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IS THERE A QUALITY-UPGRADING WAGE PREMIUM?*

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This paper analyses the existence of a quality-upgrading wage premium at the firm level and its connection with the exporting wage premium. Producing a higher quality product increases the likelihood of exporting and can activate a learning-by-exporting mechanism. In turn, higher quality products require employing more-skilled labour, thereby leading to higher wages. Using a methodology similar to that proposed by Schank *et al.* (2010), I test whether firms that increase their product quality pay higher wages (the learning-by-quality-upgrading hypothesis) or, conversely, if firms with higher productivity, as proxied by their higher wages, are more likely to increase the quality of their output (self-selection hypothesis).

Key words: wage differentials, international trade, exports, product quality.

JEL Classification: F16, J31, J24.

Increasing the quantity and quality of exports and creating more and better-paid jobs are major challenges faced by many countries such as Spain. These challenges and the elements that are involved (exports, quality, human capital and wages) are closely connected. For instance, studies following the pioneering work by Bernard and Jensen (1995) find an exporter wage premium (see Wagner (2007, 2012) and Schank *et al*. (2010) for references). Recently, several papers [Guadalupe (2007), Verhoogen (2008), Kugler and Verhoogen (2012) and Bustos (2011)] analyse the positive correlations between exports, quality, productivity and wages using data at the firm or establishment level[1]. The main motivation of this paper stems from Alcalá and Hernández (2010), who build a theoretical model suggesting that the wage premium paid by exporters and their higher human capital is connected to the higher quality of their output. More productive firms can overcome entry costs into international markets (and, in general, more distant markets[2]) and have more incen-

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(1) Bernard *et al*. (2011) review this empirical evidence on firm heterogeneity in international trade.

(2) Similar effects are obtained between establishments in national markets versus local markets.

tives to produce higher quality goods. In turn, this leads them to employ more human capital that, from the point of view of the econometrician, involves observable as well as unobservable skills. Because of this non-observability of some skills that are relatively important for exporting and producing higher quality, exporters are found to pay higher wages to workers with the same observable characteristics. In other words, the wage premium is the wage retribution to unobservable skills that are relatively more abundantly used by the exporters; which in turn is the consequence of exporters producing higher quality and the unobservable skills being relatively more productive when producing higher quality. However, the link between wages and product quality was not directly tested in Alcalá and Hernández (2010) because their dataset did not contain information on product quality. This paper attempts to overcome this shortcoming by analysing the correlations at the firm level between product quality, export intensity and average wages using a different dataset that contains information on all these variables at the firm level. This topic has not been treated previously with Spanish data.

Producing higher quality increases the likelihood of exporting and can activate a learning-by-exporting mechanism. In turn, higher quality products require using higher (observable and unobservable) human capital, thereby leading to higher wages. This paper has two aims: i) to ascertain whether a quality-upgrading wage premium exists beyond the exporter wage premium and ii) to analyse whether firms that increase their product quality pay higher wages (learning-by-upgrading-quality hypothesis) or, conversely, if firms with higher productivity are more likely to increase their product quality (self-selection hypothesis).

The learning-by-upgrading-quality hypothesis implies that the wage retribution to skills not observed in the econometric analysis increase at the same time that the firm increases their product quality because their employees are learning to produce goods and services with higher quality. The self-selection hypothesis implies that firms with higher productivity because they have employees with more human capital, as proxied by their higher wages, are more likely to increase their product quality.

To conduct the causality analysis, I use a methodology similar to that proposed by Schank *et al*. (2010) for exporter firms. These authors compare the learning-by-exporting versus self-selection hypotheses using a dataset of German linked employer-employees and find empirical evidence in favour of the self-selection hypothesis. This analysis is carried out within the theoretical framework of models of exports with heterogeneous firms [Melitz (2003) and Greenaway and Kneller (2007)][3].

I conduct this empirical investigation using data from the Spanish *Encuesta Sobre Estrategias Empresariales* (Survey on Business Strategies, hereinafter, ESEE) for the period 1990-2010. Measuring product quality is a complex issue that depends on the available information. Verhoogen (2008) uses ISO 9000 certification, whereas Kugler and Verhoogen (2012) use the quality measure from Sutton (1998) (R&D and ad-

(3) There are several papers that have analysed this question in Spain, focusing on the estimated total factor productivity. Delgado *et al*. (2003) obtain evidence in favour of the self-selection hypothesis, but Mañez *et al*. (2010) find evidence in favour of the learning-by-exporting hypothesis. Manjón *et al*. (2013) indicate that the assumptions used for the evolution of productivity and the role of export status turn out to be critical for finding evidence in favour of either hypothesis.

vertising intensity). The use of R&D expenditures is common in literature combining productivity, exports and product quality [Aw *et al.* (2007) and (2011), Caldera (2010), Díaz-Mayans and Sánchez (2014), and Máñez *et al.* (2014)]. The ESEE does not contain information about ISO certification. I use three measures for product quality: i) Sutton's R&D and advertising intensity measure; ii) a categorical variable that indicates whether the firm conducted or contracted quality standardization and control work; iii) a categorical variable that indicates whether the firm developed product innovations incorporating new materials, new functions or new components[4].

I analyse the direction of causality by separating the firms that start to produce at higher quality during the period from those that do not and studying the dynamics of their wages before and after the quality changes. If higher product quality increases wages and productivity, then we would observe a wage increase in the years after the decision to increase product quality. In contrast, if only the more productive firms with higher wages increase product quality, we would not observe any statistically significant temporal effects. We could also observe significant temporal effects if both hypotheses are correct.

The paper is organized as follows. Section 1 describes the dataset and the three indicators used to measure product quality: R&D and advertising expenditures over sales, quality standardization and control, and product innovation. Section 2 presents the econometric specifications and the methodology used to study causality and to test the hypotheses. Section 3 discusses the estimation results. Section 4 summarizes and concludes.

1. The data

The ESEE for the period 1990-2010 is an unbalanced panel of Spanish manufacturing firms[5]. The database contains information about an average sample of 1800 firms for every year and includes information about their activities, products, manufacturing processes, customers and suppliers, costs and prices, markets covered, technological activities, income statements, accounting balance sheets, employment and foreign trade. Firms with fewer than 10 employees are excluded from the survey. The survey contains information on 70% of all firms with more than 200 employees together with a random sample that covers 5% of the remaining firms (firms with 10 to 200 employees). Most of the variables included are yearly, although the information for some variables is only updated every four years, such as the information about work conducted or contracted by firms on quality standardization and quality control and the percentage of college graduates and engineers in total employees.

Table A1 in the appendix gives a brief statistical description of some interesting variables. Average wages of the firm are labour costs per employee (labour costs divided by yearly average of total employment). Exporter firms have higher wages than non-exporter firms and are also larger. For firms with more than 200 employ-

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(4) Martínez-Ros (2001) studies the relationship between process and product innovations and wages as a proxy for economic rents that workers can take when a firm introduces technological changes.

(5) This survey originates from an agreement in 1990 between the Ministry of Industry and the SEPI Foundation, formerly the *Fundación Empresa Pública* (Public Firm Foundation).

ees, the percentage of exporter firms with more than 249 employees is 82.8%, whereas in non-exporters, it is 76.8%. The percentage of total sales exported (export propensity) is 25.1% for exporting firms with fewer than 201 employees and 33.7% for exporter firms with more than 200 employees. We also observe that the percentage of firms that control their quality is 43.8% within exporter firms with fewer than 201 employees, whereas within non-exporter firms, it is only 24.4%. These percentages are 67,7% and 55,4% for firms with more than 200 employees, respectively. The percentage of R&D and advertising expenditures over sales is higher in exporter firms with fewer than 201 employees, 2.1% versus 0.9% for non-exporter firms, whereas within firms with more than 200 employees, these percentages are more similar: 3.4% versus 3.5% respectively. The percentage of firms featuring product innovations is always higher for exporter firms: for exporter and non-exporter firms respectively, it is 21.3% versus 7.6% for firms with fewer than 201 employees and 34.8% versus 17.6% for firms with more than 200 employees.

The ESEE does not contain information about whether a firm has any ISO certification for its product quality. Therefore, I use a measure for quality from Sutton (1998) – R&D and advertising expenditures over sales, the information obtained every four years about whether a firm has conducted or contracted quality standardization and control work (quality control), and a categorical variable that indicates whether the firm has developed product innovations incorporating new materials, new functions or new components. These three variables are available from 1991 and are combined into a single variable[6]. We can observe in the following tables that these measures for quality behave as expected. Table 1 shows that in all of the years in which information on quality control is available, there is a positive relation between this variable and the percentage of college graduates and engineers, the export propensity (percentage of sales exported) and the average wage of the firm. These same positive correlations are observed between R&D and advertising expenditures over sales and the percentage of graduates and the average firm wage (for all years between 1990 and 2010 in the latter case). Only in 1991 and 1992 are the positive correlations between R&D and advertising expenditures over sales and export propensity not significant. The positive correlations between product innovation and the percentage of graduates, export propensity and average wages are always significant.

Table 2 also shows a positive relation between these variables by industry. In the vast majority of cases, these correlations are significant.

For each year, Table 3 compares the firms that invest in R&D and advertising, control their product quality or achieve product innovations with those firms that do not, using several indicators: the percentage of graduates, the firm average wage and the export propensity. In the first three columns, we can see that the firms that invest in R&D and advertising have a higher percentage of college graduates, higher wages and a greater export propensity than the firms that do not invest. Identical be-

(6) I also conducted a separate analysis using each of these three variables. The results are very similar and are available upon request. The ESEE provides a fourth variable measuring whether a firm has developed any product innovations of any kind. However, the definition of this variable changes in 2007, thereby excluding product innovations for new designs. At any rate, the results using these latter variables are again very similar and are available upon request.

Table 1: Correlations between the quality measures and the percentage of college graduates, the export propensity and the average firm wages by year

	Quality control			R&D and advertising expenditure over sales (%)			Product innovation		
	Percentage of graduates	Export propensity	Average firm wage	Percentage of graduates	Export propensity	Average firm wage	Percentage of graduates	Export propensity	Average firm wage
1990	0.130***	0.138***	0.231***	0.298***	0.055**	0.196***			
1991					0.033	0.253***		0.088***	0.141***
1992					0.032	0.271***		0.127***	0.126***
1993					0.044*	0.261***		0.127***	0.138***
1994	0.211***	0.247***	0.363***	0.333***	0.067***	0.303***	0.148***	0.202***	0.184***
1995					0.102***	0.278***		0.140***	0.180***
1996					0.112***	0.299***		0.154***	0.177***
1997					0.081***	0.296***		0.140***	0.212***
1998	0.169***	0.268***	0.350***	0.336***	0.084***	0.293***	0.149***	0.155***	0.191***
1999					0.126***	0.285***		0.180***	0.170***
2000					0.080***	0.260***		0.203***	0.193***
2001					0.060***	0.257***		0.183***	0.186***
2002	0.176***	0.213***	0.316***	0.317***	0.081***	0.245***	0.149***	0.230***	0.211***
2003					0.052**	0.270***		0.163***	0.185***
2004					0.063***	0.297***		0.166***	0.175***
2005					0.066***	0.266***		0.179***	0.135***
2006	0.116***	0.117***	0.1837*	0.3370*	0.071***	0.250***	0.105***	0.198***	0.187***
2007					0.087***	0.259***		0.195***	0.174***
2008					0.100***	0.225***		0.179***	0.153***
2009					0.123***	0.2006***		0.203***	0.184***
2010	0.171***	0.194***	0.237***	0.236***	0.117***	0.170***	0.187***	0.183***	0.182***

Notes to Table 1: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively.

Source: Own elaboration.

Table 2: CORRELATIONS BETWEEN THE QUALITY MEASURES AND THE PERCENTAGE OF COLLEGE GRADUATES, THE EXPORT PROPENSITY AND THE AVERAGE FIRM WAGES BY INDUSTRIES

	Quality control			R&D and advertising expenditure over sales (%)			Product innovation		
	Percentage of graduates	Export propensity	Average firm wage	Percentage of graduates	Export propensity	Average firm wage	Percentage of graduates	Export propensity	Average firm wage
1	0.203***	0.115**	0.231***	0.342***	-0.028	0.419***	0.236***	-0.016	0.277***
2	0.222***	0.174***	0.210***	0.251***	0.002	0.306***	0.163***	0.034**	0.190***
3	0.212***	0.106*	0.145**	0.182***	0.230***	0.389***	0.071**	-0.092**	0.247***
4	0.090***	0.238***	0.194***	0.077***	0.114***	0.107***	0.128***	0.255***	0.220***
5	0.1631***	0.182***	0.140***	0.070**	0.198***	0.188***	0.104***	0.089***	0.098***
6	0.141***	0.051	0.158***	0.165***	0.051*	0.115***	0.119***	0.057**	0.108***
7	0.211***	0.296***	0.227***	0.084***	-0.031	0.129***	0.250***	0.250***	0.142***
8	-0.080*	0.167***	0.117***	0.450***	-0.090***	0.305***	0.002	0.027	-0.018
9	0.1352***	0.009	0.186***	0.317***	-0.205***	0.178***	-0.006	-0.014	0.027
10	0.184***	0.234***	0.181***	0.199***	0.114***	0.074***	0.123***	0.112***	0.131***
11	0.157***	0.094***	0.200***	0.111***	0.365***	0.103***	0.145***	0.191***	0.142***
12	0.108**	0.095*	0.101**	0.063**	0.160***	-0.074**	0.043	0.080***	0.049*
13	0.147***	0.200***	0.153***	0.111***	0.172***	0.117***	0.126***	0.184***	0.062***
14	0.185***	0.207***	0.176***	0.109***	0.142***	0.069***	0.125***	0.222***	0.085***
15	0.096*	0.105*	0.063	0.281***	0.019	0.128***	0.272***	0.050	0.127***
16	0.071*	0.162***	0.120***	0.171***	0.149***	0.126***	0.071***	0.196***	0.138***
17	0.115***	0.122***	0.093**	0.139***	0.145***	0.083***	0.135***	0.182***	0.110***
18	0.173***	0.141***	0.197***	0.338***	0.148***	0.106***	0.154***	0.123***	0.172***
19	0.229***	0.160***	0.250***	0.147***	0.168***	0.164***	0.215***	0.180***	0.155***
20	0.087	0.160***	0.123**	0.015	0.251***	0.162***	-0.029	0.197***	0.063**

Notes to Table 2: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. The correlations of quality control only include the years for which information is available (1990, 1994, 1998, 2002 and 2006). Industries: 1 Meat products; 2 Food and tobacco; 3 Beverages; 4 Textiles and clothing; 5 Leather, fur and footwear; 6 Timber; 7 Paper; 8 Printing and Publishing; 9 Chemical products; 10 Plastic and rubber products; 11 Non-metal mineral products; 12 Basic metal products; 13 Fabricated metal products; 14 Machinery and equipment; 15 Computer products, electronics and optical; 16 Electric materials and accessories; 17 Vehicles and accessories; 18 Other transport equipment; 19 Furniture; 20 Other manufacturing.

Source: Own elaboration.

Table 3: Ratios

	Firms with R&D and advertising expenditures versus firms without these expenditures			Firms that control their product quality versus firms that do not			Firms that develop product innovations versus firms that do not		
	Percentage of graduates	Average firm wage	Export propensity	Percentage of graduates	Average firm wage	Export propensity	Percentage of graduates	Average firm wage	Export propensity
1990	2.25	1.31	1.93	1.66	1.25	1.72			
1991		1.32	2.00					1.16	1.43
1992		1.31	2.47					1.50	1.63
1993		1.39	2.49					1.21	1.68
1994	2.76	1.43	2.36	1.79	1.39	2.15	1.66	1.21	1.92
1995		1.39	2.28					1.20	1.58
1996		1.38	2.14					1.21	1.62
1997		1.33	1.88					1.24	1.53
1998	2.09	1.29	1.82	1.57	1.36	2.11	1.63	1.21	1.57
1999		1.33	2.27					1.19	1.69
2000		1.35	2.09					1.21	1.74
2001		1.34	2.25					1.21	1.69
2002	2.26	1.33	2.34	1.63	1.30	1.77	1.61	1.23	1.91
2003		1.28	1.72					1.21	1.64
2004		1.26	1.83					1.19	1.63
2005		1.24	2.04					1.15	1.75
2006	1.96	1.19	1.96	1.42	1.17	1.39	1.48	1.22	1.88
2007		1.18	1.74					1.18	1.82
2008		1.21	1.86					1.17	1.73
2009		1.18	1.84					1.19	1.80
2010	1.89	1.21	1.84	1.54	1.20	1.67	1.67	1.18	1.69

Source: Own elaboration.

Table 3: RATIOS (continuation)

	Exporter versus non-exporter		
	R&D and advertising expenditure over sales	Quality control	Product innovation
1990	2.11	1.84	
1991	2.38		2.30
1992	2.31		2.83
1993	2.80		3.34
1994	2.92	2.61	3.48
1995	3.20		2.62
1996	3.02		2.80
1997	2.76		2.89
1998	2.91	2.32	2.63
1999	2.91		3.11
2000	2.49		3.45
2001	2.15		4.18
2002	2.55	2.29	4.69
2003	2.32		4.22
2004	2.49		4.00
2005	2.55		4.25
2006	2.37	1.71	4.96
2007	2.69		4.16
2008	2.96		3.61
2009	3.09		3.87
2010	2.69	1.86	3.36

Source: Own elaboration.

haviour is observed in the second three columns for firms that control their product quality versus firms that do not, and in the last three columns for firms that develop product innovations versus firms that do not. Finally, the continuation of Table 3 shows that R&D and advertising expenditures over sales, quality control and product innovation are higher in exporter than in non-exporter firms.

2. Methodology

I use a regression analysis to analyse the correlations between wages and quality upgrading. I estimate the following equation:

$$\ln w_{jt} = \alpha_{it} + \beta_1 Age_{jt} + \beta_2 Size2_{jt} + \beta_3 Size3_{jt} + \beta_4 Exporter_{jt} + \beta_5 Graduates_{jt} + \beta_6 Quality_{jt} + u_{jt} \quad [1]$$

where $\ln w_{jt}$ is the log of the wage of the firm: the log of the total labour costs divided by the yearly average of total employment of firm *j* in year *t*. *Size2* is a dummy variable for firm size that corresponds to firms employing between 50 and 249 workers, and *Size3* corresponds to firms with more than 249 workers. *Exporter* is the dummy for exporter status, *Graduates* is the percentage of college graduates and engineers in total employees, and *Quality* is the quality indicator, which can be the R&D and advertising expenses over sales suggested by Sutton (1998), a dummy variable that takes the value one when a firm has conducted or contracted quality standardization and control work (quality control), or a dummy variable that takes the value one when a firm has obtained product innovations by incorporating new materials, new functions or new components. Finally, I include a full set of interaction terms between a vector of 20 dummies for industry and another vector of time dummies (α_{it} denotes these industry-year fixed effects, i = 1, ..., 20; t = 1990, …, 2010 for the measure of Sutton; t = 1994, 1998, 2002, 2006 and 2010 for quality control; and t = 1991, …, 2010 for product innovation).

For the analysis of causality between quality upgrading and wages, I use a methodology similar to that proposed by Schank *et al*. (2010) in the context of exporter wage premiums. These authors observe how firms behave over periods of consecutive years. They start at a point in time when none of the firms exported and end when some have been exporting for a period of time. The latter are called export starters. Specifically, they use a period of 6 years and define an export starter as a firm that has no exports in the first 3 years (t = 1, 2, 3) but starts to export in year t = 4 and continues to export in years t = 5 and t = 6. Moreover, if a firm is observed more than six times in the sample, then in all observed years after t = 6, it must have been an exporter, and in all observed years before t = 1, it must have exports equal to zero. Otherwise, the firm is dropped from the sample. Non-exporters are firms that do not export in any of the years t = 1, …, 6. So, according to their variable construction, it is not possible for a firm to first be an export-starter and then a non-exporter, but the other way around (first a non-exporter, then a starter) is possible.

Estimates by Schank *et al*. (2010) indicate that the wages and labour productivity (sales per employee) of exporter starters are higher than those of non-exporter firms but that the temporal effects are not statistically significant. In other words, neither the difference in the wages nor the difference in productivity changes over the years, either in the years before the starters begin to export or in the years after they start to export. From their results, the authors conclude that firms with higher productivity (and higher wages) self-select into export markets. This is in line with the main idea of the model of Melitz (2003), who emphasizes that firm heterogeneity is a phenomenon that can help explain the distribution of trade flows. Greeneway and Kneller (2007) state that only more productive firms can bear the higher cost of entering international markets.

This methodology can be applied to the causality relation between quality upgrading and wages. I can define a set of firms that start to upgrade their product quality versus firms that never do. My testing procedure also analyses the evolution of the wages of the starters before and after the decision to control product quality. If this evolution shows a positive increase, we will conclude that higher product quality increases wages. However, if these variables are not affected in the years before and after the increase in quality, even though they are higher than those observed in firms that do not increase their product quality, we will conclude that more productive firms with higher wages decide to improve their product quality and, therefore, the direction of causality is the opposite. In other words, product quality does not increase wages, but firms with higher wages, as a proxy for average productivity, are more likely to improve their product quality.

Unlike Schank *et al*. (2010), I use a period of 4 years because with 6 years, I obtain very few observations of starter firms. Using R&D and advertising expenses over sales as a measure of product quality [Sutton (1998)], I define a firm as starting to improve its product quality if in the four-year period considered, it does not conduct R&D and advertising expenses in the first two years and has positive values for this variable in the following two. Moreover, if a firm is observed more than four consecutives times in the sample, then in all observed years after $t = 4$, it must have been a quality upgrader (investing in R&D and advertising) and in all the observed years before $t = 1$, it could not have invested. If this is not the case, the firm is dropped from the sample. Obviously, I define a firm as not improving its product quality when it presents zero values of this variable for all the four-year periods considered. With the ESEE data from 1990 to 2010, I can define 18 windows (from 1990 to 1993, from 1991 to 1994, …, from 2007 to 2010). These data for quality-upgrader starters and non-quality upgraders are pooled over these eighteen cohorts. So, it is possible that a firm is first a non-quality upgrader and then a quality-upgrader starter, but not vice versa. I use the same construction with product innovations as measure of product quality: a starter is a firm that does not obtain product innovations in the first two years but obtains product innovations in the following two. A non-starter is a firm that does not obtain product innovations in the four years considered.

With the other measure of product quality –whether the firm has conducted or contracted quality standardization and control work (quality control)– we can only ascertain the above every four years (1990, 1994, 1998, 2002, 2006 and 2010). Therefore, in this case, I have defined three cohorts of 4 years (from 1990 to 2002, from 1994 to 2006 and from 1998 to 2010). These quality variables have information in the survey only every four years; therefore, each of the three cohorts from 1990 to 2002, from 1994 to 2006 and from 1998 to 2010 have only 4 years with available data for estimation.

I have supposed that a firm starts to increase its product quality when it does not control it in the two first years but does in the following two years. A firm never increases its product quality if it does not control it in all of the 4 years considered.

3. Estimation Results

3.1. Wages and quality upgrading

Table 4 shows the estimated coefficients of equation [1] in the case of R&D and advertising expenses over sales (a continuous variable and a dummy that takes the value one when R&D and advertising expenses are positive) and the exporter dummy. The results for positive relations between firm size, age and wages are standard and are available upon request. All of the firms are included in the four first columns of the top of Table 4. The exporter wage premium is approximately 9% (8.9% in the first column ($e^{(0.085)}$-1) and 9,5% in the third column). The wage effect of R&D and advertising expenses over sales is statistically significant. A 1 percentage point increase in the percentage of these expenses increases the average wage of the firm by 0.5%. With the dummy variable, positive R&D and advertising expenses increase the average wage of the firm by 4.5% when we include the exporter dummy and the percentage of graduates, 6,2% when we only include the exporter dummy and 7.9% when we do not include any of these controls. In other words, we obtain a quality-upgrading wage premium in addition to the exporter wage premium and in addition to the fact that producing higher quality goods increases the chances of exporting.

To check whether this quality-upgrading wage premium is the same for always exporters, never exporters and firms that change their exporter status, we report these coefficients for other subsamples. The four last columns from the top of Table 4 show the result for firms that are always exporters or never exporters (we exclude the export-switcher firms). The results are very similar for the R&D and advertising expense variables and the exporter wage premium is higher. In the bottom of Table 4, we report the quality-upgrading wage premium separately for these firms in the first four columns. These wage premiums are statistically significant and higher for a firm that never becomes an exporter, so for non-exporting firms, it is even more relevant to perform upgrading investments to justify the payment of higher wages. The last four columns at the bottom of Table 4 show the estimates for only export-switcher firms. The quality-upgrading wage premium is similar to that of firms that never change their exporter status, but the exporter wage premium is considerably lower.

Table 5 shows similar results when the quality indicator is a dummy variable (quality control) that takes the value one when a firm has conducted or contracted quality standardization and control work. This information is only updated every four years. The dummy for quality control is also statistically significant in all cases. For all firms in column 1 at the top of Table 5, those that control their product quality pay 6.7% higher wages than firms that do not. If we include the exporter dummy, this percentage is 5.7%, and if we also include the percentage of graduates, it is 4.7%. These percentages are very similar for the subsample without export-switcher firms, but again, when we estimate this coefficient separately for firms that are always exporters and firms that never become exporters at the bottom of Table 5, we obtain that the quality-upgrading wage premium is higher for these latter firms. For the subsample of export-switcher firms, this wage premium is lower again.

Table 4: R&D and advertising expenses and wages

	All firms				Without export-switcher firms			
Percentage of R&D and advertising expenses over sales		0.0054*** (4.29)				0.0056*** (3.56)		
Dummy=1 if R&D and advertising expenses>0	0.0045*** (5.49)		0.0607*** (6.80)	0.0761*** (8.45)	0.0467*** (4.58)		0.0597*** (5.63)	0.0826*** (7.65)
Exporter	0.0846*** (8.87)		0.0907*** (9.11)		0.1188*** (8.24)		0.1306*** (8.64)	
Percentage of graduates	0.0118*** (14.22)				0.0123*** (15.22)			
R^2	0.635	0.606	0.613	0.608	0.656	0.623	0.633	0.625
Observations	36,651	37,041	36,957	37,041	25,591	25,875	25,811	25,875
Firms	4,902	4,925	4,919	4,925	3,906	3,928	3,922	3,928
	Firms that are always exporters		Firms that never become exporters		Only export-switcher firms			
Percentage of R&D and advertising expenses over sales							0.0051*** (2.51)	
Dummy=1 if R&D and advertising expenses>0	0.0142* (1.56)	0.0318*** (2.09)	0.0577*** (4.04)	0.0671*** (4.65)	0.0408*** (2.59)	0.0512*** (3.18)		0.0544*** (3.39)
Exporter					0.0325*** (2.77)	0.0311*** (2.58)		
Percentage of graduates	0.0144*** (15.01)		0.0093*** (7.60)		0.0103*** (5.62)			
R^2	0.612	0.571	0.550	0.538	0.604	0.586	0.585	0.585
Observations	15,901	16,074	9,690	9,737	11,060	11,146	11,166	11,166
Firms	2,194	2,199	1,726	1,737	996	997	997	997

Notes to Table 4: OLS estimates. Dependent variable: logarithm of average firm wage. *** and * represent significance at the 1% and 10% levels, respectively. All estimations include firm size dummies, age of the firm and a full set of interaction terms between these dummies (industry-year fixed effects). $|t|$-statistics are in brackets. Standard errors are corrected for heteroskedascity and clustered by firm throughout.

Source: Own elaboration.

Table 5: QUALITY CONTROL AND WAGES

	All firms			Without export-switcher firms		
Quality control	0.0647***	0.0557***	0.0456***	0.0727***	0.0589***	0.0488***
	(8.86)	(7.79)	(6.58)	(8.32)	(6.94)	(6.01)
Exporter		0.0885***	0.0788***		0.1254***	0.110***
		(8.74)	(8.14)		(8.75)	(8.03)
Percentage of graduates			0.0121***			0.0125***
			(15.32)			(16.39)
R^2	0.618	0.623	0.646	0.634	0.642	0.664
Observations	11,207	11,176	11,093	8,034	8,009	7,949
Firms	4,650	4,644	4,633	3,667	3,661	3,658

	Firms that are always exporters		Firms that never become exporters		Only export-switcher firms		
Quality control	0.0468***	0.0344***	0.0848***	0.0780***	0.0404***	0.0391***	0.0303***
	(4.67)	(3.67)	(5.33)	(5.00)	(2.96)	(2.89)	(2.27)
Exporter						0.0250*	0.0234*
						(1.79)	(1.74)
Percentage of graduates		0.0138***		0.0103***			0.0107***
		(14.48)		(8.67)			(6.01)
R^2	0.589	0.626	0.556	0.569	0.593	0.593	0.613
Observations	4,959	4,913	3,050	3,036	3,173	3,167	3,144
Firms	2,089	2,085	1,577	1,570	983	983	983

Notes to Table 5: OLS estimates. Dependent variable: logarithm of average firm wage. Estimations only include the years for which the quality control variable is available (1990, 1994, 1998, 2002 and 2006). *** and * represent significance at the 1% and 10% levels, respectively. All estimations include firm size dummies, age of the firm and a full set of interaction terms between these dummies (industry-year fixed effects). |*t*|-statistics are in brackets. Standard errors are corrected for heteroskedascity and clustered by firm throughout.

Source: Own elaboration.

Table 6 shows the results when the quality indicator is a dummy variable that takes the value one when a firm has obtained product innovation through new materials, new functions or new components. In this case, the quality-upgrading wage premium only is statistically significant for all firms, for the subsamples that exclude switcher firms, and for firms that are always exporters; it is not statistically significant for firms that never become exporters or for export-switcher firms[7]. Therefore, this quality indicator is not suitable for the analysis of causality because we need to observe the quality-upgrading wage premium beyond the traditional exporter wage premium.

3.2. Causality

Based on our definition of a starter firm, Table 7 shows the average firm wages (labour costs per employee) and the statistical test that controls whether these averages are statistically identical between the firms that either start to invest in R&D and advertising or start to control their product quality versus the firms that neither invest in R&D and advertising nor control their product quality. Wages are deflated by the aggregate consumer price index. Using ESEE data from 1990 to 2010, I obtain 299 investor starters and 2248 non-investors with the continuous measure of product quality. With the other measure of product quality –whether the firm has conducted or contracted quality standardization and control work– I obtain 199 firms that start to control their product quality and 558 non-controllers.

The average wages for firms that start to invest in R&D and advertising are higher than those for firms that do not invest. In the case of firms that start to conduct or contract quality standardization and control work, wages are also higher than in firms that do not, and these differences are all statistically significant.

Table 8 shows the results of the estimated equations used to analyse the correlations between wages and these starter and non-starter firms according to the methodology proposed by Shank *et al*. (2010). These equations are also estimated using another overlap sample of firms to avoid a potential problem: some firms may not be comparable to others due to a lack of overlap in the distribution of firm characteristics between investor starters and non-investors. I use the methodology proposed by Crump *et al*. (2009), who characterize the optimal subsamples for which the average treatment effect can be estimated the most precisely. They use the propensity score to compare observations with similar probabilities of belonging to the treated and the control group, conditional on observed variables. They conclude that for a wide range of distributions, a good approximation is to discard all observations with estimated propensity scores outside of the range [0.1, 0.9]. Table A2 of the appendix shows the *probit* model that estimates the probability of starting to invest in R&D and advertising and the probability of starting to control product quality. These probabilities have been estimated with firm characteristics in $t = 1$ (two years before the starters begin to invest or control quality).

The quality-upgrading wage premium for firms that start to invest in R&D and advertising in column 1 of Table 8 is 11.2% for the full sample, apart from an ex-

(7) This same result is obtained when we estimate these equations separately using as the quality indicator a dummy variable that takes the value one only when a firm has obtained product innovations through new materials, new functions, or new components.

Table 6: PRODUCT INNOVATIONS AND WAGES

	All firms			Without export-switcher firms		
Product innovation	0.0140** (1.86)	0.0246*** (3.08)	0.0367*** (4.48)	0.0179*** (2.08)	0.0284*** (3.06)	0.0446*** (4.60)
Exporter	0.0923*** (9.48)	0.0997*** (9.84)		0.1276*** (8.69)	0.1414*** (9.17)	
Percentage of graduates	0.0119*** (14.22)			0.0124*** (15.37)		
R^2	0.624	0.604	0.597	0.649	0.625	0.614
Observations	35,116	35,424	35,505	24,474	24,696	24,755
Firms	4,695	4,710	4,714	3,699	3,713	3,717

	Firms that are always exporters		Firms that never become exporters		Only export-switcher firms		
Product innovation	0.0211*** (2.28)	0.0340*** (3.36)	0.0094 (0.45)	0.0087 (0.40)	-0.0012 (0.08)	0.0069 (0.46)	0.0108 (0.71)
Exporter					0.0385*** (3.18)	0.0374*** (3.02)	
Percentage of graduates	0.0142*** (15.17)		0.0096*** (7.67)		0.0103*** (5.56)		
R^2	0.601	0.557	0.545	0.531	0.598	0.578	0.577
Observations	15,404	15,584	9,070	9,112	10,642	10,728	10,750
Firms	2,141	2,146	1,572	1,581	996	997	997

Notes to Table 6: OLS estimates. Dependent variable: logarithm of average firm wage. *** and ** represent significance at the 1% and 5% levels, respectively. All estimations include firm size dummies, age of the firm and a full set of interaction terms between these dummies (industry-year fixed effects). $|t|$-statistics are in brackets. Standard errors are corrected for heteroskedascity and clustered by firm throughout.

Source: Own elaboration.

Table 7: AVERAGE WAGES

	R&D and advertising expenses over sales			Conducting or contracting quality standardization and control work		
	Starters (N=299)	Non-investors (N=2248)	Prob. value for differences of means=0	Starters (N=199)	Non-controllers (N=558)	Prob. value for differences of means=0
t = 1	14,647.7	13,357.1	0.03	15,817.3	12,408.9	0.00
t = 2	14,474.5	13,432.0	0.06	16,075.7	12,538.6	0.00
t = 3	14,870.0	13,504.6	0.02	16,773.8	13,032.3	0.00
t = 4	14,723.0	13,602.4	0.05	17,661.4	13,532.9	0.00

Notes to Table 7: Wages are deflated by the aggregate consumer price index.

Source: Own elaboration.

Table 8: Starter firms and wages

	Firms that start to invest in R&D and advertising and wages		Firms that start to control their product quality and wages			
	Full sample	Overlap sample	Full sample		Overlap sample	
Starter	0.106*** (3.11)	0.157 (1.26)	0.067* (1.45)	0.064* (1.44)	0.078 (1.20)	0.066 (1.17)
(t = 2)*Starter	-0.040 (0.84)	-0.090 (0.51)	0.027 (0.46)	0.034 (0.60)	0.006 (0.08)	0.027 (0.37)
(t = 3)*Starter	-0.039 (0.77)	-0.214 (1.42)	0.034 (0.53)	0.025 (0.40)	0.039 (0.43)	0.023 (0.28)
(t = 4)*Starter	-0.035 (0.69)	-0.122 (0.78)	0.043 (0.73)	0.041 (0.74)	0.037 (0.43)	0.022 (0.31)
Size (employees)						
50-249 employees	0.207*** (23.27)	0.251*** (5.95)	0.189*** (9.48)	0.164*** (8.53)	0.193*** (5. 06)	0.189*** (5.20)
More than 249 employees	0.334*** (26.24)	0.476*** (6.76)	0.346*** (11.90)	0.310*** (11.14)	0.383*** (7.22)	0.318*** (6.22)
Exporter	0.170*** (20.69)	0.091*** (2.64)	0.078*** (5.81)	0.077*** (5.88)	0.038 (1.23)	0.029 (0.99)
Age	0.038*** (17.01)	0.003*** (2.81)	0.004*** (10.70)	0.004*** (10.56)	0.001 (0.83)	0.001 (1.36)
Percentage of graduates				0.010*** (7.56)		0.017*** (7.05)
R^2	0.527	0.572	0.404	0.430	0.605	0.654
Observations	10,059	668	2,853	2,853	635	635
Firms	2547	548	757	757	453	453

Notes to Table 8: Wages and sales are deflated by the aggregate consumer price index. The last four columns only include observations of years for which information about quality control and percentage of graduates is updated. OLS estimates. Dependent variable: logarithm of average firm wage. All estimations include a full set of interaction terms between these dummies (industry-year fixed effects). $|t|$-statistics are in brackets. Standard errors are corrected for heteroskedascity and clustered by firm throughout.

Source: Own elaboration.

porter wage premium of 18.5%. The investor starters pay higher wages. However, the interaction terms between the starter dummy variable and dummies for the four periods considered are not statistically significant in any case. Consequently, wages do not show significant increases in the years before and after the decision to invest in R&D and advertising. In fact, the quality-upgrading wage premium does already exist in the years before firms start to invest. Therefore, the causality relation is not due to the learning-by-quality-upgrading hypothesis (a higher product quality generates higher wages) but to the self-selection hypothesis. That is to say, more productive firms with higher wages, as a proxy for average productivity, are more likely to invest in R&D and advertising.

In the overlap sample in column 2, there are 64 investor starters (out of 299). Due to the common support condition, wages are not significantly different between investor starters and non-investors in $t = 1$. In the overlap sample, investor starters and non-investors become more comparable and there is no selection effect, so the starter dummy becomes insignificant. However, the most important result is that the interaction terms between the dummy of starting to invest and dummies for the three subsequent periods considered are not statistically significant in any case. Therefore, once again, wages do not show significant increases in the years before and after the decision to invest.

The last four columns of Table 8 show the results when using quality control as a measure of product quality. I include and exclude the percentage of graduates. The results point in the same direction. Firms that start to control their product quality pay higher wages than firms that do not. The quality-upgrading wage premium is approximately 6.7% in the two specifications of the full sample, in addition to the exporter wage premium, which is lower than in starter investors (approximately 8%), and the educational wage premium (a 1 percentage point increase in the percentage of graduates of the firm increases the average wage of the firm by 1%). However, the most important result is that the interaction terms between the dummies for starter firms and the dummies for the 4 periods considered are not statistically significant in all cases. In the overlap sample, there are 141 controller starters (out of 199) and, once again, these interaction terms are not statistically significant. We can conclude that more productive firms with higher wages are more likely to increase product quality. Hence, I find evidence for the self-selection hypothesis.

3.3. Alternative indicators of quality upgrading or different strategies for quality upgrading?

It is possible that the control of quality and investments in R&D and advertising are two different and substitutive strategies for quality upgrading, in the sense that firms that opt for one strategy do not follow the other, and not two alternatives ways to measure the product quality. To test this possibility, we use data for the years in which we have information for both types of quality upgrading investments. Table 9 shows that 38.8% of the observations do not control their product quality, but they invest in R&D and advertising. Only 5.5% of the observations do not invest in R&D and advertising but do control their product quality, and 37.3% do both types of quality upgrading (18.4% neither invest in R&D and advertising nor control their product quality).

If we repeat the previous analysis considering that quality upgrading can be defined by these two strategies, we obtain similar results. Table 10 shows the estimates

Table 9: Percentage of observations in years 1990, 1994, 1998, 2002, 2006 and 2010

	Without quality control	With quality control	Total
R&D and advertising=0	18.41	5.52	23.94
R&D and advertising>0	38.79	37.27	76.06
Total	57.20	42.79	

Source: Own elaboration.

Table 10: R&D and advertising expenses and quality control and wages in years 1990, 1994, 1998, 2002, 2006 and 2010

	All firms		Without export-switcher firms		Firms that are always exporters	Firms that never become exporters	Only export-switcher firms	
Quality upgrading	0.0745***	0.0584***	0.0760***	0.0603***	0.0398**	0.0607***	0.0561***	0.0426***
	(7.24)	(5.78)	(6.13)	(4.94)	(2.12)	(3.80)	(3.03)	(2.36)
Exporter	0.0840***	0.0755***	0.1202***	0.1062***			0.0229*	0.0218*
	(8.19)	(7.69)	(8.23)	(7.60)			(1.62)	(1.60)
Percentage of graduates		0.0121***		0.0125***	0.0139***	0.0101***		0.0106***
		(15.17)		(16.23)	(14.54)	(8.30)		(5.97)
R^2	0.624	0.646	0.642	0.664	0.616	0.568	0.593	0.613
Observations	11,186	11,103	8,016	7,956	4,920	3,036	3,170	3,147
Firms	4,647	4,636	3,663	3,652	2,087	1,570	984	984

Notes to Table 10: OLS estimates. Dependent variable: logarithm of average firm wage. ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. All estimations include firm size dummies, age of the firm and a full set of interaction terms between these dummies (industry-year fixed effects). |*t*|-statistics are in brackets. Standard errors are corrected for heteroskedascity and clustered by firm throughout.

Source: Own elaboration.

for the quality-upgrading wage premium using a dummy variable that takes the value one when the firms control their product quality or when they invest in R&D and advertising. The quality-upgrading wage premium is statistically significant in all subsamples after controlling for exporter and skill wage premium, and it is higher for firms that never become exporters than it is for firms that are always exporters.

Finally, Table 11 shows the analysis for our definition of starter firms according to the methodology proposed by Shank *et al*. (2010), but using these same data for the years for which we have information for both types of quality upgrading investments. The find the same results as in the previous sections. The starters pay higher wages in the full sample and the interaction terms between the starter dummy and the dummies for the four periods considered are not statistically significant in the full or in the overlap sample.

4. Conclusions

The main finding of this paper is that there is a quality-upgrading wage premium in addition to the standard exporter wage premium. Higher quality products require using higher human capital that includes observed as well as unobserved skills, which leads to paying higher wages. I find a quality-upgrading wage premium after controlling for the exporter and educational wage premiums. Moreover, this wage premium is higher for firms that never become exporters. In general, firms that invest in R&D and advertising pay wages 4.5% higher than firms that do not make these investments. Firms that control their product quality pay wages 4.7% higher than firms that do not control quality, and firms that obtain product innovations pay wages 1.4% higher than firms that do not obtain innovations.

Producing higher quality increases the likelihood of exporting and can activate a learning-by-exporting mechanism. In turn, I used a methodology similar to that proposed by Schank *et al*. (2010) in the context of exporter firms to ascertain the origin of the quality-upgrading wage premium. The two potential explanations are a self-selection mechanism and a learning-by-quality-upgrading mechanism. All results point in the same direction. I do not find evidence in favour of firms that increase their product quality paying higher wages after controlling for the exporter and educational wage premium. Therefore, I find no evidence in favour of the learning-by-quality-upgrading hypothesis. The results indicate that firms paying higher wages, as a proxy for average productivity due to higher human capital, are more likely to increase product quality; that is, the evidence favours the self-selection hypothesis.

Table 11: Firms that start to invest in R&D and advertising or to control their product quality and wages

	Full sample	Overlap sample
Starter	0.0898* (1.75)	0.0436 (1.24)
(t = 2)*Starter	-0.0217 (0.23)	0.0432 (0.88)
(t = 3)*Starter	0.0108 (0.09)	0.0292 (0.57)
(t = 4)*Starter	-0.1060 (1.23)	0.0431 (0.93)
Size (employees)		
50-249 employees	0.1884*** (14.89)	0.2254*** (5. 60)
More than 249 employees	0.3154*** (17.46)	0.2675*** (5.59)
Exporter	0.1147*** (11.47)	0.0382 (1.21)
Age	0.0033*** (13.00)	0.0021*** (2.36)
Percentage of graduates	0.0113*** (10.04)	0.0203*** (5.06)
R^2	0.451	0.540
Observations	5,366	556
Firms	2,533	489

Notes to Table 11: Wages and sales are deflated by the aggregate consumer price index. Only observations of years for which information about quality control is updated are included. OLS estimates. Dependent variable: logarithm of average firm wage. ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. All estimations include a full set of interaction terms between these dummies (industry-year fixed effects). $|t|$-statistics are in brackets. Standard errors are corrected for heteroskedascity and clustered by firm throughout.

Source: Own elaboration.

Appendix

Table A1: Survey on Companies' Strategies 1990-2010. Averages

	All firms		Exporters		Non-exporters	
	Fewer than 201 employees	More than 200 employees	Fewer than 201 employees	More than 200 employees	Fewer than 201 employees	More than 200 employees
Average wages	22518.81	32999.57	25822.94	33141.76	19584.10	31795.34
	(10766.1)	(12906.1)	(11521.0)	(12690.8)	(9091.4)	(14769.8)
Age	30.22	46.06	33.23	45.94	27.57	46.72
	(18.01)	(26.00)	(20.13)	(25.96)	(15.44)	(26.21)
Size (employees)						
Fewer than 50	0.719		0.556		0.865	
Between 50-249	0.280	0.173	0.444	0.168	0.135	0.229
More than 249		0.823		0.828		0.768
Export propensity	11.786	30.53	25.08	33.70		
	(21.957)	(27.91)	(26.31)	(27.44)		
R&D and advertising over sales (%)	1.468	3.403	2.123	3.395	0.888	3.532
	(4.062)	(5.017)	(4.782)	(4.828)	(3.183)	(6.601)
Product innovations	0.1418	0.333	0.213	0.348	0.076	0.176
Quality control	0.335	0.665	0.438	0.677	0.244	0.554

Notes to Table A1: Standard deviations are in brackets. The quality control variable only includes the years for which this information is available (1990, 1994, 1998, 2002 and 2006).

Source: Own elaboration.

Table A2: Probit models

	Probability of starting to invest in R&D and advertising	Probability of starting to control product quality	Probability of starting to invest in R&D and advertising or to control product quality
Size (employees)			
Between 50-249	0.124 (0.79)	1.022*** (3.57)	0.523***(2.80)
More than 249	-0.354 (1.32)	2.058*** (4.92)	0.772***(3.18)
Exporter	0.256** (1.95)	0.079 (0.37)	0.161 (1.06)
Age	-0.002 (0.57)	-0.014* (1.90)	-0.005 (1.10)
Observations	2,263	545	1,131
Pseudo R^2	0.09	0.243	0.125

Notes to Table A2: All estimated models include a constant, dummies for industry and year. |z|-statistics are in brackets. ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively.

Source: Own elaboration.

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RESUMEN

Este artículo analiza la existencia de una prima salarial por aumentar la calidad del producto a nivel de empresa y su conexión con la prima salarial de las empresas exportadoras. Producir bienes de alta calidad incrementa la probabilidad de exportar y puede activar el mecanismo de aprender exportando. A su vez, productos de mayor calidad requieren emplear trabajadores más cualificados y, por tanto, retribuidos a un mayor salario. Utilizando una metodología similar a la propuesta por Schank y otros (2010), se comprueba si las empresas que incrementan la calidad de su producto pagan mayores salarios (hipótesis de aprender aumentando la calidad) o, contrariamente, si las empresas con mayor productividad, aproximada ésta por sus mayores salarios, son más proclives a incrementar la calidad de sus productos (hipótesis de autoselección).

Palabras clave: diferencias salariales, comercio internacional, exportaciones, calidad del producto.

Clasificación JEL: F16, J31, J24.