and export intensities, foreign capital and market shares that may influence firms' reaction to trade. However, these characteristics are not strictly exogenous and fixed effect estimations may lead to biased and inconsistent estimates.

To explain TFP at the firm level, we use the following framework:

$$TFP_{it} = \alpha_0 + \alpha_1 TFP_{it-1} + \beta' X_{it}^{C} + \gamma' X_{jt}^{T} + \eta_t + \eta_i + \varepsilon_{it}, \quad (2)$$

where TFP_{it} is total factor productivity at the firm level as measured by equation (1),[12] X_{it}^{C} is a vector of firm characteristics, X_{jt}^{T} is a vector of trade variables, η_t are time-specific effects which take into account macroeconomic shocks common to all firms, η_i is an individual specific effect and ε_{it} is an error term.

[11] Alternatively, Fernandes (2007) proposed a 'direct approach' consisting of introducing trade policy indicators and all the characteristics in the first equation of the production function. Although she finds that there is no strong difference between the direct and indirect approaches, we will proceed in a similar way to check the robustness of our results.
[12] Industry indicators are not necessary in our regression analysis because the reference firm included in the total factor productivity measure plays the same role.

We check the impact of trade intensification using two trade policy variables: tariff rates and import penetration rates. For tariffs, we use the EU's MFN tariffs[13] since Spain had already adapted its tariffs to the CET by 1991.[14] We choose to use the simple average of these indicators at the industry level since a weighted average (using imports or value added as weights) tends to underestimate tariffs. While it could be argued that tariffs are endogenously determined, we believe that the use of EU tariff rates guarantees a sufficient disconnection between the choice of these tariffs and Spanish lobbies. Thus, we use the lagged value of tariffs. Tariffs are supposed to protect firms and should have a negative impact on TFP. We define the import penetration rate at the industry level for year t (IPR_{jt}) as the ratio between imports and imports plus production at the two-digit level. Since the IPR depends directly on industry production, there is also a potential endogeneity bias in this case. For this reason, we consider the IPR as an endogenous variable in our system. We also take into account the Herfindahl index calculated as the sum of the squared market shares of firms in an industry. The higher the Herfindahl index, the less competitive the market. We believe that in non-competitive industries, firms adjust their profit margins in response to trade liberalisation, rather than their productivity, thus we expect a negative sign for this variable. In the same line, the market share (as indicated by the firm) is an interesting variable as it gives a subjective view of a firm's performance that may differ from the one we observe. The difference between the market share we calculate and that indicated by the firm is due mainly to the fact that an entrepreneur refers to a precise market in terms of products, while we calculate the market share as the ratio of the firm output and the output of the whole industry. As explained, firms with larger market shares may increase firm TFP in response to competitive pressure or reduce their margins. However, more productive firms may capture a larger share of the market. Therefore, we cannot clearly predict the sign of this variable.

Ethier (1982), Markusen (1989) and Grossman and Helpman (1991) pointed out that foreign competition may also affect incentives to innovate, increase technology transfers or raise intra-firm productivity through an increase in the variety of intermediate inputs or capital goods due to higher quality and/or better technology. To test this hypothesis, we also include the import share of firms to explain firm TFP and expect this variable to have a positive impact. Another important hypothesis in the literature on integration is that integration allows better access to international markets. However, Spanish producers were already granted free access from 1986 onwards. The rapid increase in Spanish exports during the 1990s provides sufficient evidence that the effects of EU adhesion were diffused over

[13] We find similar results using effectively applied rates and the weighted average of MFN tariffs.
[14] Tariffs at the two-digit level of the NACE classification were aggregated according to the ISIC Rev. 3 classification to match it with the classification used in the ESEE.

time. It could be the case that a decrease in trade costs in the EU lowered the minimum productivity level that Spanish exporters needed to enter the EU market.

Wagner (2007) summarises the results of 45 econometric studies with micro data referring to 33 countries. He concludes that exporters are, in general, more productive than non-exporters. This may be due to the 'learning by exporting' process by which productivity may improve following access to foreign markets. Indeed, this process allows firms to access useful technological innovations, make international contacts which facilitate technological diffusion and fosters the more efficient organisation of firms. Alternatively, it may be explained by the presence of sunk costs at exporting. The most productive firms self-select into the export market because they are more likely to cope with the sunk costs of entry and survive in the international market. In the Spanish case, Delgado et al. (2002) identify a self-selection effect, while they find that learning by exporting holds only for younger firms. For all these reasons, we expect export intensity to have a positive effect on TFP.

Finally, the link between foreign direct investment (FDI) and TFP appears robust in most studies for developing countries, confirming Coe and Helpman's (1995) hypothesis that openness can also foster technological spillovers through FDI. Joint ventures or the participation of foreign companies brings new managerial abilities and techniques that benefit firm TFP. We also include the foreign capital share in order to account for this effect.

Since the lagged levels instruments used in the differenced-GMM proposed by Arellano and Bond (1991) are shown to be weak instruments for first-differenced equations, we apply the System-GMM approach (Blundell and Bond, 1998, 2000) which in addition to lagged levels also uses lagged first-differences as instruments for equations in levels.[15] This estimation method allows us to consider that all the firm characteristics (total factor productivity, foreign capital share, import-to-output ratio, export-to-output ratio, market share) and the import penetration rate are endogenous. In the case of the Herfindahl index, the exogeneity status of this variable appears to be a more appropriate assumption in this model. First, the Herfindahl index is calculated at the two-digit industry level and, at this level, it is rather rare that the productivity of a firm unambiguously influences the market share of other firms in the industry since the industry refers to a broad range of products and small markets. Herfindahl indices calculated at the industry level provide important information about the overall differences among industries such as the existence of barriers to entry that are specific to the sector. But these sector specificities may have little to do with the technical or managerial efficiencies of a firm. Second, the Sargan test rejects the opportunity to use this variable as an instrument assuming its predetermination or endogeneity. For the reasons we have already mentioned, EU tariff rates should be treated as exogenous variables.

[15] The estimation is performed with the XTABOND2 software in Stata.

4. RESULTS

In this section, we present the results of various sets of estimations. First, we study the average sensitivity of Spanish firms' TFP to the import penetration rate, the tariff rate and firm characteristics such as the share of foreign capital, market share and export ratio and competition at the industry level measured by the Herfindahl index. We insist on the different effect trade indicators have on TFP. Second, we focus on the importance of firms' import intensity by adding the import intensity as an explanatory variable. Third, we check asymmetries among firms in terms of their reaction to trade policy indicators. We show that reactions differ depending on their size, import and export status and foreign ownership. Finally, we present some robustness checks to confirm that our results concerning the impact of trade indicators on firm TFP are not sensitive to the specifications used.

a. Average Sensitivity to Protection and Competition

We first examine the average sensitivity of TFP to trade measures by estimating equation (2) using the System-GMM method.[16] Table 5 shows the results of the estimations including either the import penetration rate, tariff rate, or both indicators. For variables considered as endogenous, we use the lagged levels of these variables dated $t-2$ and before (using all available lags) as instruments for the first-differenced equations. For the levels equations we use the lagged first-differences as instruments. The validity of the instruments is checked by the Sargan test of over-identifying restrictions. The estimated models also satisfy the absence of autocorrelation of order 2 in the residuals. Our results[17] show that IPR and tariffs have a positive and a negative impact, respectively.[18] These results are in line with the theoretical predictions, though it was not so evident that the sensitivity of TFP to tariffs would be significant in the case of a European country. More interesting is the fact that foreign competition measured by IPR and tariffs seems to have a complementary effect. Indeed, when we introduce both variables in the regression, they are both significant at the 1 per cent level, the coefficient of the IPR estimate remains the same while the tariff coefficient is lowered. One may ask whether the potential correlation between the two variables

[16] To control the results from the GMM estimation, we implement the same regressions with OLS and within groups. As expected, OLS levels appear to give an upward-biased estimate of the coefficient of the lagged dependent variable whereas within groups gives a downward-biased estimate of this coefficient. These results are presented in Appendix B.

[17] Another important issue is the case of the food sector that is highly protected by the EU. The entry of Spain into the EU brought about a raise in the protection level towards third countries, and thus a reorientation of its imports, production and exports in this sector. Then, it could be the case that external tariffs had protected Spanish firms from the international competition in this sector. We ran the estimations excluding this sector and obtained similar results (available upon request).

[18] Note that we find the same results when we exclude firms that appear for only two or three years.

TABLE 5
Average Effect of Import Penetration Rate and Tariffs on TFP (1991–2002)

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$; *Dependent Variable:* $\ln(TFP_{it})$								
Model	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
IPR	0.265***	0.250***	0.240***				0.241***	0.222***	0.217***
	(0.037)	(0.037)	(0.037)				(0.039)	(0.039)	(0.039)
$Tariff_{t-1}$				–0.230***	–0.227***	–0.218***	–0.138***	–0.143***	–0.135***
				(0.021)	(0.020)	(0.021)	(0.023)	(0.023)	(0.023)
Foreign capital ratio	0.069*	0.079**	0.062*	0.072*	0.083**	0.068*	0.069*	0.076**	0.062*
	(0.036)	(0.035)	(0.035)	(0.039)	(0.037)	(0.037)	(0.036)	(0.035)	(0.035)
$Mratio_{t-1}$		0.160***	0.139***		0.147***	0.135***		0.156***	0.139***
		(0.050)	(0.049)		(0.050)	(0.050)		(0.050)	(0.049)
$Xratio_{t-1}$	0.087**		0.065*	0.067*		0.045	0.072**		0.050
	(0.034)		(0.033)	(0.035)		(0.035)	(0.034)		(0.034)
Herfindahl	–0.141***	–0.134***	–0.147***	–0.050	–0.053	–0.065	–0.116***	–0.111***	–0.123***
	(0.041)	(0.040)	(0.041)	(0.041)	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)
Market share	0.120**	0.112*	0.117**	0.149**	0.154**	0.154**	0.132**	0.124**	0.128**
	(0.057)	(0.058)	(0.056)	(0.063)	(0.064)	(0.061)	(0.057)	(0.058)	(0.056)
TFP_{t-1}	0.333***	0.334***	0.336***	0.336***	0.337***	0.339***	0.332***	0.332***	0.334***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Constant	–0.066***	–0.066***	–0.067***	0.006	0.001	–0.002	–0.046***	–0.045***	–0.048***
	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.012)	(0.012)	(0.012)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,772	15,772	15,772	15,772	15,772	15,772	15,772	15,772	15,772
The *p*-values are reported for all the tests:									
m1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
m2	0.128	0.298	0.299	0.324	0.314	0.308	0.323	0.312	0.308
Sargan	0.311	0.330	0.683	0.130	0.304	0.706	0.159	0.403	0.728
	Endogenous variables Total factor productivity, Foreign capital share, Import to output ratio, Export to output ratio, Market share, Import penetration rate, Import penetration rate of EU countries					*Exogenous variables* Herfindahl index, Tariff			

Notes:
Standard errors are in parentheses. * Significant at 10%, ** at 5%, *** at 1%.

Source: Authors' calculations.

biases these coefficient estimates. Let us recall that EU tariffs can be considered to be exogenous for the Spanish economy and they apply only to Spanish imports coming from non-EU countries. Consistent with this fact, IPR is only weakly correlated with the tariff rate (30 per cent). IPR represents the presence of foreign products in the Spanish market, particularly European products, while tariffs are more a measure of government intervention and international prices.

These indicators allow us to capture the complementary effects of increased competition. Namely, the quantity side of the competition pressure works through an increase in domestic market share and the price side of the competition effect works through a decline in tariffs, thus driving down the price of domestic products. According to the estimations that take into account both indicators, the sensitivity is rather large: a 10 per cent reduction in tariffs will lead to a 1.4 per cent increase in TFP and a 10 per cent increase in IPR will lead to an increase of 2.2 per cent. These results are very important since they confirm a high sensitivity to the price component, although tariff levels are substantially lower than in the 1980s.

Firm characteristics are significant and confirm that the productivity distribution is not a random process but can be controlled by an explanatory process. The shares of exports in production and the share of foreign capital in total capital are included in estimations because exporters and the affiliates of foreign companies are generally expected to be more productive than average. The share of foreign capital has a positive and significant impact only at the 10 per cent level. The coefficient of the export-to-output ratio is positive and significant. Sometimes, when the import-to-output ratio is included, the export-to-output ratio is not significant. This may be because exporters generally import their intermediate materials in order to keep their production costs under control. It is possible that the level of productivity is better explained by participation in the export market than by the intensity of exports. Concerning the effect of market structure, the Herfindahl index calculated at the industry level has a negative sign, while the market share of the firm as indicated by the survey respondents has a positive effect on TFP. These results indicate that firms in highly concentrated industries have a lower level of TFP than firms in other industries, while the TFP of firms with a higher market share will have a higher level of TFP or set higher prices, thus leading to the overestimation of firm TFP.

b. Additional Gains from Imported Inputs

Our results show that firms' connections with the international market influence their productivity level. The effect of tariffs and import penetration rates on productivity is often linked to the idea that competition accounts for the main source of trade liberalisation gains. However, the decrease in tariffs and non-tariff barriers leads to a reduction in the price of imported inputs as well. It

also increases the volume of imported inputs as well as their diversity. Domestic firms have access to a wider range of qualities for their intermediate goods at lower prices and/or to unknown technologies. This technology transfer may improve their productivity as well. We study this issue by taking into account the firms' import shares. This variable has a positive and significant impact on TFP, although the other coefficient estimates (in particular IPR and tariffs) are not affected by this new variable. Based on this evidence, it is obvious that Spanish manufacturing firms benefited from an additional positive effect of openness via imports. This 'technological effect' is complementary to the two previously analysed effects of protection and foreign competition.

c. Asymmetries in Sensitivity to Protection and Competition

It is especially interesting to study whether the effect of trade variables on firm-level productivity is conditioned by firm characteristics. Our previous results accurately describe the average behaviour of firms, but data at the firm level allow for a deeper analysis of firm heterogeneity. In particular, size, origin of capital, export and import status may not directly explain their TFP level, but could explain the fact that firms react differently to a given change in trade indicators. In turn, this variety of reactions will translate into different productivity levels. Obviously, there are some correlations between these characteristics as shown in the summary statistics (Table 2). In particular, large firms have, on average, larger export intensities, import intensities and share of foreign capital than small firms. Thus, the share of small firms that export or import is rather low compared to the share of large firms.

In this section, we propose a different type of specification to investigate this issue. We interact trade openness indicators with dummies that distinguish between these types of firms. The dummies we consider are: *Large*, firms with more than 50 employees during the first year in the sample; *Foreign*, firms with more than 10 per cent of the capital coming from abroad at least one year in the sample; *Exporters*, firms that export more than 10 per cent of their production for at least one year in the sample; and *Importers*, firms that imported at least one year over the period. The results and tests of the equality of the coefficients of the interacted variables between the different alternatives are displayed in Table 6.

Concerning size, our results show that the presence of foreign products has a similar impact on the productivity of large and small firms. Larger firms seem to react to the increase in imports in a similar way to small firms. In contrast, the size of firms matters concerning their reactions to tariff cuts. Small firms are largely sensitive to tariffs, while the coefficient estimate is not significant for large firms. The insensitivity of large firms to tariffs may reflect the fact that large firms are more sensitive to competition in terms of quantity, while small

TABLE 6
Interaction of IPR and Tariffs with Firm Characteristics

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$[a] *Dependent Variable:* $\ln(TFP_{it})$				*Equality Tests of Coefficients*[b]
Model	*(1)*	*(2)*	*(3)*	*(4)*	
IPR ∗ *LARGE*	0.238***				
	(0.045)				0.471
IPR ∗ *SMALL*	0.206***				
	(0.042)				
$Tariff_{t-1}$ ∗ *LARGE #*	–0.017				
	(0.031)				0.000
$Tariff_{t-1}$ ∗ *SMALL #*	–0.237***				
	(0.029)				
IPR ∗ *IMPORTER*		0.237***			
		(0.040)			0.012
IPR ∗ *NO IMPORTER*		0.127***			
		(0.048)			
$Tariff_{t-1}$ ∗ *IMPORTER #*		–0.081***			
		(0.027)			0.001
$Tariff_{t-1}$ ∗ *NO IMPORTER #*		–0.212***			
		(0.033)			
IPR ∗ *EXPORTER*			0.231***		
			(0.043)		0.241
IPR ∗ *NO EXPORTER*			0.180***		
			(0.042)		
$Tariff_{t-1}$ ∗ *EXPORTER #*			–0.088***		
			(0.033)		0.134
$Tariff_{t-1}$ ∗ *NO EXPORTER #*			–0.145***		
			(0.027)		
IPR ∗ *HIGH FDI*				0.168***	
				(0.060)	0.300
IPR ∗ *LOW FDI*				0.235***	
				(0.041)	
$Tariff_{t-1}$ ∗ *HIGH FDI #*				0.057	
				(0.051)	0.000
$Tariff_{t-1}$ ∗ *LOW FDI #*				–0.185***	
				(0.025)	
Foreign Capital Ratio	0.047	0.048	0.037	0.082**	
	(0.035)	(0.034)	(0.034)	(0.037)	
$Mratio_{t-1}$	0.131***	0.137***	0.141***	0.132***	
	(0.049)	(0.049)	(0.049)	(0.048)	
$Xratio_{t-1}$	0.047	0.042	0.059	0.052	
	(0.034)	(0.034)	(0.037)	(0.033)	
Herfindahl #	–0.144***	–0.133***	–0.134***	–0.126***	
	(0.040)	(0.041)	(0.040)	(0.040)	
Market Share	0.144***	0.128**	0.127**	0.129**	
	(0.055)	(0.055)	(0.054)	(0.054)	
TFP_{t-1}	0.341***	0.337***	0.342***	0.340***	
	(0.016)	(0.016)	(0.016)	(0.016)	

TABLE 6 *Continued*

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$[a] *Dependent Variable:* $\ln(TFP_{it})$				*Equality Tests of Coefficients*[b]
Model	*(1)*	*(2)*	*(3)*	*(4)*	
Constant	–0.047*** (0.012)	–0.045*** (0.012)	–0.045*** (0.012)	–0.051*** (0.012)	
Year dummies	Yes	Yes	Yes	Yes	
Observations	15,772	15,772	15,772	15,772	
The *p*-values are reported for all the tests:					
m1	0.000	0.000	0.000	0.000	
m2	0.287	0.299	0.280	0.285	
Sargan	0.697	0.741	0.604	0.924	

Notes:
[a] Exogenous variables have # and endogenous variables do not. Standard errors are in parentheses. * Significant at 10%, ** at 5%; *** at 1%.
[b] *p*-value is reported. For example, the first value reports the test of the equality of the coefficients of *IPR * SMALL* and *IPR * LARGE*.

Source: Authors' calculations.

firms are sensitive to any kind of competition. Nevertheless, small firms are also sensitive to third-country prices while large firms are not. When we take into account import status (column 2), the technological effect appears clearer than in previous estimations. While non-importing firms raise their productivity 1.3 per cent if the IPR increases 10 per cent, importers' productivity increases 2.4 per cent in the same period. Without more qualitative information about imported capital and intermediate goods and the share of each of the two categories, it is difficult to test whether firm imports translate into better technology, better quality or better prices. Indeed, our results show that importing firms benefit from an additional positive effect when foreign competition increases. Firms that do not import are twice as sensitive to tariffs as importers. Non-importers are more affected by tariff cuts, which is consistent with the fact that non-importers are mostly small firms that may have lower margins. We do not find similar asymmetries among exporters and non-exporters. Exporters appear to take more advantage of foreign competition than non-exporters and to be less sensitive to tariffs, but the test of equality of the coefficients does not allow us to consider that exporters and non-exporters react differently to tariffs or IPR. Firms with lower foreign participation are more sensitive to tariffs than foreign firms (non-significant). More surprisingly, there is no difference as regards the impact of foreign competition on firms depending on their foreign ownership.

In sum, small firms and those that do not import or firms with mainly domestic ownership react more positively to tariff cuts. Tariff rates are a direct component

of foreign product prices and the weakest firms (small firms, non-importing or fully domestically-owned firms) react more strongly to prices than the others do. In fact, robust firms (large firms, importing firms, partially or fully owned by foreigners) are more willing to produce under increasing returns. Their production costs are low enough to permit them to decrease prices via reductions in their margins. In contrast, the import penetration rate takes into account the reduction of non-tariff trade barriers and the intensification of trade inside the EU. A higher level for this variable represents more foreign products on the domestic market. When the number of foreign products increases, a wider range of products is available in the market. This process improves the quality of products and can also reduce the quantity sold by domestic firms. When this occurs, even the most competitive firms have to react to higher competition. In other words, when an increase in trade influences foreign prices, it does not influence the productivity of the most competitive firms. Yet, on the other hand, when there is a strong additional increase in the quantity and quality of imports, then all the firms react strongly.

d. Robustness Checks of the Estimates

To assess the robustness of our findings, we present alternative specifications and methods. First, we follow the 'direct approach' proposed by Fernandes (2007). To this end we modify the Olley and Pakes (1996) methodology assuming that firms anticipate the effect of trade on their productivity level. If this hypothesis holds, the two-step method used previously may produce some biased estimates for IPR. Actually, if the impact of foreign products on productivity has already been taken into account by the firm, then the lagged value of productivity introduced as a regressor in the two-step approach may depend on IPR. Fernandes (2007) addresses this issue by estimating a production function equation that includes tariffs as regressors. This requires making some assumptions concerning the endogeneity of the variables added, namely tariffs and IPR in our case, as is done for the traditional inputs. Note that we will now obtain estimates of the production function for the whole manufacturing sector since trade policy indicators are only available at the industry level. As discussed previously, IPR is more likely to be considered endogenous when explaining firms' outputs or productivity, while EU tariffs are more likely to be independent of those variables. The results are displayed in Table 7, assuming that the import penetration rate has the same econometric properties as the capital and assuming that the tariff behaves freely.

When we use the direct approach, the coefficients of labour, capital and intermediate consumption are similar to those obtained in the previous regressions by industries in Table 3. The highly significant coefficients of the import penetration rate and the tariffs display the expected signs, confirming our previous findings. Indirectly, the results obtained using the direct approach also provide evidence

TABLE 7
Impact of Import Penetration Rate and Tariffs on TFP in the Direct Approach

	Direct Approach, Modified from Olley and Pakes (1996)	
Model	*(1)*	*(2)*
l	0.382***	0.390***
	(0.004)	(0.004)
k	0.145***	0.124***
	(0.006)	(0.006)
m	0.481***	0.468***
	(0.002)	(0.002)
$Tariff_{t-1}$	–0.800***	–0.844***
	(0.100)	(0.105)
IPR	0.305***	0.388***
	(0.060)	(0.064)
Firm characteristics	No	Yes
Industry dummies	Yes	Yes
Observations	17,348	16,155

Notes:
Standard errors are in parentheses. * Significant at 10%, ** at 5%; *** at 1%.

Source: Authors' calculations.

that IPR and tariffs do not capture just an industry-specific effect on productivity in the two-step approach.

Second, we test alternative specifications. We first verify that introducing the Herfindahl index in the specifications presented above does not influence our results. With this aim, we exclude the Herfindahl index from the estimations. The results displayed in Table 8 confirm that the results remain unchanged. In the same way, we replace the import-to-output ratio and the export-to-output ratios at the firm level by dummy variables for import and export ratios greater than 10 per cent.[19] We also introduce the import penetration rate (*IPREU*) using Spanish imports from EU countries (instead of all countries) to check whether our results are almost entirely explained by a specificity of the European market. The results concerning the impact of trade variables on TFP are not sensitive to these alternatives, neither for the average impact of these indicators (Table 9) nor when interacted with firm characteristics (Tables 10 and 11). In particular, firms that import are more sensitive to the import penetration rate of EU countries even if

[19] The import and export dummies are not significant without this threshold.

TABLE 8
Models without the Herfindahl Index

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$; *Dependent Variable:* $\ln(TFP_{it})$								
Model	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
IPR	0.270***	0.255***	0.246***				0.244***	0.225***	0.221***
	(0.038)	(0.038)	(0.038)				(0.039)	(0.039)	(0.039)
$Tariff_{t-1}$				–0.231***	–0.228***	–0.219***	–0.140***	–0.143***	–0.136***
				(0.021)	(0.020)	(0.021)	(0.024)	(0.023)	(0.023)
Foreign capital ratio	0.070**	0.079**	0.063*	0.072*	0.084**	0.069*	0.069*	0.076**	0.062*
	(0.036)	(0.035)	(0.035)	(0.039)	(0.037)	(0.037)	(0.036)	(0.035)	(0.035)
$Mratio_{t-1}$		0.158***	0.138***		0.146***	0.134***		0.154***	0.137***
		(0.050)	(0.049)		(0.050)	(0.050)		(0.050)	(0.049)
$Xratio_{t-1}$	0.081**		0.060*	0.066*		0.045	0.066*		0.046
	(0.034)		(0.033)	(0.035)		(0.035)	(0.034)		(0.034)
Market share	0.105*	0.098*	0.103*	0.147**	0.154**	0.153**	0.120**	0.113**	0.117**
	(0.057)	(0.057)	(0.055)	(0.063)	(0.064)	(0.061)	(0.057)	(0.057)	(0.056)
TFP_{t-1}	0.335***	0.335***	0.337***	0.337***	0.337***	0.340***	0.333***	0.333***	0.336***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Constant	–0.074***	–0.074***	–0.076***	0.003	–0.002	–0.006	–0.052***	–0.052***	–0.055***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.013)	(0.012)	(0.012)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,772	15,772	15,772	15,772	15,772	15,772	15,772	15,772	15,772
The *p*-values are reported for all the tests:									
m1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
m2	0.309	0.299	0.298	0.326	0.317	0.311	0.321	0.313	0.308
Sargan	0.100	0.295	0.634	0.127	0.305	0.704	0.132	0.371	0.692
	Endogenous variables					*Exogenous variables*			
	Total factor productivity, Foreign capital share, Import to output ratio, Export to output ratio, Market share, Import penetration rate, Import penetration rate of EU countries					Tariff			

Notes:
Standard errors are in parentheses. * Significant at 10%, ** at 5%; *** at 1%.

Source: Authors' calculations.

TABLE 9
Models with Import and Export Dummy Variables and IPR from EU Countries

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$ *Dependent Variable:* $\ln(TFP_{it})$			
Model	*(1)*	*(2)*	*(3)*	*(4)*
IPR	0.263***	0.238***		
	(0.037)	(0.039)		
IPREU			0.293***	0.248***
			(0.044)	(0.046)
$Tariff_{t-1}$		–0.137***		–0.149***
		(0.023)		(0.023)
Foreign capital ratio	0.094***	0.092***	0.073**	0.078**
	(0.033)	(0.033)	(0.033)	(0.033)
$Import\ dummy_{t-1}$	0.019*	0.019*	0.018*	0.017*
	(0.010)	(0.010)	(0.010)	(0.010)
$Export\ dummy_{t-1}$	0.009	0.007	0.010	0.006
	(0.011)	(0.011)	(0.010)	(0.011)
Herfindahl	–0.133***	–0.110***	–0.087**	–0.065
	(0.040)	(0.041)	(0.040)	(0.040)
Market share	0.098*	0.109*	0.081	0.092*
	(0.056)	(0.056)	(0.056)	(0.056)
TFP_{t-1}	0.339***	0.338***	0.344***	0.342***
	(0.017)	(0.017)	(0.017)	(0.017)
Constant	–0.039***	–0.023*	–0.027***	–0.009
	(0.011)	(0.012)	(0.010)	(0.011)
Year dummies	Yes	Yes	Yes	Yes
Observations	15,772	15,772	15,772	15,772
The *p*-values are reported for all the tests:				
m1	0.000	0.000	0.000	0.000
m2	0.272	0.284	0.251	0.267
Sargan	0.452	0.497	0.362	0.474
	Endogenous variables Total factor productivity, Foreign capital share, Import dummies, Export dummies, Market share, Import penetration rate, Import penetration rate of EU countries		*Exogenous variables* Herfindahl index, Tariff	

Notes:
Standard errors are in parentheses. * Significant at 10%, ** at 5%; *** at 1%.

Source: Authors' calculations.

it is less pronounced than before (at the 10 per cent level). Thus, firms that import benefit substantially more from competition by EU countries. In the period under study, Spanish tariffs for EU products were already set to zero, but the presence of European products in the Spanish market increases over the entire period.

TABLE 10
Interactions in the Models with Importer and Exporter Dummies

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$[a] *Dependent Variable:* $\ln(TFP_{it})$				*Equality Tests of Coefficients*[b]
Model	*(1)*	*(2)*	*(3)*	*(4)*	
IPR ∗ *LARGE*	0.273***				0.185
	(0.044)				
IPR ∗ *SMALL*	0.216***				
	(0.042)				
$Tariff_{t-1}$ ∗ *LARGE #*	–0.019				0.000
	(0.031)				
$Tariff_{t-1}$ ∗ *SMALL #*	–0.238***				
	(0.029)				
IPR ∗ *IMPORTER*		0.261***			0.001
		(0.039)			
IPR ∗ *NO IMPORTER*		0.125***			
		(0.048)			
$Tariff_{t-1}$ ∗ *IMPORTER #*		–0.079***			0.000
		(0.027)			
$Tariff_{t-1}$ ∗ *NO IMPORTER #*		–0.215***			
		(0.034)			
IPR ∗ *EXPORTER*			0.262***		0.061
			(0.042)		
IPR ∗ *NO EXPORTER*			0.184***		
			(0.042)		
$Tariff_{t-1}$ ∗ *EXPORTER #*			–0.084**		0.104
			(0.033)		
$Tariff_{t-1}$ ∗ *NO EXPORTER #*			–0.147***		
			(0.027)		
IPR ∗ *HIGH FDI*				0.228***	0.815
				(0.059)	
IPR ∗ *LOW FDI*				0.243***	
				(0.041)	
$Tariff_{t-1}$ ∗ *HIGH FDI**				0.048	0.000
				(0.051)	
$Tariff_{t-1}$ ∗ *LOW FDI**				–0.185***	
				(0.025)	
Foreign capital ratio	0.066*	0.074**	0.064*	0.088**	
	(0.034)	(0.033)	(0.033)	(0.037)	
$Import\ dummy_{t-1}$	0.018*	0.019*	0.019*	0.017*	
	(0.010)	(0.010)	(0.010)	(0.010)	
$Export\ dummy_{t-1}$	0.007	0.006	0.010	0.007	
	(0.010)	(0.011)	(0.011)	(0.010)	
Herfindahl for industry #	–0.138***	–0.125***	–0.126***	–0.114***	
	(0.040)	(0.040)	(0.040)	(0.040)	
Market share	0.123**	0.111**	0.114**	0.104*	
	(0.054)	(0.055)	(0.053)	(0.053)	

TABLE 10 *Continued*

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$[a] *Dependent Variable:* $\ln(TFP_{it})$				*Equality Tests of Coefficients*[b]
Model	*(1)*	*(2)*	*(3)*	*(4)*	
TFP_{t-1}	0.344***	0.340***	0.345***	0.343***	
	(0.017)	(0.017)	(0.016)	(0.017)	
Constant	–0.020*	–0.020*	–0.020*	–0.022*	
	(0.012)	(0.012)	(0.012)	(0.012)	
Year dummies	Yes	Yes	Yes	Yes	
Observations	15,772	15,772	15,772	15,772	
The *p*-values are reported for all the tests:					
m1	0.000	0.000	0.000	0.000	
m2	0.264	0.280	0.258	0.260	
Sargan	0.487	0.529	0.353	0.815	

Notes:
[a] Exogenous variables have # and endogenous variables do not. Standard errors are in parentheses. * Significant at 10%, ** at 5%; *** at 1%.
[b] *p*-value is reported. For example, the first value reports the test of the equality of the coefficients of *IPR * SMALL* and *IPR * LARGE*.

Source: Authors' calculations.

TABLE 11
Interactions in the Models with IPR from EU Countries

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$[a] *Dependent Variable:* $\ln(TFP_{it})$				*Equality Tests of Coefficients*[b]
Model	*(1)*	*(2)*	*(3)*	*(4)*	
*IPREU * LARGE*	0.232***				0.423
	(0.054)				
*IPREU * SMALL*	0.277***				
	(0.050)				
$Tariff_{t-1}$ * LARGE #	0.002				0.000
	(0.032)				
$Tariff_{t-1}$ * SMALL #	–0.273***				
	(0.029)				
*IPREU * IMPORTER*		0.267***			0.099
		(0.047)			
*IPREU * NO IMPORTER*		0.169***			
		(0.062)			
$Tariff_{t-1}$ * IMPORTER #		–0.070**			0.000
		(0.027)			
$Tariff_{t-1}$ * NO IMPORTER #		–0.255***			
		(0.033)			

TABLE 11 *Continued*

	GMM SYS $(t-2)$ *and* $\Delta(t-1)$[a] *Dependent Variable:* $\ln(TFP_{it})$				*Equality Tests of Coefficients*[b]
Model	*(1)*	*(2)*	*(3)*	*(4)*	
*IPREU * EXPORTER*			0.242***		
			(0.052)		0.425
*IPREU * NO EXPORTER*			0.286***		
			(0.052)		
$Tariff_{t-1}$ * *EXPORTER #*			–0.045		
			(0.034)		0.001
$Tariff_{t-1}$ * *NO EXPORTER #*			–0.174***		
			(0.027)		
*IPREU * HIGH FDI*				0.178**	
				(0.070)	0.269
*IPREU * LOW FDI*				0.263***	
				(0.049)	
$Tariff_{t-1}$ * *HIGH FDI #*				0.044	
				(0.053)	0.000
$Tariff_{t-1}$ * *LOW FDI #*				–0.198***	
				(0.025)	
Foreign capital ratio	0.074**	0.063*	0.066**	0.103***	
	(0.035)	(0.033)	(0.033)	(0.036)	
$Import\ dummy_{t-1}$	0.018*	0.019**	0.019*	0.016	
	(0.010)	(0.010)	(0.010)	(0.010)	
$Export\ dummy_{t-1}$	0.011	0.010	0.019*	0.008	
	(0.010)	(0.011)	(0.011)	(0.010)	
Herfindahl #	–0.081**	–0.081**	–0.075*	–0.070*	
	(0.039)	(0.039)	(0.039)	(0.039)	
Market share	0.124**	0.111**	0.102*	0.086	
	(0.053)	(0.054)	(0.053)	(0.053)	
TFP_{t-1}	0.348***	0.349***	0.355***	0.351***	
	(0.016)	(0.016)	(0.016)	(0.016)	
Constant	–0.014	–0.012	–0.018*	–0.010	
	(0.011)	(0.011)	(0.011)	(0.011)	
Year dummies	Yes	Yes	Yes	Yes	
Observations	15,772	15,772	15,772	15,772	
The *p*-values are reported for all the tests:					
m1	0.000	0.000	0.000	0.000	
m2	0.251	0.249	0.223	0.235	
Sargan	0.485	0.256	0.179	0.641	

Notes:
[a] Exogenous variables have # and endogenous variables do not. Standard errors are in parentheses. * Significant at 10%, ** at 5%; *** at 1%.
[b] *p*-value is reported. For example, the first value reports the test of the equality of the coefficients of *IPR * SMALL* and *IPR * LARGE*.

Source: Authors' calculations.

During this period, the variety of products has increased, particularly the availability of capital and intermediate goods. Importers have been able to find products that better match their needs, are of better quality or that incorporate new technologies. Therefore, importers benefit from the additional positive effects on their productivity level.

5. CONCLUSIONS

During the last decade, Spain experienced a rapid growth of external trade without facing large trade imbalances. Considering the huge increase in internal demand since the early 1990s, the question of how to increase domestic production, competitiveness and productivity has been a key issue for Spain. The country is often viewed as a successful case for new EU members that are concerned about large trade imbalances since Spain seems to have managed this transition process quite well throughout the 1990s. However, the competitiveness of the Spanish economy began to decline, especially after the introduction of the euro in 1999, and the trade deficit has increased sharply in the last few years. According to Chóren et al. (2004), inflation has been very harmful for the competitiveness of the Spanish economy in recent years, although this is explained mainly by the increase in prices in non-trading sectors. In the trading sectors (manufactures), labour productivity has increased at a slow rate and labour and financial costs have been maintained, but margins have diminished due to an increase in other costs.

Our study confirms that TFP in the Spanish manufacturing sector has increased over the entire period. This growth in aggregate TFP is explained partly by intra-firm productivity growth; that is, a better use of technologies and managerial abilities. Despite the moderate growth in TFP, we show that the decrease in European tariffs on third-country products and the increased presence of foreign products contributed positively to this process. Moreover, these two effects were complementary. Another important finding is that importing foreign products had an additional positive impact on TFP and can be seen as proof of a technological effect that allows for additional productivity improvements.

However, we confirm theoretical predictions on the importance of firm heterogeneity. Each type of firm reacts differently since some firms are more sensitive than others to tariffs and competition. In particular, small firms and firms that do not participate in foreign markets via exports, imports or ownership can be considered to be more ‘sensitive’ than others to tariff reductions. The effect of competitive pressure on TFP is similar for firms of different sizes and for exporters and non-exporters. In contrast, importers react more positively to foreign competition in terms of TFP gains than other firms.

Our paper concludes that, even in a European country with relatively low levels of protection such as Spain, additional gains can be expected from a trade

liberalisation process. However, a large part of the positive effect comes from the increased presence of foreign products and the more indirect effects of openness through firms' imports rather than from a tariff reduction.

APPENDIX A

For the cleaning process, we chose to use interpolation to fill the gaps for a particular variable if a firm reported no value in a given year, while values were reported in the year before and the year after the missing one. In particular, we did so for all the components of the value added, labour and investment in order to obtain better estimates for the TFP. This only applies to 114 observations out of 24,241. From the sample we dropped all the observations corresponding to firms that did not answer for that year except if data were interpolated using the criterion explained above. Capital stock is measured using the inventory perpetual method. We use a depreciation rate of 9 per cent based on the average depreciation rate as used in Mas et al. (2005). We use fixed assets (equipment, construction, etc.) as the initial capital stock level for the available initial year and then add investment flows by type of fixed assets. After eliminating the firms for which we do not have capital stock in any year, we obtained 3,167 observations per year. Finally, we drop observations with unrealistically large spikes in the data (e.g. negative value added, a more than 300 per cent growth in value added with a reduction in employment).

We use a production price index at the three-digit industry level to express production and intermediate consumption in constant terms. We deflate the investment by an investment price index at the three-digit level. The other variables do not need to be deflated because they are expressed in numbers or in ratios. Deflators come from the *Instituto Nacional de Estadística* (National Statistics Institute of Spain). Using deflated values as measures of quantities leads to a potential measurement problem (see Klette and Griliches, 1996).[20] Nevertheless, there is no easy empirical solution to this problem and the method we use has become standard, though it may reflect both true efficiency and mark-ups.

[20] This problem arises if firms operating in imperfectly competitive markets fix a price according to their costs (and efficiency) so that real output and sales may not grow at the same rate. Bernard et al. (2003) develop a model in which each product can be produced by multiple firms and that firms engage in pure Bertrand competition (limit pricing). They conclude that relatively productive firms exhibit relatively large mark-ups. Then, revenue per unit input bundle can be used as a proxy for physical productivity. Alternatively, Katayama et al. (2006) assume that all firms face different demand elasticities and conclude that revenue per unit bundle values depend upon profits which, in turn, are higher for firms with low demand elasticities (but do not necessarily depend on their effective productive efficiency or product quality).

APPENDIX B

Fixed Effects and OLS Estimates of the Main Equations

	Dependent Variable: ln(TFP_{it})								
	OLS Levels			*Within Groups*			*GMM SYS* $(t-2)$ *and* $\Delta(t-1)$		
Model	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
IPR	0.086***		0.067***	0.046		0.046	0.240***		0.217***
	(0.012)		(0.012)	(0.030)		(0.030)	(0.037)		(0.039)
$Tariff_{t-1}$		–0.105***	–0.083***		–0.067	–0.067		–0.218***	–0.135***
		(0.014)	(0.015)		(0.063)	(0.063)		(0.021)	(0.023)
Foreign	0.030***	0.034***	0.032***	0.039***	0.039***	0.040***	0.062*	0.068*	0.062*
	(0.006)	(0.006)	(0.006)	(0.014)	(0.014)	(0.014)	(0.035)	(0.037)	(0.035)
$Mratio_{t-1}$	0.099***	0.108***	0.097***	0.089***	0.089***	0.089***	0.139***	0.135***	0.139***
	(0.014)	(0.014)	(0.014)	(0.023)	(0.023)	(0.023)	(0.049)	(0.050)	(0.049)
$Xratio_{t-1}$	0.022***	0.021***	0.018**	0.042**	0.043***	0.042**	0.065*	0.045	0.050
	(0.008)	(0.008)	(0.008)	(0.017)	(0.017)	(0.017)	(0.033)	(0.035)	(0.034)
Herfindahl	–0.108***	–0.077**	–0.093***	–0.029	–0.006	–0.010	–0.147***	–0.065	–0.123***
	(0.031)	(0.031)	(0.031)	(0.056)	(0.059)	(0.059)	(0.041)	(0.041)	(0.041)
Market share	0.054***	0.056***	0.057***	0.024*	0.024*	0.024*	0.117**	0.154**	0.128**
	(0.009)	(0.009)	(0.009)	(0.013)	(0.013)	(0.013)	(0.056)	(0.061)	(0.056)
TFP_{t-1}	0.767***	0.767***	0.765***	0.218***	0.218***	0.218***	0.336***	0.339***	0.334***
	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.017)	(0.017)	(0.017)
Constant	–0.027***	–0.001	–0.014**	–0.030***	–0.014*	–0.024**	–0.067***	–0.002	–0.048***
	(0.005)	(0.005)	(0.006)	(0.009)	(0.008)	(0.010)	(0.011)	(0.010)	(0.012)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,772	15,772	15,772	15,772	15,772	15,772	15,772	15,772	15,772
R^2 adj.	0.67	0.67	0.67	0.58	0.58	0.57			
The *p*-values are reported for all the tests:									
m1							0.000	0.000	0.000
m2							0.299	0.308	0.308
Sargan							0.683	0.706	0.728

Notes:
Standards errors are in parentheses. * Significant at 10%, ** at 5%; *** at 1%.

Source: Authors' calculations.

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