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ENTREPRENEURIAL SKILLS AND WORKERS' WAGES IN SMALL FIRMS

Rui Baptista, Francisco Lima and Miguel Torres Preto

This paper contributes to the understanding of how small firms are organized and managed. We develop and test a simple empirical entrepreneur-worker matching model in small firms where individual skills play a central role. The model contemplates the existence of complementarities between workers' and entrepreneur's skills. The empirical analysis provides results consistent with the matching model: entrepreneurs are more skilled than workers and more skilled entrepreneurs manage larger firms; more skilled entrepreneurs hire more skilled workers. The estimation of wage regressions shows that the higher the level of education and experience of the entrepreneur, the higher the wage premium for workers.

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1. Introduction

When creating a business the entrepreneur chooses which workers to hire. Even when running similar firms and facing the same market conditions, two different entrepreneurs with different skills likely will not decide in the same way. The more skilled entrepreneur will probably hire more skilled workers. What is the reason for this skill matching and why is it efficient? As in the Becker (1973) marriage model, where the mating of likes is optimal if there are complementarities between the attributes of partners, this paper argues that positive sorting between the entrepreneur and the worker is efficient: the skilled entrepreneur runs a better performing business and workers get a higher pay for their skills.

The production process within a firm consists of tasks performed by skilled labour. Production technologies frequently involve team work (Alchian and Demsetz, 1972) exhibiting complementarities between different tasks (Kremer, 1993). The efficient assignment of skills to tasks (Sattinger, 1993) implies the assignment of more skilled workers to more demanding tasks (Kremer and Maskin, 1996), namely those in managerial positions (Rosen, 1982). In a population of individuals, those who possess higher entrepreneurial knowledge and ability choose to be entrepreneurs (Schumpeter, 1934). Their entrepreneurial skills will determine how much their venture will grow (Lucas, 1978). To understand the interplay between entrepreneurial skills and the skills of the workers hired by the entrepreneur, one needs to analyze the matching between the two kinds of skills (Oi, 1983).

The present paper proposes a model matching entrepreneurs' and workers' skills. The matching of skills is multidimensional – one entrepreneur hiring several workers – and the number of hires is the outcome of the matching process (Garicano and Hubbard, 2007a). In testing the model, our study focuses on small entrepreneurial firms where the entrepreneur-manager's skills and span of control play a major role (Penrose, [1959] 1995; Lucas, 1978).

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The entrepreneur has a fixed amount of time to run the firm. Time is divided between production (which depends essentially on human resources) and coordinating workers (supervising and training). When the entrepreneur is more skilled, the opportunity cost (in terms of production) of coordinating workers is higher. To foster business growth, the high-skilled entrepreneur has to increase her locus of control by hiring more workers. Due to production complementarities, entrepreneurial time is more valuable to production if combined with better workers' skills. High skill workers should need less attention from the entrepreneur/manager and are more autonomous and able to solve more demanding problems. Therefore, the high skill entrepreneur hires high skill workers to leverage her skills, leading to positive sorting.[1] If the matching process implies that workers' skills are more valuable to the high-skill entrepreneur, then workers' wages should be higher. Empirically, we should observe a positive relationship between wages and entrepreneurial skills. This outcome of the model is tested in the empirical part of the paper.

We rely on a longitudinal matched employer-employee dataset covering the whole Portuguese private sector for 1995-2003. The dataset includes information on worker characteristics, firm variables and, in particular, entrepreneur demographics. We select small firms (less than 50 workers) owned by a sole entrepreneur-manager. We start by describing the skill stratification – entrepreneurs are more skilled than workers – and scale effects – more skilled entrepreneurs run larger firms[2] – found in our data. To inspect the matching process, we present estimates of the match between entrepreneurs and workers along different dimensions of skill. This analysis, more descriptive in nature, points to the existence of sorting.

[1] As in Becker's (1973) marriage model. Ornaghi (2009) presents another application of the same idea: mergers of firms with similar technology, products and culture.
[2] Though these are limited by our restriction on firm size.

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We also estimate wages on entrepreneur skills along with worker and firm attributes to assess the value of the match, that is, if sorting leads to higher wages. The estimation models consider wages in two ways: wages for the first workers hired at firm creation; and wages across the firm's life span accounting for the workers' unobserved heterogeneity (worker fixed effects). The results are consistent with the model: the estimated relationship between entrepreneurial skills and wages is positive.

We contribute to several strands of the literature. In the field of strategy, we contribute to the understanding of how an entrepreneur-manager expands the firm by hiring high-skill workers, changing the productive opportunity of the firm (Penrose, [1959] 1995). The study of the matching process also highlights how the entrepreneur acts as a strategic manager responsible for resource allocation and reconfiguration (Teece and Pisano, 1994; Teece et al., 1997; Teece, 2007; Augier and Teece, 2008). The value of the match depends on the entrepreneur's ability to hire the best workers and to combine entrepreneurial skills with workers' skills. To the extent that it is captured by wages, the value of the matching of skills provides an alternative measure of the relationship between entrepreneur's skills and business performance (Bates, 1990; Brüderl et al., 1992; Bosma et al., 2004). In labour economics, an important literature stream looks at the relationship between wages and firm size, mostly finding that larger firms pay higher wages to similar workers (Stolzenberg, 1978; Melow, 1982). It can be argued that entrepreneurial skills are also part of the explanation for rewarding workers' skills differently. If more skilled entrepreneurs run larger firms, workers in larger firms will be expected to earn higher wages. Finally, this paper contributes to an underdeveloped field of study, namely, the study of human resource management in small firms (Cardon and Stevens, 2004), and, in particular, on firms' hiring and compensation policies.

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In the next section, we develop the matching model and use it to discuss the extant literature and guide the empirical analysis. The third section describes the dataset and relationship between entrepreneur's and workers' skills within firms. In the fourth section, we present the results from wage estimations. We discuss the estimation methods under possible sources of bias and alternative explanations for the results. The fifth section concludes the paper.

2. The Matching Model

We follow Garicano and Hubbard (2007a), who study the match between two kinds of agents: the manager and the workers. In our setting, the manager of the firm is the entrepreneur. We assume that agents are endowed with one unit of time and skill level $q \in [0,1]$. Skill can be interpreted as the capacity to solve more complex problems, or as a lower cost to acquire the knowledge necessary to complete a task. An entrepreneur with skill level q_e hires *n* workers with skill level q_w with $q_e > q_w$ – i.e. the entrepreneur is more skilled than her workers. The entrepreneur and workers form a firm and its production is given by:

$$y = F(q_e, q_w) = v(q_e)g\big(n(q_w)\big) \tag{1}$$

where $v(.)$ and $g(.)$ are twice-differentiable, increasing and strictly concave, continuous functions. We do not consider capital in order to keep the model as simple as possible. The production function in equation (1) is not separable (Alchian and Demsetz, 1972), meaning that the cross derivative is not zero ($\partial^2 F/\partial q_e \partial q_w \neq 0$). The function is the outcome of the

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joint production of one entrepreneur and n workers. The model rests on the assumption that entrepreneur and worker skills are imperfect substitutes. The assumed technology has two main properties: (i) the entrepreneur skills increase the productivity of all workers; and (ii) the entrepreneur skills and worker skills are complementary in production.

The same kind of production function appears in different forms in the literature. Lucas (1978) and Jovanovic (1994), focusing on the size of the firm, define the production function as $y = q_e g(n)$. In Lucas's model, workers' skills are absent and the main characteristic of the function is the multiplicative effect of the entrepreneur skills, as in equation (1). The skills of the entrepreneur give rise to a scale effect – higher skilled entrepreneurs manage larger firms. The diminishing returns expressed in the concavity of g limit the size of the firm. The same type of technology appears in Rosen (1982), but in a context of hierarchical job assignment. More skilled workers are assigned to a managerial position and their skill has a scale effect, similar to the effect of the entrepreneur's skill in Lucas's (1978) model. Both models are silent concerning the matching of skills.[3]

Oi (1983) is one of the first to consider the match between the skills of the entrepreneur and skills of the workers. Production technology is $y = f(q_e(1-\lambda n), nq_w)$, where q_e is the entrepreneur's skill and q_w is the worker's skill, as in equation (1). Labour is measured in efficiency units, nq_w. The entrepreneur has one unit of time to use in production and in monitoring workers' performance. The time spent monitoring workers is given by λn, where λ is the time needed to monitor each worker. The entrepreneur uses the remaining time $(1-\lambda n)$ in production. This implies that only a fraction of the entrepreneur's skills contribute to production, given by $q_e(1-\lambda n)$. The function is not separable and the cross

[3] Rosen (1982) suggests his model could be extended to study sorting along the lines proposed by Becker (1973).

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derivative of *f*(.) is positive, leading to a scale effect, as in Lucas (1978): more skilled entrepreneurs hire more workers.

The novelty in Oi (1983) is the opportunity cost resulting from the need to monitor workers, which leaves less entrepreneurial time available to production. The higher the entrepreneur's skill q_e, the higher the value of skills applied to production $q_e(1-\lambda n)$. To run a larger firm, the skilled entrepreneur needs to compensate for the higher opportunity cost of monitoring workers, given by $q_e \lambda n$. The solution is to hire more skilled workers, as their higher contribution to production compensates the higher opportunity cost of the skilled entrepreneur – positive sorting.

A main feature of technology in the above models is the existence of complementarities in production between the entrepreneur and the workers. The role of complementarities in the matching process appears in its purest form in the O-ring theory proposed by Kremer (1993).[4] This author defines the production technology as $y = \prod_{i=1}^{n} q_i$, ignoring who controls the firm or the need to perform different tasks within the firm. This function implies that if one worker fails, then output is zero (the O-ring argument). The author proves the existence of positive sorting – workers with the same skill level will be matched together (self-matching). Perfect complementarity drives the result. Kremer and Maskin (1996) introduce tasks with different skill sensitivity into the production function. If only two workers are considered, this yields: $y = q_1^{\alpha} q_2^{\beta}$. The exponents measure the effect of each worker's skill on production, and $\alpha > \beta$, implying that $q_1 > q_2$. Again, skills are complementary, which originates positive sorting: the matching of the best workers in performing task 1, the more demanding task, with the best workers in performing task 2, the less demanding task (cross-matching). The

[4] The role of complementarities in production goes beyond the scope of the matching issue (see Alchian and Demsetz, 1972).

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technology is also similar to Rosen (1982) but without the distinction between hierarchical layers, thus not contemplating a scale effect.

The production technology depicted in equation (1), following Garicano and Hubbard (2007a), integrates the scale effects and skills complementarities in a form similar to the one proposed by Oi (1983).[5] The model endogenously determines the number of workers in a multidimensional matching between one agent and *n* agents.

In equation (1), the value of the entrepreneur's production is $v(.)$. The output of the firm is the entrepreneur's skill value $v(.)$, multiplied by the effective time spent in production by the 1 + *n* agents, $g(.)$. The entrepreneur has to devote time to coordinating workers. The cost of coordination occurs since the effective time agents dedicate to production is less than the total available amount of time: $g(n) < 1 + n$.

Following Garicano and Hubbard (2007a), we assume that if workers are more skilled, then the entrepreneur can employ more workers (increase the span of control): $n'(q_w) > 0$ with $n(q_w) > 0$ for all $q_w > 0$. The entrepreneur is time-constrained and must delegate tasks in order for the firm to grow. If workers are more skilled, the entrepreneur spends less time supervising the team, because more skilled workers require less attention (Garicano, 2000; Garicano and Rossi-Hansberg, 2004), solve more complex problems or difficult tasks (Garicano and Hubbard, 2007a), or possess lower learning costs of knowledge acquisition (Garicano and Hubbard, 2005, 2007b; Garicano and Rossi-Hansberg, 2006).[6] Thus workers' skills facilitate higher leverage of the entrepreneur's skills.

Assuming that there are no other production factors, the entrepreneur chooses the workers' skills to maximize firm profits,

[5] See also Garicano and Rossi-Hansberg (2004, 2006) and Garicano and Hubbard (2005).
[6] Or they can perform more tasks per unit of time (Sattinger, 1975).

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$$\max_{q_w} v(q_e)g(n(q_w)) - w(q_w)n(q_w)$$

The first order condition for the entrepreneur optimization problem is given by

$$v(q_e)g'(n(q_w)) = w(q_w) + \frac{w'(q_w)}{n'(q_w)} n(q_w) \qquad (2)$$

The left-hand side of equation (2) is the marginal value of an increase in workers' skill and the right-hand side is the marginal cost of that increase for one additional worker of skill q_w. The marginal value is the increase in effective production time, g', multiplied by the value of entrepreneur's skill, *v*. The marginal cost is the additional wage plus a factor that reflects the increase in wage due to the additional skill, *w'*, per additional worker, *n'*, times the number of workers employed, *n*. To increase the size of the firm and circumvent the time restriction, the entrepreneur employs more skilled workers.

What happens when the entrepreneur's skill-level increases? In a model like Lucas (1978), the first order condition is $q_e g'(n) = w$. When the entrepreneur's skill-level q_e increases, for a given wage, the entrepreneur responds by increasing the number of workers. In the case of the production function in equation (1), the entrepreneur increases the number of workers as in Lucas (1978), but hires more skilled workers and pays higher wages.[7] Therefore, we have a scale effect due to entrepreneurial skill and positive sorting between the entrepreneur and workers.

[7] The increase in firm size is smaller than in a case where the workers' skills are absent. There is a trade-off between the quantity (firm size) and quality (skills) of the workers not present in other models except in Oi (1983).

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In the matching model, more skilled workers spend less production time acquiring knowledge, with lower learning costs, and are more valuable to the entrepreneur. This explains the positive relationship between worker's skill and wages. At the margin, the opportunity cost associated with the loss of production due to workers learning is higher for a more skilled entrepreneur: if a more skilled worker needs less time to learn, then he is more valuable to a better entrepreneur, given that the value of entrepreneur's skills is higher and the production function exhibits skills complementarities. The specialization of the entrepreneur in solving more complex problems – her comparative advantage as manager – is intensified when working with more skilled workers. At the margin, when the entrepreneur is more skilled, the value of more skilled workers is higher, which translates into higher wages. Therefore, we expect to find a positive relationship between wages and the entrepreneur's skills. We propose to test this relationship between the entrepreneurial skills and workers' wages arising from the matching model.

Restrictions

The role of an entrepreneur, who manages the firm (Kaldor, 1934; Coase, 1937), is present in all the studies mentioned above. However, we do not consider firms where there is an entrepreneurial team controlling the firm's resources (Kamm et al., 1990; Ruef et al., 2003; Ucbasaran et al., 2003). Empirically, it would be difficult to isolate the role of skills of more than one owner with the data available. Given our restriction on size, it is more likely to find small businesses owned by just one entrepreneur than by an entrepreneurial team. We are dealing with simple governance structures (Williamson, 1979) managed by a central agent (Alchian and Demsetz, 1972).

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In addition, along with the size and sole ownership restrictions, we deliberately exclude the hierarchical ladder from the model by including only two layers: the entrepreneur-manager and the workers. Otherwise, we would have to deal with issues related with the internal working of the firm, such as hierarchical control (Williamson, 1967), the existence of internal labour markets (Doeringer, 1967; Doeringer and Piore, 1971), job assignment (Sattinger, 1975, 1993; Calvo and Wellisz, 1979; Waldman, 1984; Gibbons and Waldman, 1999), or the matching with the quality and quantity of the remaining firm's resources (Sattinger, 1979; Stevenson and Jarillo, 1990; Eisehardt and Martin, 2000).

Previous Empirical Evidence

Empirical evidence on skill matching between entrepreneurs (or managers) and workers is still scarce. Garicano and Hubbard (2005, 2007a) test their knowledge-based hierarchy model in the context of US law firms. Garicano and Hubbard (2005) find evidence of positive sorting between partners and associates in law firms, measuring lawyers' skills by their experience and education (the quality of the law school). Garicano and Hubbard (2007a) find that partners' skills have a positive effect on the associates' earnings. Smeets and Warzynski (2008) use data from one firm to test the career dynamics and span of control resulting from knowledge-based hierarchy models, as opposed to other theories of hierarchies in organizations, but the authors do not directly test the existence of positive sorting.

The extant literature is mainly focused on the relationship between firm size and wages.[8] Fox (2009) presents empirical evidence on the relationship between wages and firm size in the context of the Garicano and Rossi-Hansberg (2006) hierarchical matching model. This author finds that the firm-size wage gaps increase with job responsibility: workers assigned to

[8] Idson and Oi (1999) review the literature. See also Ferrer and Lluis (2008), Fox (2009), and Gibson and Stillman (2009) for more recent studies.

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jobs with more responsibilities receive relatively more than comparable workers in smaller firms. A related strand of the literature looks at sorting between worker and firm productivity or, alternatively, at the relationship between worker and firm specific effects estimated from a wage equation.[9] For example, Mendes et al. (2010) estimate firm specific productivity effects from a production function and find positive sorting between workers' skills and firm productivity. These studies can be read in the light of Becker's (1973) marriage framework, but focus instead on the matching between one worker and one firm in the context of search models (Burdett and Coles, 1999).

3. Data

Every private firm in Portugal answers an annual survey – *Quadros de Pessoal* (QP) – conducted by the Ministry of Labour. The survey is mandatory for firms with at least one employee and started in the 1980s. It includes information on workers, business owners and firms. The QP is a longitudinal matched employer-employee dataset where a unique identification number links and traces workers, firms and business owners across time.[10] We use the 1995-2003 period covering over 250,000 firms and two million workers in each annual survey. Worker information includes gender, tenure, schooling, job assignment, wages and hours of work. The survey contains the same individual information for the business owners, excluding earnings and hours of work. Firm information includes location, industry (five-digit ISIC codes), total sales, initial capital and type of ownership.

3.1 The Sample

[9] Applying the estimation methods proposed by Abowd et al. (1999).
[10] The survey is the source of several papers studying workers (e.g. Martins, 2009), entrepreneurs (e.g. Amaral et al., 2011), firms (e.g. Geroski et al., 2010); and firms and workers (e.g. Baptista et al., 2011).

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We need to impose some conditions on the sample given our objective of establishing the relationship between the entrepreneur's skills and workers' wages. We select firms based on three conditions. First, we select small firms, employing less than 50 workers. As discussed in Section 2, it is difficult to identify the role of entrepreneurial skills in larger firms with complex hierarchical structures. Second, we select firms owned by a sole entrepreneur. We do not have enough information on the ownership structure and internal decision making process to establish a clear link between each member of the entrepreneurial team and their workers. Third, the entrepreneur has to be the top manager of the firm. We need to guarantee that the entrepreneur effectively manages the firm, is responsible for the strategic decision making, and intervenes in the definition of the firm's hiring and compensation policies.

Overall, firms with less than 50 workers represent 98 percent of all firms and 50 percent of total employment in the economy. Selecting only firms owned by a single manager-entrepreneur restricts the sample to 60 percent of firms with less than 50 workers. Table 1 presents the firm size distribution for the years covered by the sample (1995-2003). The majority of the firms (65.1 percent) employ up to five workers and only 4.3 percent employ between 20 and 50 workers. The proportion of workers in each firm size range considered – 0-5, 5-10, 10-20, and 20-50 workers – is around 25 percent.

Table 1

3.2 Skill Measures

The variables measuring worker skills are education, labour market experience, and tenure. Education measures pre-market training, i.e. individual investment in acquiring skills

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typically carried out before entering the labour market. Labour market experience and tenure measure skills acquired on the job (Becker, 1962, 1964). Table 2 shows the worker descriptive statistics for the sample with almost 1.8 million worker-years. Workers are, on average, 35 years old, and 41 percent are female. Three dummy variables measure schooling: nine-year education, corresponding to compulsory schooling in Portugal during the period under study; secondary education, corresponding to twelve-year school enrolment (high-school); and college education, corresponding to at least a college degree.

Table 2

Only 2.4 percent of workers completed college education, 14 percent completed secondary education, and 15.9 percent completed the nine-year education. More than two thirds are below the nine-year education level. This reflects the relatively low educational attainment of the Portuguese population. The average tenure is nearly five years – the sample is composed by small firms where worker turnover is expected to be higher (Idson, 1996). Average experience in the labour market is 21 years, measured as age minus years of schooling and tenure. The standard deviations for tenure (6.245) and experience (12.197) are high when compared with the respective means, assuring that there is enough source variation to identify the parameters of interest.

3.3 Skill Stratification, Scale Effects and Sorting

Before moving to the estimation of wage equations, we examine whether there is any descriptive evidence in the dataset pointing to the conditions of the matching model, namely:

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skill stratification – entrepreneurs are more skilled than workers; scale effects – more skilled entrepreneurs manage larger firms; and positive sorting – more skilled entrepreneurs employ more skilled workers.

Skill stratification

We compare the skills of entrepreneurs and workers – education, tenure and experience – in Table 3 for the year 2003. We compute an entrepreneur's "tenure" by counting the years since admission, noting that tenure does not necessarily coincide with firm age: the entrepreneur is not necessarily the founder, as the owner may have bought or inherited the firm. We define education and experience as in the case of workers. Entrepreneurs are better educated than workers: for example, the proportion of entrepreneurs holding college education is 14.1 and the proportion of workers is 4.7 percent. Entrepreneurs also have more years of tenure and experience: entrepreneurs have 6.4 years of tenure and 28.7 years of experience while workers have 4.7 years and 21.5 years. If we measure skills by formal education, tenure and labour market experience, on average, we find that entrepreneurs are more skilled than workers.

Table 3

Scale effects

Table 4 presents the distribution of the entrepreneur's education across firm size classes in the first four columns. The last column presents the distribution of the entrepreneur's education for all firms in the sample. In the first firm size class (between one and five

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workers), 50.4 percent of the firms are owned by entrepreneurs with less than nine-year education; 19.01 percent by entrepreneurs with nine-year education; 17.29 percent by entrepreneurs with secondary education; and 13.29 percent by entrepreneurs with college education. In larger firms (between 21 and 50 workers), the proportion of firms owned by less educated entrepreneurs decreases (from 50.4 to 40.8 percent) and the proportion of firms owned by better educated entrepreneurs increases (from 13.29 to 18.88 percent). When education measures the skills of the entrepreneur, this descriptive cross tabulation points to a scale effect. As we are selecting small firms, the effect is modest.

Table 4

Positive sorting

We expect to find positive sorting through the workers' wages in Section 4. However, we can inspect the data directly to probe if more skilled workers are more likely to be employed by more skilled entrepreneurs. We classify and order firms by the level of the entrepreneur's skills, measured by education: (1) firms owned by entrepreneurs having less than nine years of education, (2) having completed nine years of education, (3) having completed secondary education, and (4) holding at least a college degree. With firms ordered in this way, we define an ordered probit model for the four kinds of firms and estimate the probability of a worker from a given skill-level being employed by an entrepreneur from a higher or lower skill-level.[11] Workers' skills are measured by education, work experience and tenure. We also control for worker's gender and the characteristics of the firm, namely, location and industry. Industry controls are included since positive sorting can be due to technology production

[11] We perform the same exercise with the entrepreneur's experience and the results are similar.

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complementarities requiring a certain skill level from the entrepreneur and the worker. For example, a software firm will probably be founded by a computer scientist (or a similar background) and will need to hire workers with programming skills, obtained most likely through a degree on computer science (or similar).

Garicano and Hubbard (2005) compute the law firm associates' education and experience (normalized) shares across the partners' education and experience and find that the associates are more likely to work with similar partners. We performed the same exercise and found similar results. However, since we are not dealing with a set of organizations as homogeneous as that of law firms, we need to control for industry to try to isolate the sorting due to skills. An ordered estimation model seems the appropriate way of inspecting the data. Homogeneity is ensured by size (small firms, presumably labour intensive) and type of ownership (sole owner who manages the firm).

Table 5 presents the marginal effect of the ordered probit for the probability of employment of young workers in the different kind of firms.[12] We select young workers (under 25) because their skills are captured mainly by education. They are new to the labour market and therefore the acquisition of human capital due to work experience is modest. In this way, we try to reduce the observable dimensions where the matching with entrepreneurs occurs.[13]

Table 5

[12] The 95 percent confidence intervals of the estimated threshold parameters do not overlap, suggesting that we can order firms by entrepreneurs' education as should happen with the matching model.
[13] However, the estimation with all workers renders similar results.

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In the first column of Table 5, workers with nine or more years of education have a negative probability of employment in firms owned by entrepreneurs with less than nine years of education. Looking by row, across the level of workers' education, the marginal effects increase as we move from firms owned by those with less than nine years of education to firms owned by entrepreneurs with college education, indicating that more educated workers have a higher probability of employment at firms owned by more educated entrepreneurs. From the second to the fourth column, the marginal effects correspond to the exact match – entrepreneurs and workers with the same educational level. These marginal effects are always higher than the other marginal effects in the same column. Workers have a higher probability of employment in firms where the entrepreneur has the same education level as themselves. Overall, the evidence derived from the ordered probit points to the existence of positive sorting between entrepreneurs and workers.

4. Workers' Wages

The matching model in Section 2 predicts the positive sorting between workers and entrepreneurs. The more skilled entrepreneurs own larger firms (scale effect) and employ more skilled workers (sorting). According to equation (2), workers' wages should be higher when entrepreneurs are more skilled. By introducing the entrepreneur's skill in a wage equation as an explanatory variable, we expect it to have a positive coefficient, even after controlling for observable workers' skills – education and labour market experience. In the context of the model, this would be consistent with production complementarities between entrepreneurs and workers, as in equation (1).

4.1 Wage Equations and Estimation Methods

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We augment the typical wage equation (Mincer, 1974) in order to determine how entrepreneurial skills influence the formation of wages and test the existence of positive sorting. Define the following (log) wage equation for each worker *i* in year *t*,

$$W_{it} = \beta_0 + SW_{it}\beta_1 + SE_{it}\beta_2 + SI_{it}\beta_3 + O_{it}\beta_4 + s_i + \epsilon_{it} \quad (3)$$

where the vectors *SW* and *SE* measure the (observable) skills of the worker and the entrepreneur, namely education, tenure, and work experience; *SI* includes interactions between worker and entrepreneur skills, as we discuss below; *O* represents other factors affecting wages, i.e. controls for year, worker's gender, firm's industry and location; *s* is a worker specific effect; and ϵ is the error term. We estimate the wage equation with three specifications: specification (1) includes workers' skills (*SW*) and other controls (*O*); specification (2) adds entrepreneurial skills (*SW*); specification (3) introduces the interaction variables (*SI*).

Positive sorting means that more skilled workers will be matched with more skilled entrepreneurs. In terms of wages, this implies that more skilled entrepreneurs will command higher wages and the expected signs of β_2 are positive. The wage equation includes the interaction variables *SI* to test the existence of a non-linear relationship in the log equation (3). If the estimated coefficients are positive, then the high-skill worker benefits proportionally more than the low-skill worker from being employed by a high-skilled entrepreneur. The interaction variables only include education. For most workers and entrepreneurs, education is a pre-market accumulation of human capital, even though there is a potential problem of endogeneity if correlated with the error term. Tenure is specific to the observable employment relationship. Experience measures human capital accumulated in

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previous employment relationships and is defined too broadly to obtain a meaningful interpretation. We discuss these issues further in Subsection 4.3.

We estimate the wage equation using two methods. First, we apply ordinary least squares (OLS) restricting the observations to the moment of firm creation. Second, we apply a fixed-effects longitudinal model. We face the usual issue of correlation between the regressors, most notably *SW*, and the unobserved components of the model, *s* and ϵ. By using these two methods, we expect to reduce the inconsistency accruing from this correlation.

In the first method, workers appear in the estimation in the first year of employment in a new firm. The wages reported in the dataset correspond to October, thus only workers employed in firms created since November of the previous year enter in the regression. We aim to reduce the information asymmetry between the researcher and the entrepreneur concerning the unobserved (to the researcher) components of workers' skills. At the beginning of the employment relationship, the wage is set based on the skills that the entrepreneur can observe at the moment of hiring. As production takes place, the entrepreneur starts to learn about the unobserved workers' skills and wages will reflect this learning process.[14] The restriction reduces the bias arising from the unobserved skills of the worker. We do not claim to eliminate the whole inconsistency, but we argue that it is smaller than if we used firms of all ages. The restriction to firm entry has another advantage: we are excluding those business owners who may have acquired or inherited the firm, and thus achieving a definition of entrepreneurship closer to that on the management literature on new venture creation (e.g. Shane and Venkataraman, 2000).

The second method applies fixed-effects estimation and controls for worker heterogeneity. The fixed-effects model identifies the coefficient on entrepreneurial skills in two ways: when

[14] The model does not account for a learning process about the workers' skills, but this is likely to exist, for example as in Gibbons and Waldman (1999).

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the worker switches to a firm owned by an entrepreneur with a different education level; and when the worker does not switch employers, but the entrepreneur's education level increases. We discuss this issue further in the next subsection. The reduction in the bias depends on the extent that the specific worker-effects capture the value (to the entrepreneur) of the unobserved workers' skills.

An important difference between our specifications and others present in the literature is that we are not controlling for firm size (log number of workers). We have already discussed the reasons for using small firms, which limits the role of size. However, in the model, size is a consequence of a scale effect due to the entrepreneur's skills and we benefit from the advantage of having information about those skills. This argument is only valid because we are abstracting from other reasons for higher wages associated with larger firms (as discussed in Section 2).

4.2 Results

Table 6 presents the estimated results for firms' entry year while Table 7 displays the results of the fixed-effects model. Table 8 shows the interaction terms from specification (3) of both models. Estimations of specification (1) in Tables 6 and 7 with the workers' skills (*SW*) and other factors affecting wages (*O*) are only used for comparison, so as to verify that there is no abrupt change in the coefficients when estimating the other two specifications. The measures of workers' skills show the expected positive relationship with wages – education (positive), tenure (concave) and experience (concave).

Table 6

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Specification (2) introduces (observable) entrepreneur's skills into the wage equation. This specification reveals a positive correlation between wages and the entrepreneur's experience and tenure. The relationship between entrepreneurial experience and wages seems modest with both estimation methods. However, for the first year of firm life (Table 6), wages increase by eight percent, evaluated at the average entrepreneur's experience (28.7 years). Wages change by one percent for five years and three percent for ten years of entrepreneurial experience, also at firm entry. For the fixed-effects estimation, the effect is close to zero. The effect of tenure is modest (less than 0.01 log points), even when evaluated at the average entrepreneurial tenure (6.4 years).

The higher the entrepreneur's education level, the larger the wage premium collected by the worker. The impact on wages at firm entry is 17 percent (0.159 log points) for an entrepreneur with at least college education, four percent for one with secondary education, and not significant for one with nine-year education. For the fixed-effects estimation, the nine year education coefficient is significant, though less than one percent. The coefficients for secondary and college education decrease to two and five percent. The estimation results confirm the predictions of the model. Moreover, these effects are captured while controlling for industry and firm location, precluding an explanation based solely on technology and local labour market conditions.

Table 7

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Table 8 presents separately the coefficients of the interaction variables introduced in specification (3) of Table 6 (Panel A) and Table 7 (Panel B). Three different types of variables account for specific interaction effects between entrepreneur's and worker's levels of education. Generally, the coefficients are significant only when the entrepreneur or the worker hold a college degree. The evidence is mixed, but seems to indicate that workers with a college education benefit more from the education of the entrepreneur.

Table 8

4.3 Discussion

The estimation results are consistent with the predictions of the matching model. We show that there is a positive relationship between entrepreneurial skills, mainly determined by education, and workers' wages. The interaction coefficients – between the entrepreneur's and workers' skills – indicate that more educated workers benefit more from the entrepreneur's education. The results rest on the assumption that our two estimation methods reduce the bias coming from the possible endogeneity of the regressors. Restricting to firms with less than 50 workers allows us to argue that the scale effect comes essentially from the entrepreneurial skills. We set the size restriction so as to be able to abstract from other issues associated with the management and internal organization of larger firms. The replacement of the usual measures of firm size with entrepreneurial skills in the wage equation provides a direct way to understand the value of the entrepreneur-manager.

What are the possible sources of bias? The first concern is that the match is not random (Jovanovic, 1979; Diamond, 1982; Mortensen, 1982). A selection bias is likely to occur when

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we observe the first year of a firm's life (Table 6 and panel A of Table 8) or when workers move between firms to identify the parameters (Table 7 and panel B of Table 8). Even when restricting the estimation to younger workers (as we do in the ordered probit for the worker assignment to firms in Section 3), we should expect job movements earlier in the worker's career (Topel and Ward, 1992). In addition, young workers can follow a job search strategy in two stages: first search for a career and second search for an employer – a process of career matches and employer matches (Neal, 1999).

The wage increase due to entrepreneurial skills in equation (2) is specific to the match entrepreneur-worker and has a parallel with the effect of specific human capital accumulated with on-the-job experience (Becker, 1962, 1964; Topel, 1991). When the worker moves to another firm, the match is (presumably) destroyed and has no value in the new firm. By this reasoning, and knowing that the value of the match is not fully captured by the skills observable to the researcher, we would have to delve into worker- and entrepreneur-specific effects. In line with Abowd et al. (1999) and, more recently, Dustmann and Pereira (2007), Abowd et al. (2010), and Buchinsky et al. (2010), our study can be further developed by modelling the several sources of unobserved heterogeneity, namely to take into full account the quality of the match. Other possible strategy is to follow the worker when displaced due to firm closure or mass layoffs (see for instance, Eliason and Storrie, 2006; Couch and Placzek, 2010). This could be a way to inspect if the worker carries part of the value of the match to a new firm. In this context, it would be more interesting to determine the extent to which the match with a previous employer is valuable when the worker decides to become an entrepreneur by creating a spinoff (Klepper and Sleeper, 2005; Franco and Filson, 2006; Franco and Mitchel, 2008; Klepper and Thompson, 2010).

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On the side of the entrepreneur, some sources of bias also arise. An obvious one is the change in education that contributes to the identification of the respective coefficients in the fixed-effects estimation. This case scenario is highly likely due to the low educational attainment of the Portuguese population, which is also present among entrepreneurs, though to a lesser extent. Another issue is the ability of our estimation to distinguish between entrepreneurial competence and the intangible value of the organizational capital (Prescott and Visscher, 1980). In the estimation restricted only to the first year of firm life, entrepreneurial skills play the central role but, as the firm ages, the entrepreneur makes adjustment decisions over time, reflecting a process of organizational learning (Cangelosi and Dill, 1965; Fiol and Lyles, 1985) and acting as a core element of strategic management (Teece et al., 1997; Eisenhardt and Martin, 2000).

The use of small firms in the estimation excludes the effect of entrepreneurial skills along dimensions harder to capture. In a mature business, the value of the match, even for new workers, reflects not only the capabilities of the entrepreneur, but also the organization's established routines (Augier and Teece, 2006). As the firm ages, wages should change for the entrepreneur's early workers and for the newcomers. The restriction to new firms abstracts from this issue. In the fixed-effects estimation, though only for small firms, the effect of entrepreneurial skills incorporates intangibles resulting from the combination of workers' skills within the organization.

One way to address part of the selection involved in the match would be to estimate the wage equation conditional on the entrepreneurial choice; to use a decision model if we devise the proper exclusion restrictions to identify the parameters. A model similar to the ordered probit of Section 3 could convey the necessary information to correct the parameters of the wage equation. The problem is how to model the decision with the two kinds of agents – the

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entrepreneur and the worker – and find variables (in our dataset) to identify the parameters. Otherwise, we would have to rely on some non-linearity present in the equations.

While wage models that account for the heterogeneity of the agents (and the match) and models with explicit entrepreneurial decisions conditioning wages seem promising extensions to our work, an alternative way of deepening our enquiry would be to increase the level of detail in the measures of observable skills. Our measures of work experience are too general to capture further dimensions of skills and are a reason for our focus on the education variable. We can use measures of occupation- and industry-specific experience for both entrepreneurs and workers. Previous entrepreneurship experience may also play a role in the success of the business (Brüderl et al. 1992; Cooper et al., 1994; Bosma et al., 2004). This also leads us to inquire about the nature of entrepreneurial skill, for example whether it is specific or general, as in the Jack-of-all-Trades theory (Lazear, 2005). Hartog et al., (2010) confirm that entrepreneurial skills are more balanced than those of the worker. Furthermore, in the case where the level of skills of the workers and entrepreneurs is the same – for the observable experience and education – the nature of those skills is not necessarily the same (Hartog el al., 2010).

Our results are valid for small firms in the whole economy. The average effects, even if consistent, are meaningful if we want to know more about industries and associated technologies. Capital is less critical for small business, but running a restaurant is not the same as running a software company concerning the skills needed for the entrepreneur and the workers. Though that is beyond the scope of this paper, a first approximation would be to apply the empirical model separately to different industries.

Finally, there may be other reasons for the entrepreneur-worker match, which we did not assess in this study. Entrepreneurs in small businesses will tend to employ people they know

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and trust, as they lack the resources for a comprehensive selection of employees (Aldrich and Langton, 1998). Similarly, entrepreneurs may choose their workers among the same family or ethnic group (Aldrich and Langton, 1998; Reskin, 1999; Ruef et al., 2003). Future research could contrast sorting based on skills with sorting based on other traits.

5. Conclusion

The present paper contributes to the understanding of how small firms are organized and managed. We develop and test an entrepreneur-worker matching model in small firms where knowledge, or individual skills, plays a central role. We provide evidence on the matching process between the workers and the individual who owns and manages the firm. The model assumes the existence of complementarities between the workers' and entrepreneur's skills. We use a longitudinal matched employer-employee dataset with information on workers, firms and entrepreneurs. The sample was restricted to firms with less than 50 employees and with a sole entrepreneur-manager. Skills are measured by education, labour market experience, and tenure. The main assumption is that these forms of human capital are correlated with individual ability to solve problems.

In the firms studied, entrepreneurs are more skilled than workers – skill stratification– and more skilled entrepreneurs manage larger firms – scale effects. Estimates of the matching probabilities also indicate the existence of positive sorting between workers and entrepreneurs. The empirical analysis provides results consistent with the matching model: the estimation of wage regressions shows that the higher the level of education and experience of the entrepreneur, the higher the wage premium for workers. We argue that our estimation methods are a viable estimation strategy to identify the parameters of the wage equation. However, we also discuss the possible sources of bias. While the restriction to sole ownership

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is justified by the need to identify the entrepreneur's locus of control, the restriction to small firms is at the cornerstone of our analysis. Expanding the analysis to larger firms would not allow for a comparable level of confidence in the identification of the parameters associated with entrepreneurial skills. A grey area remains as skills are only partly observable by the researcher. Devising an estimation model to allow for greater precision in measuring and identifying skills is one of the possible extensions to our work.

The high mortality of small businesses is a concern for policy-makers, as entrepreneurship is considered a route out of disadvantageous economic conditions. Our results stress that workers' wages reflect the value of the match with entrepreneur's skills. Thus, entrepreneurial skill has an impact not only on job creation, but also on the quality of jobs created. When promoting entrepreneurship, policy-makers should not only look at the potential value of the business idea, but also at the skills of the entrepreneur. By the same token, workers should also ask for the curriculum vitae of the entrepreneur before accepting a job offer.

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TABLES

Table 1. Workers and firm size, 1995-2003

Firm size class (number of workers)	[1-5]	[6-10]	[11-20]	[21-50]	Total
Workers	482,299	446,665	426,616	415,678	1,771,258
%	27.2	25.2	24.1	23.5	100
Firms	267,234	85,975	39,558	17,726	410,493
%	65.1	20.9	9.6	4.3	100

Table 2. Descriptive statistics – workers, 1995-2003

Variables	
Hourly wage (logarithm)	1.120
	[0.382]
Female (dummy)	0.408
	[0.491]
Age (years)	34.552
	[11.467]
Nine-year education (dummy)	0.159
	[0.366]
Secondary education (dummy)	0.140
	[0.347]
College education (dummy)	0.024
	[0.153]
Tenure (years)	4.682
	[6.245]
Experience (years)	20.975
	[12.197]
Observations	1,771,258

Notes: Standard deviation in brackets underneath the mean. Hourly wage is the sum of base wage with regular payments divided by the number of monthly paid hours, deflated using the Consumers Prices Index.

Table 3. Skill stratification: workers versus entrepreneurs, 2003

Variables	Workers	Entrepreneurs
Nine-year education (dummy)	0.204	0.188
	[0.403]	[0.391]
Secondary education (dummy)	0.160	0.176
	[0.366]	[0.381]
College education (dummy)	0.047	0.141
	[0.213]	[0.348]
Experience (years)	21.544	28.744
	[12.167]	[12.960]
Tenure (years)	4.652	6.434
	[6.118]	[7.337]
Observations	246,072	58,124

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Note: Standard deviation in brackets underneath the mean.

Table 4. Firm distribution: entrepreneurs' education level across firm size class, 2003

Entrepreneur education level	Firm size class (number of employees)				Total	Observations
	[1-5]	[6-10]	[11-20]	[21-50]		
Less than nine-year	50.40 %	49.02	47.00	40.80	49.44	28,737
Nine-year	19.01	18.11	19.14	19.27	18.85	10,955
Secondary	17.29	17.27	19.00	21.04	17.59	10,223
College	13.29	15.60	14.85	18.88	14.12	8,209
Total	100.00	100.00	100.00	100.00	100.00	58,124

Note: Dummies defined for the *education* variables.

Table 5. Sorting between entrepreneurs and young workers (less than 25 years old) by education: ordered probit (marginal effects), 2003

Worker education level	Entrepreneur education level			
	Below nine-year	Nine-year	Secondary	College
Nine-year	-0.161***	0.006***	0.069***	0.085***
	[0.011]	[0.001]	[0.005]	[0.007]
Secondary	-0.282***	-0.014***	0.110***	0.186***
	[0.012]	[0.003]	[0.004]	[0.011]
College	-0.360***	-0.093***	0.081***	0.372***
	[0.012]	[0.010]	[0.006]	[0.026]
Observations	13,238			
Wald χ-squared	4610.79			
Pseudo R-squared	0.0913			

Notes: Dependent variable is the entrepreneur's education (four levels). Estimations also include *female*, *experience*, *tenure*, *industry* (defined for 2-letter ISIC classification) and *region* dummies. Standard errors are in brackets. * Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6. Workers' wages and entrepreneur's skills: new firms, 1995-2003

Variables	(1) Worker skills	(2) Worker and entrepreneur skills	(3) Interaction of skills
Female	-0.1431***	-0.1451***	-0.1450***
	[0.004]	[0.004]	[0.004]
Nine -years education	0.0748***	0.0667***	0.0702***
	[0.004]	[0.004]	[0.006]
Secondary education	0.1861***	0.1612***	0.1583***
	[0.006]	[0.006]	[0.010]
College education	0.6079***	0.5443***	0.4574***
	[0.019]	[0.019]	[0.040]
Experience	0.0156***	0.0151***	0.0151***
	[0.001]	[0.001]	[0.001]
Experience^2 x 10^{-2}	-0.0226***	-0.0220***	-0.0220***
	[0.001]	[0.001]	[0.001]
Entrepreneur skills			
Nine-year education		0.0045	0.0131***
		[0.004]	[0.005]
Secondary education		0.0426***	0.0402***
		[0.005]	[0.005]
College education		0.1590***	0.1325***
		[0.008]	[0.010]
Experience		0.0027***	0.0027***
		[0.000]	[0.000]
Experience ^{2} x 10^{-2}		-0.0046***	-0.0045***
		[0.001]	[0.001]
Intercept	0.6809***	0.6369***	0.6394***
	[0.015]	[0.015]	[0.015]
Interaction of skills	No	No	Yes (see Table 8)
F test	255.43	237.57	202.83
Adjusted R-squared	0.233	0.244	0.246
Observations	47,171	47,171	47,171

Notes: Dependent variable is the logarithm of hourly wage at the moment of firm entry. *Tenure* is zero for all workers—regressions only include the first year of firms' life. Dummies defined for the *education* and *female* variables. *Experience* measured in years. All regressions include *year*, *industry* and *region* dummies. Panel A of Table 8 presents the interaction coefficients of specification (3). Robust standard errors are in brackets. * Significant at 10%; **significant at 5%; *** significant at 1%.

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Table 7. Workers' wages and entrepreneur's skills: worker fixed-effects regressions, 1995-2003

Variables	(1) Worker skills	(2) Worker and entrepreneur skills	(3) Interaction of skills
Nine-year education	0.1472***	0.1443***	0.1439***
	[0.001]	[0.001]	[0.002]
Secondary education	0.3006***	0.2942***	0.2932***
	[0.002]	[0.002]	[0.002]
College education	0.6026***	0.5877***	0.5799***
	[0.004]	[0.004]	[0.006]
Experience	0.0569***	0.0565***	0.0565***
	[0.000]	[0.000]	[0.000]
Experience^2 x 10^{-2}	-0.0264***	-0.0263***	-0.0261***
	[0.000]	[0.000]	[0.000]
Tenure	0.0035***	0.0034***	0.0034***
	[0.000]	[0.000]	[0.000]
Tenure^2 x 10^{-2}	-0.0123***	-0.0129***	-0.0129***
	[0.001]	[0.001]	[0.001]
Entrepreneur skills			
Nine-year education		0.0076***	0.0077***
		[0.001]	[0.001]
Secondary education		0.0199***	0.0208***
		[0.001]	[0.001]
College education		0.0452***	0.0384***
		[0.001]	[0.002]
Experience		0.0005***	0.0005***
		[0.000]	[0.000]
Experience ^{2} x 10^{-2}		-0.0004**	-0.0004**
		[0.000]	[0.000]
Tenure		0.0002*	0.0002
		[0.000]	[0.000]
Tenure ^{2} x 10^{-2}		-0.0001	-0.0001
		[0.000]	[0.000]
Intercept	0.0082	-0.0025	-0.0017
	[0.008]	[0.008]	[0.008]
Interaction terms	No	No	Yes (see Table 8)
F test	3717.39	3247.43	2769.48
Adjusted R-squared	0.163	0.164	0.164
Observations (number of workers)	1,771,258 (910,130)	1,771,258 (910,130)	1,771,258 (910,130)

Notes: Dependent variable is the logarithm of hourly wage. Dummies defined for the *education* and *female* variables. *Tenure* and *experience* measured in years. All regressions include *year*, *industry* and *region* dummies. Panel B of Table 8 presents the interaction coefficients of specification (3). Standard errors are in brackets. * Significant at 10%; ** significant at 5%; *** significant at 1%.

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Table 8. Interaction of entrepreneur's and worker's education, 1995-2003

Variables	Entrepreneur education		
	Nine -years education	Secondary education	College education
Panel A: New Firms (from model (3) in Table 6)			
Worker education * Entrepreneur education			
Nine -years education	-0.0224**	0.0014	-0.0886
	[0.009]	[0.015]	[0.067]
Secondary education	0.0169	-0.0024	0.0994*
	[0.011]	[0.012]	[0.056]
College education	0.0127	0.0504***	0.1680***
	[0.017]	[0.019]	[0.048]
Panel B: Worker-fixed effects (from model (3) in Table 7)			
Worker education * Entrepreneur education			
Nine-year education	-0.0014	0.0012	0.0134*
	[0.002]	[0.003]	[0.008]
Secondary education	-0.0004	-0.0037	0.0145**
	[0.003]	[0.003]	[0.007]
College education	0.0117***	0.0167***	0.0121**
	[0.003]	[0.003]	[0.006]

Notes: Dependent variable is the logarithm of hourly wage. Dummies defined for the *education* variables. See notes in Tables 6 and 7. Standard errors are in brackets. * Significant at 10%; ** significant at 5%; *** significant at 1%.

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