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FIRM CHARACTERISTICS, LABOR SORTING, AND WAGES*

FRANCISCO ALCALÁ AND PEDRO J. HERNÁNDEZ†

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Abstract

We analyze the implications of optimal price and quality choices by efficiency-heterogeneous firms, for the sorting of workers with different skills into firms with different characteristics. Under very reasonable assumptions, the model provides an integrated explanation within a competitive framework for the observed correlations between several establishment characteristics (size, employees' average education, capital/labor ratio, and remoteness of selling markets) and average wages. We test the model's implications using Spanish employer-employee matched data that allow to simultaneously control for establishment and worker characteristics. We find that average education in the establishment is increasing in the remoteness of its main market. Establishment size, remoteness of main market, and coworkers' average education have significant, robust and quantitatively important positive joint effects on wages. The national-market orientation effect on labor composition and on wages (with respect to local-market orientation) is at least as important as the international-market effect (with respect to national-market orientation). All establishment wage premia are non-decreasing on worker education and most of them are strictly increasing.
Keywords: Quality Competition, Exporting Firms, Unobservable Skills, Wages. (*JEL*: J24, J31, I20).

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1. INTRODUCTION

There is by now a sizeable empirical literature pointing out that some characteristics of firms are associated with large average wages. In particular, it has been claimed that large establishments, exporters, firms with high capital/labor ratio, and firms with high average-education employees pay higher wages. Yet we are still far away from being confident that we fully understand the mechanisms for these establishment wage effects. For instance, formal explanations for these establishment-characteristics wage premia have focused on the firm-size effect and have not provided a simple framework that captures all of them. Moreover, as we will argue below, the empirical evidence offered so far is still weak in several respects.[1]

In this paper we build a simple model analyzing the implications of optimal output-quality choices by efficiency-heterogeneous firms, for the sorting of workers with different skills into firms with different characteristics. Under very reasonable assumptions, the model is able to provide an integrated explanation within the competitive framework for all the cited correlations between establishment characteristics and wages. In the empirical part of the paper, we test the model's implications thereby providing a joint reassessment of the relationships between establishment characteristics and establishment labor composition and wages, and extending the evidence in several directions.

As already noted, in our model firms differ in efficiency and choose prices as well as quality, whereas workers differ by measured education and unmeasured skills (which, notwithstanding, are observable by firms). Under very reasonable assumptions, optimal decisions on quality imply that workers with more education and higher unmeasured skills are sorted into more efficient firms, which in turn sell in more distant markets and are larger in equilibrium. As a result, the model predicts that we should observe: (1) average education of employees tends to be higher in larger firms and firms selling in more distant markets; (2) firms with higher average education, larger size or selling in more distant markets pay higher average wages (even after controlling for

[1] Abowd and Kramarz (1999) is a general survey on studies linking firm and worker data. The existence of a positive firm-size wage premium is probably the most extensively documented firm characteristic effect and has been analyzed among others by Idson and Oi (1999) and Troske (1999). Oi and Idson (1999), and Lallemand, Plasman, and Rycx (2005) provide reviews of the theoretical arguments and the empirical results. The hypothesis that exporter firms pay larger wages has also received extensive treatment by a recent literature starting with Bernard and Jensen (1995), which is surveyed in Schank, Schnabel and Wagner (2006). The effect of average coworkers' education on individual wages is analyzed in Bayard and Troske (1999), Troske (1999), and in Battu, Belfield and Sloane (2003). High complementarity between skilled workers (Kremer (1993) and Kremer and Maskin (1996)) has been suggested as a possible explanation for this effect. Finally, for the relationship between the capital/labor ratio and average wages in the establishment see Abowd, Kramarz, and Margolis (1999), Troske (1999), and Arai (2003).

workers' education). The model also points out the relevant parameters determining the relationship between firm's capital/labor ratio and the observed average wages (conditional on education) it pays, and predicts that whatever the sign of the relationship between establishment-characteristics wage effects and worker education, the sign should be the same for all establishment characteristics.

The model can be related to the recent literature that emphasizes efficiency heterogeneity at the firm level to explain several important facts related to international trade and the dynamics of aggregate productivity (Melitz (2003), and Bernard et al. (2003)). As in those papers, the existence of trade costs in our model induce only the most productive firms to self-select into exporters. The paper can thus be seen as exploring the implications of firm-efficiency heterogeneity on labor sorting and the wage structure in a consistent way with that literature.

In the second part of the paper, we test the implications of the model using Spanish data from the 2002 Encuesta de Estructura Salarial (Survey on the Wage Structure). This survey contains matched data for more than 150,000 workers and 15,000 establishments, and includes most relevant characteristics of individuals (such as education, genre, age, years in the current firm, type of contract, etc.) and establishments (location, industry, size, market orientation, etc.). We explain the details on the data and the sample being used in Section 3.

In Section 4 we use these data to analyze the model's implications on the relationship between establishment characteristics (establishment main market –or *market orientation*- and size) and the educational composition of its labor force. Bernard and Jensen (1997) provide evidence that the ratio of non-production to production workers is larger in exporting firms. Similarly, Maurin, Thesmar, and Thoenig (2002) argue that the tasks related to product development, marketing, and customizing have a potentially very different content depending on whether they are performed for the domestic or the foreign market, so that the very act of exporting requires a skill upgrading of these activities. Using data on the occupational structure, they show that the fraction of high-skill jobs increases with the share of exported output, particularly in the development/marketing areas. Our data allow us to distinguish between not only exporters and non-exporters, but between establishments whose main market is either the local, the national, the European Union, or the *rest of the world* (non-EU countries) market. Our results also show that average education in establishments whose main market is the European Union is greater than in establishments oriented to the domestic market. The difference is still larger when comparing establishments whose main market is the rest of the world with domestic-market oriented establishments. However, there is also a substantial difference in average education between local-market establishments and national-market establishments that has not been uncovered so far. This difference is larger than the difference between national-market and European-market establishments, and is at least as important as the difference between national-market and rest of the world-market establishments. We obtain similar results using the fraction of college graduates in the establishment instead of the mean of employees' years of schooling. Thus, it appears to be more of a sequence of echelons in the effect of market orientation (from the local to the national market, and then to the European and to the world market) than a binary exporting versus non-exporting effect. The effect is just increasing in the *remoteness* of the markets being served, as predicted by the model. In fact, the difference in efficiency needed for a firm to move on from the local market to the national market might be at least as large as the difference to become an exporter. Finally, we find that in the case of establishments oriented to non-local markets, larger firms also employ higher average-education workers.

In Section 5 we test the model's implications on wages controlling simultaneously for all the usual worker characteristics and the cited establishment characteristics. Analyses of the firm-size wage premium typically fail to control for market orientation (or for the less demanding exporting status variable) with which firm size is highly correlated. Moreover, the common shortcoming to almost all studies on the exporting status wage premium is that they use average data at the plant or firm level and therefore cannot control for individual worker characteristics. Since, as we already noted, employees' average education is positively correlated with the exporting status, the results are likely to be biased. The exception is Schank, Schnabel and Wagner (2006) who use linked employer-employee data from Germany. However, these authors rely on imputed data for white-collar workers and obtain some rather debatable results, as we will argue.

In this section we show that all the variables suggested by the theoretical model have the expected signs, are jointly statistically significant, and have an important quantitative impact. According to our preferred estimation, workers in establishments whose main market is the national market obtain average wages 10.5-percent higher than wages in local-market establishments. This wage premium rises to 18.1-percent and to 20.3-percent, respectively, when the main market is either the EU or the rest of the world. Thus, as with the analysis on establishments' labor composition, the national-market wage premium (with respect to local-market establishments) is at least as important as the international-market premium (with respect to national-market establishments), which again has been the only one analyzed so far by the literature. Including all of our establishment characteristics in the wage equation reduces the coefficient on worker's years of schooling by more than one third, which is consistent with the common presumption that education coefficients partially capture the effect of unmeasured skills. Working in establishments with the *good* characteristics (those that our model associates with high skills sorting) brings about a wage premium that is almost comparable to the education premium. For example, according to our preferred model estimates, working in a medium size establishment whose main market is the national market brings about the same wage premium (23.9-percent) over the reference group (small local establishments) than 5.2 additional years of schooling. The results are robust to changing the way in which individuals' education as well as establishments' average education are measured in the model, and to the inclusion of proxies controlling for other possible effects that have been suggested by the literature. More specifically, we include proxies for the potential bargaining power of workers and unions and for the effect of internal labor markets, which have been argued to be more significant in large establishments.

In the last subsection of Section 5 we address the question of whether establishment-characteristics wage premia show any specific pattern with respect to worker education. We find that all the establishment characteristics have positive and significant wage effects for all education groups, and that these effects are non-decreasing in education in all cases and strictly increasing in most of them.[2] For example, the coefficients on coworkers' average education and on establishment's market orientation obtained for the sub-sample of college graduates double and in some cases triple the coefficients obtained for the sub-sample of workers not having completed secondary studies. This brings about very large establishment wage premia for college graduates. For instance, we may consider the case of a college graduate employed in a medium-size establishment exporting most of its production to the European Union and with coworkers' average education in the 75th percentile of the corresponding distribution. On average, this type of worker obtains a wage 86.4-percent higher than an individual with the same education who works in a small local-market establishment situated in the 25th percentile of the distribution on establishments' average-education. The same comparison of establishment characteristics but for workers without completed secondary studies brings about a premium of 29.8-percent. These results suggest that unmeasured skills are much more valuable in the case of high-education workers. In Section 6 of the paper we summarize and conclude.

2. THE MODEL

In this Section we build a partial equilibrium model where efficiency-heterogeneous firms choose prices as well as quality to sell in different markets, and employ workers with heterogeneous measured and unmeasured characteristics (*education* and *other skills*, respectively). We analyze the relationships between the firm's equilibrium characteristics (such as size and exporting status) and its labor composition and average wages, which have not been explored in the previous short literature of models with varying levels of output quality and labor skills (Stokey (1991), and Gabszewicz and Turrini (2000)).

Demand and Technology

Firms are indexed by j and may sell their output in different markets indexed by h. Consumers are identical in all markets but markets may differ in size. M_h is the size of market h (i.e., the number

[2] These results are in contrast with the short preliminary evidence on this issue obtained with less rich data sets (see Battu, Belfield and Sloane (2003), Lallemand, Plasman and Rycx (2005), and Shank, Schnabel and Wagner (2006)). It may be noted however that except in the case of the first paper, these papers distinguish between blue-collard and white-collard workers instead of between workers with different education levels.

of consumers). Demand for firm *j* in market *h*, y_j^h, depends on firm's price p_j^h and quality $q_j^h \geq 1$ in that market, and on market size according to the following inverse demand function:

$$(1) \qquad p_j^h = \delta(q_j^h) + \sigma\left(y_j^h / M_h\right);$$

where[3]

$$\delta(1) + \sigma(0) = 0;$$
$$\partial\delta / \partial q_j^h \equiv \delta' > 0, \partial^2\delta / \partial\left(q_j^h\right)^2 \equiv \delta'' \leq 0,$$
$$\partial\sigma / \partial(y_j^h / M_h) \equiv \sigma' < 0; \; -(y_j^h / M_h)\sigma'' / \sigma' < 2.$$

Output is obtained by using capital and labor, which in turn may be *educated* or *non-educated*, and *skilled* or *unskilled*. *Skill* is the characteristic representing workers' productive capacities that are observable by firms but are *unmeasured* by conventional statistics (so that we cannot control for them in the empirical analysis). Education is observable by firms and measured by statistics. Hence possible combinations sum up to four types of workers: l_j^{ES} is the number of educated and skilled workers employed by firm *j*, l_j^{NS} are the non-educated and skilled workers, l_j^{EU} are the educated and unskilled workers, and l_j^{NU} are the non-educated and unskilled workers. We also use the following notation: $l_j^E \equiv l_j^{EU} + l_j^{ES}, l_j^N \equiv l_j^{NU} + l_j^{NS}, l_j \equiv l_j^E + l_j^N$. Firm *j* has the following production function, which for any given choice q_j of output quality is a conventional CES production function:

$$(2) \qquad y_j = A_j \left(\frac{a_K \left(K_j\right)^\rho}{q_j^{\gamma_K}} + \frac{a_{NU}\left(l_j^{NU}\right)^\rho}{q_j^{\gamma_{NU}}} + \frac{a_{NS}\left(l_j^{NS}\right)^\rho}{q_j^{\gamma_{NS}}} + \frac{a_{EU}\left(l_j^{EU}\right)^\rho}{q_j^{\gamma_{EU}}} + \frac{a_{ES}\left(l_j^{ES}\right)^\rho}{q_j^{\gamma_{ES}}} \right)^{1/\rho};$$
$$\gamma_K, \gamma_{NU}, \gamma_{NS}, \gamma_{EU}, \gamma_{ES} \geq 1; \rho < 1;$$

where A_j is the firm-specific efficiency parameter. The specific property of this function is that increasing output quality comes at the cost of lower output per worker. Moreover, it may be reasonable to think that producing higher quality goods out of unskilled and uneducated labor may be increasingly difficult. Unskilled non-educated work becomes a decreasingly good substitute for skills and education when it comes at producing higher quality. We formalize this idea by

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[3] The assumption that $\delta(1) + \sigma(0) = 0$ is just a normalization on quality. We take *q*=1 to be the minimum quality for the good to be of any use (so that demand is strictly positive at a zero price if and only quality is above this level). The condition $-(y_j^h / M_h)\sigma'' / \sigma' < 2$ on the curvature of the (per capita) inverse demand function σ is the standard assumption that guarantees the second order conditions of profit maximization.

assuming that productivity of unskilled and uneducated labor decreases faster than that of skilled and educated labor, as quality increases:[4]

$$\gamma_{ES} < \gamma_{NS} < \gamma_{NU}; \gamma_{ES} < \gamma_{EU} < \gamma_{NU}.$$

Production and Transportation Costs

Interest rate (plus physical-capital depreciation rate) and wages are taken as given by firms, and are denoted by r, w^{NU}, w^{NS}, w^{EU}, and w^{ES}.[5] We assume $w^{iS} > w^{iU}$, $i = E, N$. Minimizing the cost function $C_j(y,q) = rK_j + \sum l_j^i w^i$ for a given pair (y_j,q_j) subject to the production function, yields the following FOC:

$$(3)\quad \begin{aligned} &\frac{a_K}{rq_j^{\gamma_K}}\left(K_j\right)^{\rho-1} = \frac{a_{NU}}{w^{NU}q_j^{\gamma_{NU}}}\left(l_j^{NU}\right)^{\rho-1} \\ &= \frac{a_{NS}}{w^{NS}q_j^{\gamma_{NS}}}\left(l_j^{NS}\right)^{\rho-1} = \frac{a_{EU}}{w^{EU}q_j^{\gamma_{EU}}}\left(l_j^{EU}\right)^{\rho-1} = \frac{a_{ES}}{w^{ES}q_j^{\gamma_{ES}}}\left(l_j^{ES}\right)^{\rho-1}. \end{aligned}$$

Computing the cost function for optimal input choices is also standard:

$$(4)\quad \begin{aligned} &C_j(y_j,q_j) = \frac{y_j}{A_j}\phi(q_j) \\ &\equiv \frac{y_j}{A_j}\left(\left(\frac{q_j^{\gamma_K}}{a_K}r\right)^{\frac{\rho}{\rho-1}} + \left(\frac{q_j^{\gamma_{NU}}}{a_{NU}}w^{NU}\right)^{\frac{\rho}{\rho-1}} + \left(\frac{q_j^{\gamma_{NS}}}{a_{NS}}w^{NS}\right)^{\frac{\rho}{\rho-1}} + \left(\frac{q_j^{\gamma_{EU}}}{a_{EU}}w^{EU}\right)^{\frac{\rho}{\rho-1}} + \left(\frac{q_j^{\gamma_{ES}}}{a_{ES}}w^{ES}\right)^{\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}} \end{aligned}$$

Note that $\phi'(q_j) > 0$ and $\phi''(q_j) > 0$.

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[4] Usually, devoting more time per unit of output is not sufficient to produce higher quality output. It is also indispensable to use above-average skills (besides having the appropriate education). For example, it is unlikely that a low skilled architect is able to design innovative solutions to outstanding architectural problems whatever the time provided for the project; similarly, it is unlikely that the service provided in a top restaurant by a highly skilled waiter can be matched by low skilled waiters just by increasing the number of these. In such cases, unskilled workers' marginal productivity goes to zero as the quality being targeted increases. In fact, in previous models (Stokey (1991), and Gabszewicz and Turrini (2000)) goods of a given quality can only be produced by workers with certain minimum human capital. In our model we only set the weaker assumption that output per worker decreases faster for unskilled and non-educated labor than for skilled and educated one, when quality is increased.

[5] Assuming that different firms have different access to financial markets (i.e., they face different interest rates r_j) would have similar implications than those stemming from differences in the efficiency parameter A_j.

So far, the costs we have considered involve only production costs. Nevertheless, selling in different markets involves market-specific transportation, logistics, and other non-production costs. We assume that selling in market h implies an additional cost τ_h per unit of output. In general, we may expect this cost to be increasing in the remoteness of market h, though τ_h is likely to be far from linear in distance.[6] Thus, firm j's cost of producing and selling y_j^h units of quality q_j^h in market h is:

$$(5) \qquad C_j^h(y_j^h, q_j^h) = y_j^h \left[\frac{\phi(q_j^h)}{A_j} + \tau_h \right].$$

Equilibrium

For each possible market, firm j profit maximization subject to the demand function (1) implies the following FOC that determine the optimal values y_j^{h*} and q_j^{h*}:

$$(6) \qquad \delta'(q_j^*) = \phi'(q_j^*) / A_j;$$

$$(7) \qquad y_j^{h*} / M_h = -\frac{\delta(q_j^*) + \sigma\left(y_j^{h*} / M_h\right) - \left(1/A_j\right)\phi(q_j^*) - \tau_h}{\sigma'(y_j^{h*} / M_h)}.$$

Assuming $\delta'(1) > \phi'(1)/A_j$, equation (6) has a solution $q_j^* > 1$, which is unique and independent of the market. Since $\delta''(q) \leq 0$ and $\phi''(q) > 0$, equation (6) implies that higher efficiency firms choose higher quality in equilibrium:

$$(8) \qquad \frac{dq_j^*}{dA_j} = \frac{\delta'}{\phi'' - A_j\delta''} > 0.$$

[6] The rise in costs per unit of output when selling in more distant markets may involve important discontinuities. Exporting may imply a discrete jump in costs due to additional administrative procedures, tariffs, use of foreign languages, etc. Similarly (though often overlooked), the cost increase when a previously local firm goes on to start selling in the national market may also be significant. This move typically involves a new logistic echelon between production and retailing, implying qualitatively new needs in terms of inventory, warehousing, material handling, packaging, information, and transportation. As observed in the Introduction, in the empirical part of this paper we distinguish between firms selling most of their output in the local, the domestic, the European Union or the rest of the world markets.

A necessary and sufficient condition for firms to be active in a given market *h* (i.e., $y_j^{h*} > 0$) is $\delta(q_j^*) + \sigma(0) - (1/A_j)\phi(q_j^*) - \tau_h > 0$.[7] In such a case, equation (7) holds, which in turn implies that more efficient firms will be larger (in terms of output) in every market where they are active:[8]

$$\frac{dy_j^{h*}}{dA_j} = -\frac{M_h}{\sigma'}\frac{\phi}{(A_j)^2}\frac{1}{2 + (y_j^{h*}/M_h)\sigma''/\sigma'} > 0. \quad (9)$$

Note that this result is obtained in spite of more efficient firms be producing higher quality output. In fact, producing higher quality does not imply selling at higher prices. This can be observed in the following expression whose sign is undefined:

$$\frac{dp_j^{h*}}{dA_j} = \delta'\frac{dq_j}{dA_j} + \sigma'\frac{d(y_j^h/M_h)}{dA_j} = \frac{(\delta')^2}{\phi'' - A_j\delta''} - \frac{\phi}{(A_j)^2}\frac{1}{2 + (y_j^h/M_j)\sigma''/\sigma'}. \quad (10)$$

For example, if inverse demand is inelastic to quality (small δ') and rather convex (high σ''), higher-efficiency firms will tend to sell higher-quality goods at lower prices than firms producing lower-quality goods (this may happen since consumers are implicitly assumed to be willing to pay for diversity). Moreover, it may occur that a firm sets a higher price than a lower-efficiency firm does in a given market, and a lower price in a different market.[9] This casts some doubts on the use of prices as proxies for quality in empirical studies.

Labor Sorting and Average Wages

From the FOC in (3) and assuming interior equilibria ($0 < l_j^{ih} < l_j$; *i=N,E*; *h=U,S*), we obtain that for both education groups the ratio of skilled workers will be larger in firms producing higher quality:

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[7] Below we elaborate more on the relationship between efficiency and the decision to be active in different markets.

[8] Recall that our assumptions on σ(.) ensuring that the second order conditions of profit maximization are satisfied, just imply that $2 + (y_j^h/M_h)\sigma''/\sigma'$ is positive.

[9] Consider two firms with almost the same efficiency level, so that the first term $(\delta')^2/(\phi'' - A_j\delta'')$ is almost the same for both firms; and a demand function such that $2 + (y_j^h/M_h)\sigma''/\sigma'$ tends to zero as per capita demand y_j^h/M_h decreases, and tends to infinity as y_j^h/M_h increases. In nearby markets, per capita sales y_j^h/M_h will be large and therefore dp_j^{h*}/dA_j will tend to be positive. Whereas for the most distant markets such as both firms sell, per capita sales will be close to zero and dp_j^{h*}/dA_j will be negative.

(11) $$\frac{d\left(l_j^{iS}/l_j^{iU}\right)}{dq_j}=\frac{\gamma_{iU}-\gamma_{iS}}{1-\rho}\left[\frac{a_{iS}w^{iU}}{a_{iU}w^{iS}}q_j^{\gamma_{iU}-\gamma_{iS}}\right]^{1/(1-\rho)}q_j^{-1}>0, i=N,E.$$

Similarly, we have

$$\frac{d\left(l_j^{Ei}/l_j^{Ni}\right)}{dq_j}=\frac{\gamma_{Ni}-\gamma_{Ei}}{1-\rho}\left[\frac{a_{Ei}w^{Ni}}{a_{Ni}w^{Ei}}q_j^{\gamma_{Ni}-\gamma_{Ei}}\right]^{1/(1-\rho)}q_j^{-1}>0, i=U,S.$$

From this last expression and assuming $l_j^{ES}/l_j^{E}\geq l_j^{NS}/l_j^{N}$,[10] we obtain that the ratio of educated workers $e_j=l_j^E/l_j$ is also larger in firms producing higher quality:

(12)
$$\begin{aligned}
\frac{d(e_j)}{dq_j}&=\frac{l_j^N l_j^E}{(l_l)^2}\left[\frac{1}{l_j^E}\frac{dl_j^E}{dq_j}-\frac{1}{l_j^N}\frac{dl_j^N}{dq_j}\right]\\
&=\frac{l_j^N l_j^E}{(l_l)^2}\left[\frac{l_j^{ES}}{l_j^E}\frac{1}{l_j^{ES}}\frac{dl_j^{ES}}{dq_j}+\frac{l_j^{EU}}{l_j^E}\frac{1}{l_j^{EU}}\frac{dl_j^{EU}}{dq_j}-\left(\frac{l_j^{NS}}{l_j^N}\frac{1}{l_j^{NS}}\frac{dl_j^{NS}}{dq_j}+\frac{l_j^{NU}}{l_j^N}\frac{1}{l_j^{NU}}\frac{dl_j^{NU}}{dq_j}\right)\right]\\
&>\frac{l_j^N l_j^E}{(l_l)^2}\left[\left(\frac{l_j^{ES}}{l_j^E}-\frac{l_j^{NS}}{l_j^N}\right)\frac{1}{l_j^{NS}}\frac{dl_j^{NS}}{dq_j}-\left(\frac{l_j^{NU}}{l_j^N}-\frac{l_j^{EU}}{l_j^E}\right)\frac{1}{l_j^{NU}}\frac{dl_j^{NU}}{dq_j}\right]\\
&=\frac{l_j^N l_j^E}{(l_l)^2}\left(\frac{l_j^{ES}}{l_j^E}-\frac{l_j^{NS}}{l_j^N}\right)\left[\frac{1}{l_j^{NS}}\frac{dl_j^{NS}}{dq_j}-\frac{1}{l_j^{NU}}\frac{dl_j^{NU}}{dq_j}\right]\geq 0.
\end{aligned}$$

Now, since more efficient firms produce higher quality, equations (11) and (12) imply that more efficient firms use a larger proportion of skilled workers within each education group, and a larger proportion of high-education workers with respect to their total employment:

(13) $d\left(l_j^{iS}/l_j^{iU}\right)/dA_j>0; i=N,E;$

(14) $de_j/dA_j>0.$

Let w_j^i denote the average wage paid by firm *j* to workers with education level *i*:

[10] It is seems unanimously agreed that unmeasured skills and education are positively correlated since skills can be very useful in achieving a high level of formal education. Hence the fraction of skilled workers that are educated should be larger than the fraction on unskilled that are educated.

$$w_j^i = \frac{w^{iU} l_j^{iU} + w^{iS} l_j^{iS}}{l_j^{iU} + l_j^{iS}} = w^{iU} \frac{1 + \left(w^{iS} / w^{iU}\right) l_j^{iS} / l_j^{iU}}{1 + l_j^{iS} / l_j^{iU}}, i = N, E.$$

Since $w^{iS} / w^{iU} > 1, i = E, N$, and using (13) we obtain that more efficient firms pay higher average wages at every education level:

$$(15) \qquad \frac{dw_j^i}{dA_j} = \frac{dw_j^i}{d\left(l_j^{iS} / l_j^{iU}\right)} \frac{d\left(l_j^{iS} / l_j^{iU}\right)}{dq_j} \frac{dq_j}{dA_j} > 0, i = N, E.$$

Note that the positive relationship between efficiency and average wages depends crucially on the endogenous positive relationship between efficiency and quality. Should we assume that output quality is exogenous and the same for all firms, firms would choose the same labor composition no matter their level of efficiency.

Firm Characteristics and Average Wages

As noticed above, in equilibrium, not all firms will be active in all markets. Let $\overline{A}_h > 0$ denote the minimum efficiency level for a firm to find it profitable to be active in market *h*. This threshold is given by the value of the efficiency parameter implying zero profits per unit of output at the maximum possible price (i.e., for $y_j^h = 0$), given optimal quality decisions $q_j^{h*}(\overline{A}_h)$ and transport cost to market *h*:

$$\delta(q_j^{h*}(\overline{A}_h)) - \sigma(0) = (1/\overline{A}_h)\phi(q_j^{h*}(\overline{A}_h)) + \tau_h.$$

Thus if firm *j'* sells in market *h'* but firm *j''* does not, it must be the case that $A_{j'} > \overline{A}_{h'} \geq A_{j''}$. As expected, the efficiency threshold $\overline{A}_h$ for being active in market *h* is increasing in the cost of bringing the product to that market:

$$(16) \qquad \partial \overline{A}_h / \partial \tau_h = (\overline{A}_h)^2 / \phi(q_j^{h*}(\overline{A}_h)) > 0.$$

As a result, the remoteness of the markets where a firm sells in is informative about its higher efficiency. This also has implications on firm size. We already noted that more efficient firms have larger sales in every market. Now, since more efficient firms also sell in a larger number of markets, their total size in terms of total output, $y_j = \sum_{h \in \{h: \overline{A}_h < A_j\}} y_j^h$, is also larger.

As noted in the Introduction, there is also some empirical evidence on a positive relationship between the capital/labor ratio and average wages. In our model, this relationship depends on the technological assumptions about the relationship between quality and physical capital. A sufficient condition for quality and the capital/labor ratio to be positively related is $\gamma_K \leq \gamma_{ES}$ (to see this, just follow the argument used to obtain (11) and (12)). Under this condition, the capital/labor ratio would be positively associated with high average wages for every education level. We will not pursue this issue in the empirical part of the paper, however, since our data set does not include information about establishments' physical capital.

The general implication of the model is that under very reasonable assumptions quality competition implies that more skilled and educated workers are sorted into more efficient firms. The reason is that in equilibrium more efficient firms choose to produce higher quality goods. Since in equilibrium, more efficient firms also tend to have larger size and sell in more distant markets,[11] we should observe that: first, average education of employees tends to be higher in larger firms and firms selling in more distant markets; and second, firms with higher average education, larger size and selling in more distant markets tend to pay higher average wages to every education group. We empirically test these hypotheses in the following sections.

A final question is which pattern, if any, do firm-characteristics wage premia have with respect to worker's education. This amounts to ascertaining the sign of $d(w_j^E / w_j^N)/dA_j$. As can it be observed in expression (17) below this sign depends on most parameters of the model as well as on the distribution of skills in every education group and the differences in wages, on which we can only make conjectures. In any event, the sign will tend to be positive the larger are the differences in productivity within educated workers (between skilled and unskilled educated workers) with respect to the difference within non-educated workers (i.e., the larger the ratio $(\gamma_{EU} - \gamma_{ES})/(\gamma_{NU} - \gamma_{NS})$).

$$(17) \qquad \frac{d(w_j^E / w_j^N)}{dA_j} = \frac{w_j^E}{dw_j^N / dA_j}\left[\frac{w_j^N}{w_j^E}\frac{(dw_j^E / dA_j)}{(dw_j^N / dA_j)} - 1\right]$$

$$= \frac{w_j^E}{dw_j^N / dA_j}\left(\frac{\gamma_{EU} - \gamma_{ES}}{\gamma_{NU} - \gamma_{NS}}\frac{\left(w^{ES} - w^{EU}\right)/ w_j^E}{\left(w^{NS} - w^{NU}\right)/ w_j^N}\left(\frac{1 + l_j^{NS} / l_j^{NU}}{1 + l_j^{ES} / l_j^{EU}}\right)^2\left[\frac{\dfrac{a_{ES} w^{EU}}{a_{EU} w^{ES}} q_j^{\gamma_{EU} - \gamma_{ES}}}{\dfrac{a_{NS} w^{NU}}{a_{NU} w^{NS}} q_j^{\gamma_{NU} - \gamma_{NS}}}\right]^{\frac{1}{1-\rho}} - 1\right).$$

[11] This is consistent with the general conclusions of Bernard and Jensen (1999) and the large literature surveyed by Wagner (2005) on the main direction of causality between efficiency and the exporting status.

Moreover, the model predicts that the differences between education groups in the wage effects of firm characteristics should be of the same sign for all firm characteristics. The reason is that given any sign for $d(w_j^E / w_j^N)/dA_j$ in (17), the sign of the relationship between A_j and any of the firm characteristics (size, remoteness and average education) is always positive. We will pursue this implication in the empirical part of the paper.

3. DATA AND DESCRIPTIVE STATISTICS

In the rest of the paper we test the implications of the model. The source of our data is the Spanish *Encuesta de Estructura Salarial* for 2002 (Wage Structure Survey, EES-2002). This survey is conducted by the Spanish National Institute of Statistics (INE) following a two-stage stratified sampling methodology. In the first stage, establishments with at least ten workers are stratified by economic activity, firm size and region. Agriculture and the public sector are excluded. In the second stage, workers at every establishment are randomly selected. The survey contains matched employer-employee data for more than 15,000 employers and 150,000 employees.

The survey provides information about the region where the establishment is located, industry, group size, collective bargaining if any, and market orientation (i.e., main broad market for establishments' output; it distinguishes between local, national, European Union and rest of the world markets). We exclude from the sample firms in industries that do not have any exporting establishment (building, production and distribution of electrical energy, gas and water, education, health, social work and other social activities, and personal service activities). This leaves us with a sample of 11,567 establishments from 36 three-digit industries (main subsections of the *National Classification of Economic Activities*) for our analysis on average education in establishments.

The survey also provides information on the individual characteristics of workers randomly selected at every establishment, such as education, sex, age, years working in the current establishment, type of contract, full/part-time job, etc. In our analysis on wages, we further restrict the sample to male workers with full-time jobs and indefinite contracts.[12] We also exclude workers who went through transitory labor incapacity or were included in job promotion programs. In this way, we isolate the establishment-characteristics effect on wages from other circumstances such as gender discrimination, positive discrimination policies, underemployment, etc. All this depuration brings about a sample of 35,602 workers and 9,120 establishments.

[12] Spanish legislation distinguishes between temporary (or "fixed term") contracts and indefinite (regular) contracts. Temporary contracts were introduced to promote employment. They can be readily terminated once the contract is over, and are mainly used to hire young workers in their first employment.

Table 1 reports the main descriptive statistics on establishments' characteristics according to the EES-2002. Establishments whose main market is the EU or the rest of the world only add up to about 6.5-percent of the total. Most establishments have less than 50 workers (71.3-percent) and only 11-percent employ 200 or more workers. Although the percentage of workers with a college degree is 10.5, only 27.6-percent of the establishments in the sample include at least one worker with a college degree among their surveyed employees. The percentage of workers with a college degree in this last subset of establishments is 34.2. This suggests that the data on the fraction of college graduates should be treated as censored data.

The relationship between establishment size and market orientation shows a very strong pattern: the fraction of establishments with the smallest size is monotonically decreasing in market remoteness. The opposite occurs with the other two size groups. Establishments selling most of their production in non-local markets employ more educated labor and a larger fraction of workers with a college degree. In particular, the fraction of college graduates in establishments exporting most of their output to countries outside the EU is almost three times higher than in firms selling in local markets. It may be surprising, however, the low average education and low fraction of college graduates in establishments exporting most of their production to the EU market, compared to establishments oriented to the national market. This may be due to a Spanish specialization within the EU in rather low-skilled industries, which in turn would be the consequence of having a relatively low endowment of college graduates within the EU (before the enlargement from 15 to 25 members in 2004). The econometric analysis in the next Section lends support to this hypothesis by showing that once we control for two-digit industries the average education as well as the fraction of college-educated workers in establishments selling most output to the EU is larger than in national-market establishments.

Finally, establishments selling in more-distant markets tend to pay higher wages. Again, there is some exception, however, since establishments oriented to the national market pay the same average wage than those oriented to the EU market. Clearly, the higher average education in national-market oriented establishments may be the reason. The econometric analysis of Section 5 brings about substantially different results in this respect.

4. Establishment Characteristics and Employees' Education

In this Section we test whether larger establishments and establishments selling in more remote markets do employ workers with higher average education or a large proportion of college graduates. We use weighted least squares to estimate the following equation, where the left-hand-side variable e_j is establishment-*j* employees' mean years of schooling (or, alternatively, the fraction of college-educated employees), and where the covariates of interest are dummies for establishment size and market orientation:

(18) $$e_j = \alpha_0 + \alpha_1 S2_j + \alpha_2 S3_j + \alpha_3 M_{Nj} + \alpha_4 M_{Ej} + \alpha_5 M_{Wj} + \alpha_6 Z_j + v_j;$$

S2 is a dummy for firms employing between 50 and 199 workers, and *S3* for firms employing more than 199 workers. The dummies for market orientation are M_N for establishments selling most of their output in the national market, M_E for the European Union market, and M_W for rest of the world (i.e., non-EU countries). The reference group in the estimation is establishments with a number of employees between 10 and 49 that selling most of their output in the local market. *Zj* is a vector of other controls that includes dummies for establishment location (17 regions) and dummies for establishment industry when noted (36 industries). v_j is the error term.

Results are reported in Table 2. The left-hand-side variable for the results in columns (1)-(3) is employees' average years of schooling. Column (1) shows that all variables are positive and statistically significant at 1-percent level, except M_E. Since the type of good being produced is likely to be an important determinant of the demand for human capital and the optimal size of the establishment, we include dummies that control for industry in the specification in column (2). Industry dummies tend to increase the size and significance of the coefficients on market orientation. All the dummies for market orientation are now positive, very significant, quantitatively very important, and (statically) monotonically increasing in market distance, as predicted by the theoretical model. In particular, average education in establishments selling most of their production in the national or in the EU markets is about one year higher than in local-market establishments; and it is 2.1 years higher in establishments exporting most of its production to countries outside the EU (average schooling in the whole sample is 8.9: Table 1).

So far, the differences between local-market and national-market establishments have not been explored in the literature. As observed in the Introduction, the result that national and European market orientation effects are similar, and that the difference between local and national-market establishments is as large as the difference between national and World-market establishments is important, as it suggests that the main reason for the higher average education in exporting firms is not necessarily the consequence of the very fact of selling in international markets. According to our analytical model, the reason is a common underlying cause for both establishment's characteristics (high average education and the exporting status), namely, high efficiency. In this respect, our results in this and the next sections are indicative that the difference in efficiency between local and national establishments may be as large as the difference between national and international firms.

With respect to establishment size, the two dummies become negative though not statistically significant in column (2). Thus, not controlling for establishment's industry may bring about misleading results on the effects of market orientation and size. The non-significant results on the size effects suggest that there may be other reasons different from higher efficiency that also give rise to a larger establishment size (e.g., demand shocks or past efficiency; which may bring about a current large size if size is more persistent than efficiency, due to sunk investments, importance of self-financing, demand inertia, etc.). Our model implies that human capital should be greater in larger establishments only when this larger size arises from underlying higher efficiency. Large firms for reasons unrelated to efficiency may likely not employ workers with higher average education, but then they will also tend to fail to be oriented to non-local markets. Conversely, size may still be a signal of efficiency (and therefore bring about higher average education) in establishments oriented to non-local markets. We test this hypothesis in column 3 where we interact size with market orientation. Since the number of firms with sizes *S2* and *S3* that sell only in local markets is quite small (see Table 1) we pool them together in one single group. The coefficients for large sizes conditional on selling most of their production in national or international markets, are now positive and significant in column 3. Large national and international establishments employ workers with average schooling about 0.7 years higher than small national and international establishments (the coefficient for non-local establishments of size *S2* is somewhat larger than the one for size *S3* but the difference is not statistically significant). Note that the coefficients for market orientation not conditional on size experience only a minor reduction. In contrast, there is now a significant negative coefficient for large establishments selling mostly in the reference market (the local one). Therefore, larger establishment size *per se* does not imply greater demand for more educated workers (since there may be reasons for larger size other than higher efficiency) but only when combined with other characteristics signaling efficiency, such as non-local market orientation.

In columns (4) to (6) of Table 2 we check for the robustness of our results using now the fraction of college graduates in the establishment as the left-hand-side variable. Since about 70-percent of the establishments in the sample do not include interviews to college-educated workers, least squares estimates may be inconsistent due to censured data problems. We therefore estimate a Tobit model by maximum likelihood. The qualitative results are very similar to those already reported.[13] Size effects become insignificant when including industry dummies in column (5), and turn out positive and significant again in column (6) when they are conditional on national and international market orientation. The most noticeable differences are that the coefficients on market orientation are now strictly increasing in distance as long as industry dummies are included in the equation, and that the negative coefficient for large establishments in the reference (the local) market is now not significant at 5-percent but only at 10-percent level.

[13] Recall that the coefficients from a Tobit model do not reflect the marginal effects of the right-hand-side variables and therefore are not comparable with the LS estimates.

5. ESTABLISHMENT CHARACTERISTICS AND WAGES

We now test the model's implications on wages. The wage equation is based on the usual *Mincerian* equation where the log of the employee's hourly wage is a function of his education and potential experience. Accordingly, we include worker's schooling years (*Y*), and potential experience (*PE*) which is defined as the difference between employee's age and the expected age to complete his studies according to their official length. We also include tenure (*T*) which is defined as the number of years the individual has been working for its current employer. Then, we include establishment characteristics already used in the previous section: two dummies for firms' size (*S2* and *S3*), three dummies for market orientation (M_N, M_E and M_W) and a vector Z_j of other controls (35 dummies for three-digit industries, and 16 dummies for regions). Finally, we also include coworkers' average years of schooling (*e*).[14] Thus the wage equation is:

$$\begin{aligned}(19)\qquad \ln w_{ij} &= \beta_0 + \beta_1 Y_{ij} + \beta_2 PE_{ij} + \beta_3 (PE_{ij})^2 + \beta_4 T_{ij} + \beta_5 (T_{ij})^2 \\ &\quad + \beta_6\, S2_j + \beta_7\, S3_j + \beta_8 e_j + \beta_9 I_{Nj} + \beta_{10} I_{Ej} + \beta_{11} I_{Wj} + \theta' Z_j + u_{ij};\end{aligned}$$

where w_{ij} is worker *i*'s hourly wage in establishment *j*, and u_{ij} is the residual. We also estimate an equation with establishment fixed effects π_j,

$$(20)\qquad \ln w_{ij} = \beta_0' + \beta_1' Y_{ij} + \beta_2' PE_{ij} + \beta_3' (PE_{ij})^2 + \beta_4' T_{ij} + \beta_5' (T_{ij})^2 + \pi_j + u_{ij}',$$

which are then regressed on firm characteristics (see equation (21) below). The data used correspond to the sub-sample of men with full-time job and indefinite contracts as described in Section 3.

5.1. Main Results

Results are reported in Table 3. In columns (1)-(4) we estimate equation (19) using weighted least squares and adding successively different establishment characteristics. In the specification in column (1) we only include workers' characteristics (schooling, potential experience, and tenure) and the dummies for regions that control for geographical differences in factors such as unemployment, composition of labor supply, and price level. In column (2) we add establishment size dummies. In column (3) we add coworkers average schooling, and market orientation. In our preferred specification in column (4) we also include 35 dummies for industries.

[14] We also considered *average potential experience of coworkers* as a further right-hand-side establishment characteristic but always found it to be not statistically significant.

All the variables suggested by our theoretical model have the expected signs, are jointly statistically significant at the 1-percent level, and have an important quantitative positive impact on wages. Including establishment characteristics in the wage equation also gives raise to an important increase in explanatory power. Adjusted R^2 rises by 21.4-percent in column (4) with respect to column (1) (note that specification in column 1 already includes 16 regional dummies). According to estimation (4), workers in establishments whose main market is the whole country obtain average wages 10.5-percent higher than wages in local-market establishments. This wage premium rises to 18.1-percent and to 20.3-percent, respectively, when the main market is either the EU or the rest of the world. As with the analysis on establishments' labor composition in the previous section, the wage difference between local and national-market establishment is at least as important as the difference between national and international-market establishment effects which so far has been the only one analyzed by the literature. Coworkers' education also has an important quantitative impact. Increasing coworkers education by one standard deviation brings about a wage increase of 6.9-percent; and moving from an establishment in the 10-th percentile of the establishments' distribution across employees' mean education (5 schooling years), to an establishment in the 90-th percentile (13.2 schooling years), increases worker's wage by 20.8-percent. The establishment-size wage premium is 12.1-percent for size-*S2*, and 15.6-percent for size-*S3*, respectively. Comparing these coefficients in column (2) with those when we add the rest of variables in column (4), we observe that the estimated wage premium for size-*S2* establishments falls by 30.4-percent, whereas the premium for size-*S3* drops by 45.6-percent. These large reductions make clear the importance of a joint estimation of all establishment-characteristics effects. Overall, the large quantitative wage effect of these establishment characteristics suggests, according to our model, that unmeasured skills have a considerable productive importance.

Including all of our establishment characteristics also reduces the coefficient on worker's years of schooling by more than one third, which is consistent with the common presumption that education coefficients partially capture the effect of unmeasured skills. Working in establishments with the *good characteristics* (those that our model associates with high skill sorting) may bring about a wage premium comparable to obtaining a college degree. For example, according to our estimates in column (4), working in a medium size (*S2*) establishment whose main market is the national market brings about the same wage premium (23.9-percent) over the reference group (small local establishments) than 5.2 additional years of schooling.

In column (5) of Table 3 we report the estimates of the establishment fixed effects model of equation (20). To carry out this estimation we remove from the sample establishments where only one employee was surveyed, so that we have at least two observations to estimate each establishment fixed effect. Thus, the sample is now reduced to 33,646 workers and 7,164 establishments. It is of no surprise that this specification brings about the best fit as measured by the adjusted R^2. Fixed effects are of little help in understanding the causes of wage differences, however. Thus, we now regress the estimated fixed effects $\hat{\pi}_j$ from equation (20) on the observable establishment characteristics.[15] In this way we can assess how much of establishment fixed effects can be explained by the observable establishment characteristics, and check for the robustness of our previous estimates of these effects. Hence we estimate the following equation:

$$\text{(21)} \qquad \hat{\pi}_j = \beta'_5 S2_j + \beta'_6 S3_j + \beta'_7 e_j + \beta'_8 M_{Nj} + \beta'_9 M_{Ej} + \beta'_{10} M_{Wj} + \theta'' Z_j + \eta_j .$$

Table 4 reports the results from this equation. Taking the results for the most comprehensive specification (column 3) as the reference, observable establishment characteristics explain 30-percent of the variation in the estimated establishment fixed effects. All coefficients are statistically significant and their values are very similar to the corresponding models in Table 3.

5.2. Robustness

We now estimate the models in equations (19) and (20)-(21) using dummies for broad categories of education instead of years of schooling to control for employee's education. *HS* is now the dummy for workers with completed secondary studies, and *U* for college graduates. Also, we now use the fraction of coworkers with a college degree (*e2*) instead of coworkers' average years of schooling. Results are qualitatively very similar to those in Table 3 and are reported in Table 5 (specification in each column corresponds, respectively, to the same column in Table 3). Again, they show that being employed by an establishment with the *good characteristics* may be as important for worker's income as formal education. For example, according to the results in column (4) of Table 5, a college degree implies a 31.1-percent wage premium over completed high school. This premium is only somewhat lower than the one obtained by an employee of a medium size (*S2*) national-market establishment with a fraction of college-degree employees that is one standard deviation above average (using as reference the wage of an worker with the same individual observable characteristics who works in a small local-market establishment employing just the average fraction of college graduates).

Some alternative explanations have been suggested for the establishment-size wage premium. In Table 6 we include additional controls and interactions that help controlling for some of those alternatives. In column (1) we add a dummy for firm-level contracting (which is the likely mechanism that strong bargaining-power workers and unions in large establishments may use to

[15] This two-step procedure to assess the impact of establishment characteristics is similar to the one followed in Abowd, Kramarz and Margolis (1999).

increase their wages).[16] Firm-level contracting is highly significant. It increases average wages by 7.6-percent and its inclusion reduces the coefficient on the S3-size premium by 2.5 percentage points. Yet, all the coefficients remain significant and quantitatively high (in fact, the coefficients for market orientation tend to be now somewhat larger).

Second, internal labor markets have also been suggested as a potential source of higher average wages in larger firms. Large firms may provide better opportunities for internal promotion and more in the job training, which then needs to be rewarded to reduce turnover. Hence average wages may be larger for the same level of formal education. Notice however that these benefits would not be obtained by the employee from the outset, but only as time goes by working for the same firm. Therefore, this effect should show up as a larger payoff to tenure in larger firms. We test this hypothesis in column (2) by including interaction terms of tenure with *S2* and *S3*. Only the interaction with the largest size turns out positive and statistically significant. Tenure in *S3* establishments is about 20-percent more profitable than in small establishments. Inclusion of this interaction term reduces the S3-size premium by 3.1 percentage points (thereby eliminating the previous small difference between the *S2*-size and the *S3*-size coefficients), and leaves almost unaltered the rest of coefficients.

In column (3) we simultaneously include both the additional control and the interactions terms. The sign and size of the coefficients are similar to those in the previous columns, though only the coefficient for firm-level contracting retains statistical significance. Overall, the inclusion of these additional variables has only a minimal impact on the estimates for market orientation and coworkers' education, and reduces the estimated premium for *S3*-size establishments by six percentage points.

5.3. Establishment-Characteristics Effects by Education Groups

Do establishment-characteristics wage effects show any pattern with respect to worker's education? This is an important question because not only it helps understanding the wage structure but because –according to our model- it also provides indications about whether unmeasured skills are more valuable for high-educated or for low-educated workers. Furthermore, our theoretical model predicts that whatever the sign of the relationship between establishment-characteristics wage effects and worker education, the sign should be the same for all establishment characteristics. There is a short literature exploring this issue for some of the establishment characteristics. This literature is hindered in part by lack of suitable data and obtains results that tend to run against the common hypothesis of a positive relationship between the

[16] In the specific analysis on firm-level contracting, Card and De la Rica (2006) point out that firm-level contracting is more likely to occur where there is (or there was) a strong union presence. Our estimates of this effect are very consistent with their results.

establishment premia and education (see the next footnote). We investigate the issue by estimating equation (19) for each major education group. We include in the equation the additional firm-level contracting variable and the interaction size-tenure terms from the last subsection since they already proved their potential relevance and, as we will see, they have a substantially different impact depending on the education group.

We divide the sample into three sub-samples: workers without completed secondary education, workers with completed secondary education, and workers with a college degree. Results are shown in Table 7. All the coefficients for the three establishment characteristics have the expected positive signs and are significant at the 1-percent level in all sub-samples. For each sample, the differences between the coefficients for the *S2* and the *S3* sizes are not statistically significant, and the coefficients for market orientation are increasing in the remoteness of the market whenever the differences are statistically significant.

The differences across education groups in the estimated coefficients are sizable and follow a systematic pattern. All the establishment-characteristics wage effects are either increasing in the level of education or the difference across education groups is not statistically significant (this occurs in the comparison of the secondary and the university estimates of the *S3* and the M_N coefficients). For instance, the coefficients on coworkers' average education and market orientation for college graduates double or even triple those for primary-education workers. To give a sense of the importance of establishment premia for wages of individuals with different education levels, we may consider the premium for an individual working in a *S2*-size establishment exporting most of its production to the EU and with employees' average education in the 75th percentile of the corresponding distribution (the reference would be the wage of an individual working in a small local-market establishment that is situated in the 25th percentile of the average-education characteristic). An individual in an establishment with those characteristics obtains an average wage premium of 29.8-percent should he have not completed secondary education, and an average premium of 86.4-percent in case he has a college degree. These results suggest that unmeasured skills are considerably more important for high-education workers than for low-education workers. They also stand in contrast with most of the preliminary evidence available so far which has been obtained with a less rich set of data, variables and controls.[17]

[17] As already noted, there are very few papers so far exploring the issue. Following a somewhat less precise approach (using interaction terms between individual's education and coworkers' average education, instead of dividing the sample by education groups), Battu, Belfield and Sloane (2003) obtain that the establishment average-education wage premium is decreasing in worker's own education in the UK, though they recognize that this runs counter to their theoretical prediction. Lallemand, Plasman and Rycx (2005) analyze the size wage premium and conclude that it is generally larger for blue-collar workers. To the extent that the blue-collard versus white-collard comparison can be related to our education-groups comparison, their results would point in the opposite direction to ours. However, they do not control for firm-level contracting and the highly significant revenues to tenure that low-education workers enjoy in large firm, which seem responsible for a large share of the wage premium that low-education workers obtain in large firms.

The results on experience and tenure also warrant some comments. The wage impact of potential experience is sharply increasing in education. However, the impact of tenure (as measured by the general coefficient for the reference size group) is not. This pattern is reinforced by the results on the interactions between tenure and establishment size. Large firms are likely to offer better opportunities for internal promotion, learning, and on-the-job training, which should then bring about sharper wage increases over time. Nevertheless, the tenure-size interaction effect only emerges as positive and significant in the case of the least educated workers. For higher education individuals, the coefficients turn out negative and sometimes significant (note however that this does not mean that tenure has a negative impact on their wages since the sum of any of these interaction terms with the general coefficient for tenure is always positive). Hence medium and large size firms seem to make a difference with respect to internal promotion and training only for low education employees. College graduates obtain a very large reward to potential experience, but it is relatively less important whether this experience is obtained within the current establishment and within a small or larger firms.

6. Concluding Comments

The model in this paper explores the implications of optimal quality choices by efficiency-heterogeneous firms, for the sorting of workers with different skills into firms with different characteristics. It provides a simple integrated explanation for the observed correlations between establishment characteristics (size, average education, capital/labor ratio and market orientation) and average wages conditional on measured worker characteristics. It also points out some implications about establishment characteristics and their labor composition and about the pattern that establishment-characteristics wage effects should show with respect to worker education.

Our empirical results using Spanish employer-employee matched data are favorable to all the implications of the model, extending the available empirical evidence in several directions. Market orientation has a significant and quantitatively important positive effect on the demand for human capital that is increasing in market remoteness. Moreover, in non-locally oriented establishments, establishment size also implies higher average employees' education. Size, main-market remoteness, average employees' education, and firm-level contracting also have a jointly

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Additional results not included in the Table 7 (showing that when not controlling for these effects, workers with the lowest education obtain the largest firm-size premium), suggest that these factors can be responsible for the difference between our results and those of Lallemand, Plasman and Rycx (2005). Finally, our results for the market orientation premium tend to contradict those of Schank, Schnabel and Wagner (2006) who obtain that the premium for white-collard workers is statistically and quantitatively almost insignificant and lower than for blue-collard workers. However, these results are not obtained using directly observed data but rely on using imputed data for white-collard wages. This casts doubts about them, even more when taking into account the evidence in Bernard and Wagner (1997) pointing out that white-collard workers are the group responsible for almost all the exporting premium.

significant positive and quantitatively important effect on wages. Notably, the importance for labor demand and wages of market orientation does not only show up when comparing exporting and non-exporting establishments, as suggested by the literature so far, but when comparing national-market and local-market establishments. The differences in this last comparison tend to be as important as those in the first one. The establishment characteristics we include in the wage equation reduce the estimated education wage premium (which, as often suggested, may be capturing the effect of unmeasured skills) by more than one third.

All the establishment characteristics we have analyzed are quantitatively important for the wages of all workers whatever their education level. However, they are not equally important. Establishment-characteristics effects are increasing (though sometimes not strictly) in workers' education. In fact, the coefficients on coworkers' average education and market orientation for college graduates double or even triple those for workers with only primary education. Thus, according to the interpretation suggested by our theoretical model, unmeasured skills are much more valuable for high-education workers than for the less educated. The combined effect of the most favorable establishment characteristics analyzed in this paper may double the wage of a college graduate with respect to working in an establishment with the least favorable characteristics.

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Table 1: Establishment Characteristics: Descriptive Statistics

		Distribution of Establishments: Main Market					Mean years of schooling	Fraction of employees with college degree	Average wage (€ per hour)
		All	*Local*	*National*	*Interna-tional:EU*	*Internat.:Non-EU*			
Distribution of Establishments: Size	*All*	1	0.478	0.456	0.041	0.024	8.883 (2.920)	0.105 (0.20)	9.57 (6.60)
	10-49 workers	0.713	0.406	0.279	0.021	0.007	8.596 (2.847)	0.085 (0.195)	7.499 (5.049)
	50-199 workers	0.173	0.050	0.104	0.010	0.007	9.251 (2.964)	0.134 (0.223)	9.875 (6.474)
	>199 workers	0.114	0.022	0.072	0.010	0.009	10.119 (2.924)	0.188 (0.244)	12.375 (7.553)
Mean years of schooling		8.883 (2.920)	8.204 (2.630)	9.584 (3.083)	8.315 (2.271)	10.014 (2.734)			
Fraction of employees with college degree		0.105 (0.20)	0.058 (0.16)	0.155 (0.25)	0.063 (0.12)	0.171 (0.24)			
Average wage (€ per hour)		9.57 (6.60)	7.25 (4.68)	10.63 (7.29)	10.53 (4.67)	12.07 (7.97)			

Notes: Data source is the EES-2002 using the sample weights provided by the survey. Establishments' size, mean years of schooling, and the fraction of workers with a college degree are calculated for the sub-sample of 11567 establishments in industries that have at least one exporting firm. The fraction of employees with a college degree and average education are first obtained for each establishment and then averaged across establishments. Average wages are calculated using the sub-sample of 35602 men with full-time jobs and indefinite contracts who did not go trough transitory labor incapacity nor were they included in job promotion programs. See Section 3 for other details on the sample. Standard deviations are in parenthesis.

Table 2: Establishment Characteristics and Employees' Education

	(1)	(2)	(3)	(4)	(5)	(6)
S2	0.288**	-0.002		0.110**	0.040**	
	(0.104)	(0.102)		(0.015)	(0.013)	
S3	0.844**	-0.141		0.223**	0.005	
	(0.136)	(0.139)		(0.017)	(0.016)	
S2+S3			-0.507**			-0.038*
			(0.159)			(0.020)
M_N	1.128**	1.094**	0.937**	0.179**	0.202**	0.176**
	(0.090)	(0.094)	(0.106)	(0.013)	(0.012)	(0.013)
M_E	0.043	0.999**	0.823**	0.073**	0.322**	0.294**
	(0.147)	(0.146)	(0.154)	(0.030)	(0.028)	(0.029)
M_W	1.546**	2.106**	1.877**	0.236**	0.462**	0.429**
	(0.195)	(0.180)	(0.192)	(0.034)	(0.031)	(0.032)
$(M_N+M_E+M_W)\times S2$			0.727**			0.106**
			(0.193)			(0.025)
$(M_N+M_E+M_W)\times S3$			0.614**			0.071**
			(0.207)			(0.026)
Adjusted R^2	0.112	0.266	0.268			
Pseudo R^2				0.126	0.300	0.301
Observations	11567	11567	11567	11567	11567	11567
Industry dummies	No	Yes	Yes	No	Yes	Yes

Notes: In columns (1) to (3) the left-hand-side variable is average schooling years of the employees in the establishment. The estimation method is Weighted Least Squares using the sample weights provided by the survey. In columns (4) to (6) the left-hand-side variable is the fraction of college-educated employees in the establishment, and the estimation method is Maximum likelihood using a Tobit model and the sample weights provided by the survey. A constant and dummies for 16 regions are always included. Dummies for 35 industries are included only when noted. Robust standard errors are in parenthesis. See Section 3 for details on the data source and sample. ** means significant at 1 percent; and * at 10 percent.

Table 3: Establishment Characteristics and Wages

	(1)	(2)	(3)	(4)	(5)
Employee Characteristics:					
Y	0.066**	0.059**	0.042**	0.041**	0.042**
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
PE	0.026**	0.026**	0.027**	0.025**	0.026**
	(0.002)	(0.002)	(0.002)	(0.002	(0.001)
$PE^2/100$	-0.033**	-0.031**	-0.034**	-0.031**	-0.036**
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Tenure	0.018**	0.015**	0.014**	0.013**	0.014**
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$Tenure^2/100$	-0.020**	-0.019**	-0.020**	-0.019**	-0.021**
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Establishment Characteristics:					
S2		0.160**	0.112**	0.114**	
		(0.012)	(0.013)	(0.013)	
S3		0.252**	0.179**	0.145**	
		(0.019)	(0.018)	(0.017)	
e			0.030**	0.023**	
			(0.003)	(0.003)	
M_N			0.096**	0.100**	
			(0.013)	(0.013)	
M_E			0.162**	0.166**	
			(0.033)	(0.022)	
M_W			0.170**	0.185**	
			(0.024)	(0.026)	
Industry Dummies	No	No	No	Yes	–
Establishment Fixed Effects	No	No	No	No	Yes
Adjusted R^2	0.392	0.432	0.455	0.476	0.724

Notes: the left-hand-side variable is the log of the hourly wage. In columns (1)-(4) we estimate equation (22) using Weighted Least Squares and including different sets of establishments' characteristics. In specification in column (1) we only include workers' characteristics (years of schooling, *Y*, potential experience, *PE* and tenure), a constant and 16 dummies for regions. In column (2) we add dummies for establishment size. In column (3) we add dummies for establishment market orientation (M_N, M_E and M_W), size (*S2* and *S3*), and coworkers' average schooling (*e*). In column (4) we also include 35 dummies for industries. In column (5) we estimate the fixed-effects model of equation (23). Robust standard errors are in parenthesis. They are corrected for heteroscedasticity and for the clustered sampling scheme. Data source is the EES 2002 using the sample weights provided by the survey. The number of observations is 35602 workers and 9120 establishments in columns (1)-(4) and 33646 workers and 7164 establishments in column (5). See Section 3 for details on the data source and sample. ** means significant at 1 percent; and * at 10 percent.

Table 4: Regressing the Estimated Establishment Fixed Effects with respect to the Observable Establishment Characteristics

	(1)	(2)	(3)
S2	0.164**	0.105**	0.104**
	(0.013)	(0.013)	(0.014)
S3	0.264**	0.175**	0.149**
	(0.022)	(0.022)	(0.024)
e		0.027**	0.019**
		(0.002)	(0.003)
M_N		0.087**	0.095**
		(0.014)	(0.015)
M_E		0.148**	0.173**
		(0.025)	(0.023)
M_W		0.177**	0.194**
		(0.024)	(0.024)
Industry Dummies	No	No	Yes
Adjusted R^2	0.191	0.258	0.299

Notes: The left-hand-side variable is the establishment fixed effects estimated with equation (19) (they correspond to the results in column (4) of Table 3). The right-hand-side variables are the following. In column (1) we only include dummies for the 16 regions and establishment size (*S2* and *S3*). In column (2) we add coworkers' average schooling (*e*), and dummies for market orientation (M_N, M_E and M_W). In column (3) we also include 35 industry dummies. Robust standard errors are in parenthesis. They are corrected for heteroscedasticity and for the clustered sampling scheme. The number of establishments is 7164. See Section 3 for details on the data source and sample. ** means significant at 1 percent; and * at 10 percent.

Table 5: Establishment Characteristics and Wages. Robustness Using Alternative Measures for Employee and Coworkers' Education

	(1)	(2)	(3)	(4)	(5)
Employee Characteristics:					
HS	0.289**	0.258**	0.212**	0.193**	0.140**
	(0.011)	(0.010)	(0.011)	(0.011)	(0.009)
U	0.732**	0.666**	0.481**	0.464**	0.425**
	(0.020)	(0.020)	(0.016)	(0.016)	(0.016)
PE	0.029**	0.028**	0.029**	0.028**	0.028**
	(0.002)	(0.002)	(0.002)	(0.002	(0.001)
$PE^2/100$	-0.040**	-0.040**	-0.004**	-0.038**	-0.040**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Tenure	0.019**	0.015**	0.015**	0.014**	0.014**
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
$Tenure^2/100$	-0.021**	-0.021**	-0.022**	-0.021**	-0.021**
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Establishment Characteristics:					
S2		0.163**	0.115**	0.121**	
		(0.012)	(0.013)	(0.013)	
S3		0.256**	0.182**	0.162**	
		(0.018)	(0.017)	(0.016)	
e2			0.413**	0.395**	
			(0.049)	(0.045)	
M_N			0.086**	0.092**	
			(0.012)	(0.013)	
M_E			0.161**	0.150**	
			(0.028)	(0.021)	
M_W			0.164**	0.158**	
			(0.024)	(0.024)	
Dummies for industry	No	No	No	Yes	_
Establishment Fixed Effects	No	No	No	No	Yes
Adjusted R^2	0.404	0.446	0.474	0.496	0.724

Notes: the left-hand-side variable is the log of the hourly wage. All columns correspond to the same models in Table 3, except that we now use dummies for broad categories of education (*HS* corresponds to completed secondary studies, and *U* to a college degree) instead of years of schooling to control for employee's education; and that we use the fraction of coworkers with a college degree (*e2*) instead of coworkers' average years of schooling. See the notes in Table 3. ** means significant at 1 percent; and * at 10 percent.

Table 6: Establishment Characteristics and Wages. Robustness Including Additional Controls

	(1)	(2)	(3)
Employee Characteristics:			
Y	0.041**	0.041**	0.041**
	(0.001)	(0.001)	(0.001)
PE	0.025**	0.025**	0.025**
	(0.002)	(0.002)	(0.002)
$PE^2/100$	-0.031**	-0.030**	-0.031**
	(0.003)	(0.003)	(0.003)
Tenure	0.013**	0.013**	0.013**
	(0.001)	(0.001)	(0.001)
$Tenure^2/100$	-0.019**	-0.022**	-0.021**
	(0.004)	(0.004)	(0.004)
Establishment Characteristics:			
S2	0.107**	0.119**	0.115**
	(0.013)	(0.017)	(0.016)
S3	0.120**	0.114**	0.097**
	(0.019)	(0.023)	(0.017)
e	0.023**	0.022**	0.022**
	(0.003)	(0.003)	(0.003)
M_N	0.100**	0.099**	0.100**
	(0.013)	(0.013)	(0.013)
M_E	0.168**	0.164**	0.167**
	(0.022)	(0.022)	(0.022)
M_W	0.193**	0.187**	0.194**
	(0.026)	(0.026)	(0.026)
Firm-level contracting	0.073**		0.070**
	(0.022)		(0.022)
$Tenure \times S2$		-0.0003	-0.0006
		(0.001)	(0.001)
$Tenure \times S3$		0.0024**	0.0019
		(0.001)	(0.001)
Adjusted R^2	0.478	0.477	0.478

Notes: the left-hand-side variable is the log of the hourly wage. All models include a constant, 35 dummies for industries and 16 dummies for regions. Estimation method is weighted least squares. Robust standard errors corrected for heteroscedasticity and for the clustered sampling scheme in parenthesis. The number of observations is 35602 workers and 9120 establishments. See Section 3 for details on the data. ** means significant at 1 percent; and * at 10 percent.

Table 7: Establishment Characteristics and Wages by Education Group

	Primary	Secondary	University
Employee Characteristics:			
PE	0.016** (0.001)	0.027** (0.003)	0.060** (0.005)
PE^2/100	-0.020** (0.003)	-0.032** (0.007)	-0.001** (0.013
Tenure	0.015** (0.015)	0.016** (0.003)	0.015** (0.006)
$Tenure^2$/100	-0.024** (0.005)	-0.026** (0.008)	-0.037** (0.015)
Establishment Characteristics :			
S2	0.107** (0.017)	0.147** (0.028)	0.167** (0.048)
S3	0.091** (0.025)	0.159** (0.035)	0.133** (0.049)
E	0.016** (0.003)	0.028** (0.004)	0.041** (0.009)
M_N	0.052** (0.012)	0.136** (0.022)	0.128** (0.041)
M_E	0.095** (0.021)	0.208** (0.038)	0.305** (0.073)
M_W	0.097** (0.022)	0.214** (0.038)	0.275** (0.068)
Firm-level contracting	0.085** (0.024)	0.055* (0.029)	0.062 (0.039)
$Tenure \times S2$	0.002* (0.001)	-0.003* (0.002)	-0.009** (0.004)
$Tenure \times S3$	0.005** (0.001)	-0.002 (0.002)	-0.006 (0.005)
Number of Establishments	7466	3966	1856
Number of workers	21705	9594	4303
Adjusted R^2	0.443	0.399	0.332

Notes. We use three different sub-samples of workers according to their education level: workers without completed secondary studies (primary), workers with completed secondary studies (Secondary), and workers with a college degree (University). The left-hand-side variable is the log of the hourly wage. Estimation method is Weighted Least Squares. All models include a constant, 35 dummies for industries and 16 dummies for regions. Robust standard errors corrected for heteroscedasticity and for the clustered sampling scheme are in parenthesis. See Section 3 for details on the data source and sample. ** means significant at 1 percent; and * at 10 percent.