Economica (2001) **2001**, 45–62

The Roots of Entrepreneurship and Labour Demand: Individual Ability and Low Risk Aversion

By C. M. VAN PRAAG† and J. S. CRAMER‡

†*University of Amsterdam* ‡*Tinbergen Institute, Amsterdam*

Final version received 4 October 1999.

This paper develops a model as a means to explain business formation and the labour demand of entrepreneurs. An individual will become an entrepreneur if the expected rewards surpass the wages of employment, and the expected rewards depend on an assessment of individual ability and on risk attitude. Actual ability determines success and hence the demand for wage labour of the firm. In equilibrium these factors govern the distribution of a given workforce over entrepreneurs and employees. The model is fitted to Dutch survey data. The empirical results confirm the importance of both risk-taking and ability for successful entrepreneurship.

INTRODUCTION

> There is a far more close correspondence between the ability of business men and the size of the businesses they own than at first sight would appear probable. (Marshall 1890, 1930, p. 312)

In conditions of persistent high unemployment it is important to increase the demand for labour, and one way of doing so is to encourage the creation of new firms that hire employees. As Kaldor put it as early as 1934 in his seminal article 'The Equilibrium of the Firm', the production factor that is most important in determining the size of any (mature) firm is the coordinating ability of the entrepreneur leading the firm. There can be only one such coordinator coordinating all transactions in which the firm is involved, thereby restricting the size of the firm. The amount of all other factors of production employed is limited by the fixed supply of coordinating ability by this unique entrepreneur. In another seminal contribution, Coase (1937) argued similarly: that there are 'diminishing returns to management' in the sense of decreasing returns to scale at a given level of entrepreneurial ability.

Therefore, talented persons should be particularly encouraged to become entrepreneurs, for it is these who will contribute most to the creation of labour demand. It is this creation of labour demand that makes the choice of entrepreneurship a matter for public policy.

In this paper we consider the individual decision to become an entrepreneur as well as the ensuing firm size. Individuals who become entrepreneurs will either start a new business or purchase an existing business (as in Holmes and Schmitz 1995). Whether a member of the labour force becomes an entrepreneur or an employee depends on the associated utilities. These in turn depend on ability and on individual risk attitude, since entrepreneurship is a risky business. In the present analysis, relative risk aversion is an observed attribute of the individual. Entrepreneurial talent determines the size of the business. This talent is a function of observable characteristics.

The model owes much to the recent literature, starting with Lucas (1978), as will be shown in Section I; but various views of the entrepreneur as decision-maker, combiner of resources, risk-taker or manager are of course much older. Entrepreneurship has always been of prime concern to economists, and older writings provide a suitable backdrop to the present analysis (see van Praag 1999). We specifically name Cantillon (1755/1979), Say (1803/1971), Marshall (1890/1930), Schumpeter (1911/1934), Knight (1921/1971) and Kirzner (1973), who laid the foundations on which our model is built. The view of the entrepreneur as independent owner, decision-maker, combiner of resources and manager of the firm has been adopted by Say, Marshall and Knight. All authors (with the notable exception of Schumpeter) stress that entrepreneurs moreover bear all uncertainty or risk, in contrast to wage-earners. Our interpretation of risk, as being due to an individual's ignorance of his own abilities until they have been revealed in action, comes closest to the views of Marshall and Knight, who acknowledged that entrepreneurial ability should be backed up by good luck. All six theorists assume that potential profit, as compared with wages, is the major incentive to become an entrepreneur; and so it is in our model.

Section II describes the model, Section III the data. In Section IV we discuss the results of estimating the model on a sample of Dutch labour force participants. Section V summarizes and concludes.

I. Links with Recent Literature

In equilibrium models with full employment of a given labour force, some people become entrepreneurs and found firms that employ the others. The actual division between entrepreneurs and wage labour turns on the distribution of individual characteristics among the population. A number of such models have been developed since Lucas's (1978) seminal paper. We follow Lucas in assuming a closed economy with a given workforce that is homogeneous with respect to employee productivity. Each member of the workforce is also endowed with a specific entrepreneurial talent which varies across individuals. The workforce is first divided into entrepreneurs and employees, and the available resources are then allocated among entrepreneurs. A firm consists of the entrepreneur together with the production factors under his control. For Lucas these production factors are a given labour supply and a given quantity of homogeneous capital. However, here we must perforce assume a perfectly elastic capital supply, for the available data gives no information about capital ownership and/or investment. The entrepreneur is merely organizing the workforce.

We extend Lucas's model in one important dimension. When choosing occupations, individuals are not certain of their entrepreneurial talent: they choose the occupation that renders the highest *expected* utility, where utility is an Arrow–Pratt transformation of returns by relative risk aversion, which varies between individuals. The model in this respect resembles Kanbur's (1979) model. This is a model of occupational choice under risk between two occupations: wage-earner or employee, when a single unit of homogeneous labour is supplied and the risk-free competitive wage is received, or entrepreneur, when the individual employs labour and produces homogeneous

output according to a production function which includes the individual's entrepreneurial ability. Entrepreneurship is risky since agents do not know their own ability in advance.

In Kanbur's model, individuals apply the common (population) distribution of aptitude, and *perceived* expected ability does not vary among individuals. Here, in contrast, individual expectations of entrepreneurial talent depend on specific personal characteristics. The corresponding talent distribution is known to the individual, but the outcome is not. The actual entrepreneurial talent is an unobserved latent variable. Risk aversion, on the other hand, has been observed in the present data.

Kihlstrom and Laffont put forward a model in which individuals face the same choice between a risky entrepreneurial career or a riskless wage. They state that

> There are, of course, many factors which should influence this choice. The most important ones would include entrepreneurial ability, labour skills, attitudes toward risk, and initial access to the capital required to create a firm. The present paper focuses on risk aversion as the determinant which explains who becomes an entrepreneur and who works as a labourer. (Kihlstrom and Laffont 1979, p. 720)

Hence all these models, developed in the late 1970s, describe the division of a given workforce over the two classes of entrepreneur and wage-earner, or employer and employee. This division depends on the distribution of individual characteristics. For Lucas (1978) this is entrepreneurial aptitude, in addition to capital; for Kanbur (1979) and for Kihlstrom and Laffont (1979) the emphasis is on risk attitude with respect to entrepreneurial aptitude which is unknown until it has been proved.

There are other recent contributions to the theory of entrepreneurship which have their roots in the models discussed above. Examples are Calvo and Wellisz (1980), Jovanovic (1994), and Blanchflower and Oswald (1998). Moreover, Evans and Jovanovic (1989), Holtz-Eakin *et al.* (1994a, b) and Blanchflower and Oswald (1998) empirically estimated models that all follow Lucas by emphasizing the role of capital in addition to entrepreneurial talent.

Here we treat both risk aversion and ability as major determinants. We attempt an empirical analysis with entrepreneurial ability as a latent variable and with risk aversion observed (after a fashion) in a structural econometric model of equilibrium. This calls for several unrealistic short-cuts (one wage level, a homogeneous workforce of employees, etc.) that will become apparent as we proceed. We will therefore compare the estimation results of this 'restricted' structural model approach to reduced form results: this gives some indication about the robustness of the model estimates.

II. The Model

We establish the importance of risk attitude and entrepreneurial ability by an empirical analysis of the labour market experience of Dutch individuals, who have been interviewed three times at intervals of 30 and 10 years. We know from these interviews whether the individual has ever been an entrepreneur, and if so how many people his firm has employed, and we also have an indication of his risk attitude; the interviews moreover provide a number of

background variables at a younger age. Apart from size, little is known about the firm. This is reflected by the model specification.

The model allows for both perceived ability and risk attitude as determinants of the choice for entrepreneurship. Success, as measured by the size of the firm's workforce, depends on actual ability. For ease of exposition, we distinguish two decisions.

1. The first choice for an individual is either to start as a full time entrepreneur or to work first as a full time wage-earner. Individuals know their own risk attitude, R_i, and their person-specific *distribution* of entrepreneurial talent, θ_i. However, the precise value of entrepreneurial talent remains unknown until it is put to the test. Consequently, individuals base their first decision on known risk attitude and the relevant distribution of entrepreneurial talents.
2. The individual's actual entrepreneurial talent θ_i is revealed in practice to those who start as entrepreneurs. At the equilibrium value of the unique wage rate, entrepreneurs decide how many wage-earners to employ. This second decision determines L_i, the total workforce of each firm, including the entrepreneur. Its minimum is 1, and we assume that this value holds whenever the optimal size of the workforce would be smaller, given that the firm exists.

Distributions and specifications adopted

The individual's perception of entrepreneurial ability θ_i is distributed lognormally:

$$\log \theta_i = X_i\beta + \varepsilon_i, \tag{1}$$

where X_i is a vector of individual characteristics such as education, gender and family background. The parameter vector β will be estimated. Entrepreneurial ability is supposed to be stochastic owing to, among other factors, a yet-unknown level of good luck.

As in Kanbur's model, the operation of the economy is governed by the production function: $F(L, \theta_i) = \theta_i L^{\gamma}$, where γ is the parameter that measures the output elasticity of labour and lies between 0 and 1. With a single input, γ also indicates the returns to scale of the production process, which are assumed to be decreasing.[1]

The utility function is $U_i = y_i^{(1-R_i)}/(1-R_i)$, which implies that $R_i = -(U_i''(y)y/U_i'(y))$. R_i is the Arrow–Pratt measure of relative risk aversion, $R \neq 1$. A negative R_i indicates that i is a risk-lover, a zero R_i that i is risk-neutral and a positive R_i that i is risk-averse. Income y is either entrepreneurial profit π or the unique wage rate w. Profits are uncertain because they depend on the unknown amount of entrepreneurial ability of the individual.

A brief guide to the solution of the model

Individuals assess the potential values of labour demand and profit for the occupational choice question. Knowledge of the levels of potential labour demand, profit and the wage rate, in addition to the basic knowledge that individuals have (about the distribution of θ_i, R_i and the production and utility functions), is a sufficient basis for a proper occupational choice.

After the working population has split up into entrepreneurs and employees and an estimate of the wage rate has been formed, each entrepreneur selects the profit-maximizing size of his firm, i.e. the working force L_i, which includes the entrepreneur in addition to his employees. If the realized value of θ_i turns out to be low once the decision in favour of entrepreneurship has been made, a firm of unit size will have been started, and in such a firm the profit level can be suboptimal.[2]

In the exposition below, a circumflex indicates potential values.

Solution step 1: Calculating potential gains of entrepreneurship. All individuals consider the potential gains of entrepreneurship that they can realize. Potential profit is $\hat{\pi}_i = \theta_i \hat{L}_i^{\gamma} - w\hat{L}_i$. Output prices are normalized to unity and labour is the only scarce input, priced w. Hence, the profit maximizing workforce is

$$\hat{L}_i = \left(\frac{\gamma\theta_i}{w}\right)^{1/(1-\gamma)} \tag{2}$$

at a profit

$$\hat{\pi}_i = \left(\frac{\gamma\theta_i}{w}\right)^{1/(1-\gamma)} \left(\frac{1-\gamma}{\gamma}\right) w.$$

Since θ_i is random, so are $\hat{L}_i$ and $\hat{\pi}_i$. Solving the above system yields $\log \hat{L}_i$ and $\log \hat{\pi}_i$ as linear functions of θ_i so that they have lognormal distributions, too. The means and variances are:

for $\log \hat{L}_i$:[3]

$$\frac{1}{1-\gamma} x_i^T\beta + \frac{1}{1-\gamma}\log\left(\frac{\gamma}{w}\right), \qquad \frac{\sigma^2}{(1-\gamma)^2}, \tag{3}$$

for $\log \hat{\pi}_i$:

$$\frac{x_i^T\beta}{1-\gamma} + \frac{\gamma}{1-\gamma}\log\left(\frac{\gamma}{w}\right) + \log(1-\gamma), \qquad \frac{\sigma^2}{(1-\gamma)^2}.$$

The utility of an entrepreneur has a lognormal distribution

$$\log U_i^e \sim N(a, b^2), \tag{4}$$

where

$$a = \frac{1-R_i}{1-\gamma} X_i\beta + \frac{1-R_i}{1-\gamma}\gamma\log\left(\frac{\gamma}{w}\right) + (1-R_i)\log(1-\gamma) - \log(1-R_i);$$

$$b^2 = \left(\frac{1-R_i}{1-\gamma}\right)^2 \sigma^2$$

The utility associated with wage employment is

$$\log(U_i^w) = (1-R_i)\log w - \log(1-R_i). \tag{5}$$

Solution step 2: Choosing occupations. The entrepreneurship decision is modelled as a discrete choice, based on the (expected) utility of the alternatives. The individual is indifferent between entrepreneurship and wage employment when the utility of w and the *expected* utility of $\hat{\pi}_i$ are equal, with the expectation taken over the lognormal distribution.[4] The condition for the equality of $U(w)$ and $E(U(\hat{\pi}_i))$ (or of their logarithms) can be derived from the earlier equations, and it can be expressed in a threshold value or reservation demand for labour. Between individuals, differences in their characteristics x_i and their risk attitude R_i determine who becomes an entrepreneur and who does not; these observed variables enter into the condition that $E\log \hat{L}_i$, (which depends on x_i) exceeds the threshold set by labour reservation demand $\log c_i$, which can be derived as[5]

$$\log c_i = \frac{\sigma^2}{2(1-\gamma)^2}(R_i - 1) + \log\gamma - \log(1-\gamma). \tag{6}$$

In the empirical analysis we use $E\log \hat{L}_i > \log c_i$ as the condition for entrepreneurship.

Solution step 3: Determining firm sizes. The labour force has split up in a group of entrepreneurs and a group of employees. Employees earn w and entrepreneurs employ L_i individuals including themselves. L_i and π_i depend on the realized value of θ_i:

$$\log L_i = \frac{1}{1-\gamma}\log\theta_i + \frac{1}{1-\gamma}\log\left(\frac{\gamma}{w}\right), \tag{7}$$

$$\log \pi_i = \frac{1}{1-\gamma}\log\theta_i + \log(1-\gamma) + \frac{\gamma}{1-\gamma}\log\left(\frac{\gamma}{w}\right). \tag{8}$$

If the realized value of θ_i turns out to be less than w/γ, then, according to (7), $L_i < 1$ but the entrepreneur should operate with the suboptimal amount of labour $L_i = 1$.

Solution step 4: Determining the wage level. In equilibrium, w is such that total labour demand is equal to given aggregate labour supply of N persons,

$$\sum_{i\in I} L_i \equiv N, \tag{9}$$

where I is the group of entrepreneurs, its size endogeneously determined. Substituting the expected value of L_i in the left-hand side, we find:[6]

$$\log w = (1-\gamma)\log\left(\frac{\sum_{i\in I}\exp\left(\frac{x_i^T\beta}{1-\gamma}\right)}{N}\right) + \log\gamma + \frac{\sigma^2}{2(1-\gamma)} \tag{10}$$

for the wage level and

$$\log L_i = \frac{1}{1-\gamma}\log\theta_i - \log\left(\frac{\sum_{i\in I}\exp\left(\frac{x_i^T\beta}{1-\gamma}\right)}{N}\right) - \frac{\sigma^2}{2(1-\gamma)^2} \tag{11}$$

for individual labour demand (see the Appendix).

The model leaves little room for more realistic assumptions. There is a single wage for all employees, regardless of the hours worked and of talents and expertise.[7] Part-time employment (and part-time entrepreneurship) must be ignored since it is incompatible with the entrepreneurship decisions as an individual discrete choice. Moreover, the model does not allow for employment by public authorities or large corporations which do not owe their existence to the talents of a single individual. The solution in the empirical analysis is to restrict labour supply N effectively to persons who either are (or have been) entrepreneurs or are employed in firms with fewer than 100 employees. During the period under review, about 7% of the total Dutch labour force was in public service, over 30% in firms with more than 100 employees.

Finally, there is the apparent conflict between the optimal labour demand derived from marginal conditions and the discrete nature of the firm's work force. In equation (9) we ignore this discontinuity, and the summation must include some entrepreneurs with an optimal L_i below 1.[8]

Solution step 5: Quantifying the underestimate of L and w. All entrepreneurs for whom:

$$\theta_i < \frac{w}{\gamma}$$

TABLE 1

FREQUENCY DISTRIBUTION OF REPORTED FIRM SIZES

Size	No.	%
1	55	21
2	32	12
3	34	13
4	23	9
5–6	19	7
7–8	21	8
9–11	18	7
12–16	17	7
17–25	13	5
26–41	15	6
42–71	6	2
72 and over	5	2
Total	258	

and

$$x_i\beta \geqslant \log w - \gamma \log \gamma - (1-\gamma)\log(1-\gamma) - \frac{(1-R_i)\sigma^2}{2(1-\gamma)}$$

operate at a suboptimal level of $L_i = 1$, and a term $1 - (\gamma\theta_i/w)^{1/(1-\gamma)}$ should be added to the LHS of (9). If these terms sum to K, (9) must be amended to refer to a labour supply of $N - K$, not N, and $\log w$ from (10) differs from the correct value: in lieu of (N, w), we should have used $(N - K, w^*)$, where $w^* > w$. The effect on $\log w$ is

$$(12) \qquad (\log w - \log w^*) \sim -(1-\gamma)\,[\log N - \log(N-K)].$$

Approximate upper bounds follow from Table 1: 55, or 3% of the entrepreneurs, have firm size $L = 1$, and this is the maximum K. As the estimate of γ is 0.6, the discrepancy of the wage rate is at most 1.2%; we neglect this in what follows.

III. DATA

The data-set is unusual and deserves some attention.[9] In 1952, a survey was conducted among 5,800 children in the final grade of elementary schools in the Dutch province of Noord-Brabant, recording their ability, school performance, family background and related variables. Thirty years later these records were rediscovered, and from a search of local population registers 4,700 of the original respondents could be traced. A questionnaire was sent to all, requesting information about education, household composition, labour market status and earnings. After two reminders the remaining male non-respondents were approached by interviewers. (For financial reasons only men were interviewed, as their labour force participation rate is higher; this explains the small proportion of women in the sample.) The response rate among the 4,700 individuals located was 58% (2,700 individuals).

The same sample was interviewed (by post) for a third time in 1993. This time the objective was to complete labour market histories and in particular to gather information about entrepreneurship experiences. The intersecting sample that provides individual records for 1952, 1983 and 1993 contains almost 2,100 individuals who have ever participated in the labour force.

This rich data-set has some distinct features. First, all individuals were born in 1939 or 1940, so that the sample is homogeneous with respect to age and epoch. Second, all individuals were living in the same region, Noord-Brabant, at the age of 12. But a comparison with national statistics shows that the sample is nevertheless representative of the Netherlands: many variables related to labour force participation, industrial structure and earnings are the same as in the country as a whole. Another interesting feature is the availability of early childhood variables, such as scholastic ability and intelligence at a young age.

For present purposes, we use a subsample of 1,763 individuals; 258 of these answered 'yes' to the 1993 question 'Have you ever been self-employed in a firm that you started or purchased?' and 1,505 individuals reported that they had at any time been employed by firms having fewer than 100 employees.

Dependent variables

These are:

1. A dummy variable which is 1 for individuals who have ever been an entrepreneur and 0 otherwise; the entrepreneurs may have started a new firm, but they may also have taken over an already existing firm;
2. An integer L_i representing firm size; for employees this is 0, for entrepreneurs, it is 1 plus the answer to the 1993 question, 'What is the highest number of employees you have (ever had) in your business?' The reason for recording the maximum number of employees one has (ever) had instead of any other measure of size of staff is that this was thought to be the best available reflection of entrepreneurial talent.[10]

The vector of observed regressor variables x_j determines the systematic variation of entrepreneurial ability θ as defined in the theoretical model, and the coefficients β_j reflect their effect; it is these coefficients that are estimated in the empirical model that explains actual firm size. Occupational choice is (indirectly) affected by the same explanatory variables X_j, since it is determined by the individual comparing his or her specific expected potential firm size $\hat{L}_i$—which in turn depends on $x_i^T\beta$—to the reservation firm size c_i.

From earlier work on the empirical determinants of the choice for and success in entrepreneurship (see Blanchflower and Oswald 1998; van Praag 1996; Storey 1994), four categories of potential explanatory variables that are available in the data-set emerge:

1. *Parental background*: parents' education level, father's job level and type (self-employed or wage-earner), parental household composition and family status (as rated by the pupil's schoolteacher in 1952);
2. *IQ score*: knowledge/comprehension tests concerning school subjects, measured in 1952;
3. *Education*: level and type of each educational phase, number of phases, whether or not the pupil graduated;[11]
4. *Risk attitude*: the observed indicator of individual risk attitude R_i, which is based on the answer to the following question in the 1993 questionnaire: 'A prize of 1,000 guilders is awarded to one of ten lottery entrants. What is the maximum amount (of guilders) you would pay to participate as one of the entrants in this lottery?' The answer indicates the individual's reservation price for this lottery ticket: the average is 23.5 guilders for non-entrepreneurs and 34.5 guilders for entrepreneurs. Risk aversion R_i is measured as (1 − the answer)/100. The use of such an observed measure of individual relative risk aversion in empirical research is a novelty.[12]

A category of income data is missing. Proper information about individual (potential and reservation) wages is missing: occupational choices occur in all years between the 1950s and 1990s, whereas employee wage data are available for 1983 and 1993 only.

IV. Estimation Results

Suppose that we, as outsiders, know entrepreneurial ability θ with the same precision as the individual i in the first period of the model; i.e., suppose $\log\theta_i = X_i\beta + \varepsilon_i$, where ε is distributed as $\varepsilon \sim N(0, \sigma^2)$ (see equation (1)). Entrepreneurial ability is indirectly observed, through the firm's labour demand (see equation (11)) as:

$$\frac{1}{1-\gamma} X_i\beta - \log\left(\frac{\sum_{i\in I} \exp\left(\frac{X_i\beta}{1-\gamma}\right)}{N}\right) - \frac{\sigma^2}{2(1-\gamma)^2} + u_i,$$

where $u_i = 1/(1-\gamma)\varepsilon_i$, and therefore $u \sim N(0, \sigma^2/(1-\gamma)^2)$. However, $\log L_i$ is observed for entrepreneurs only, hence if and only if $\log L_i \geqslant \log c_i$, where

$$\log c_i = \frac{\sigma^2}{2(1-\gamma)^2}(R_i - 1) + \log\gamma - \log(1-\gamma)$$

as in equation (6).

The probability that observation i does not refer to an entrepreneur is:

$$\Pr(\log L_i < \log c_i) = \Phi\left[1 - \frac{X_i\beta}{\sigma} + \frac{1-\gamma}{\sigma}\mu + \frac{\sigma}{2(1-\gamma)}R_i + \frac{1-\gamma}{\sigma}\log\left(\frac{\gamma}{1-\gamma}\right)\right],$$

where Φ is the cumulative normal distribution, and

$$\mu = \log\left(\frac{\sum_{i\in I} \exp\left(\frac{X_i\beta}{1-\gamma}\right)}{N}\right).$$

This is all the information available about non-entrepreneurs. The information about entrepreneurs, on the other hand, is richer, since their firm size is also known. We obtain a Tobit-like loglikelihood:

$$\sum_{i\notin I} \log\Phi\left[1 - \frac{X_i\beta}{\sigma} + \frac{1-\gamma}{\sigma}\mu + \frac{\sigma}{2(1-\gamma)}R_i + \frac{1-\gamma}{\sigma}\log\left(\frac{\gamma}{1-\gamma}\right)\right]$$
$$+ \sum_{i\in I}\left[\log(1-\gamma) - \log\sigma + \log\phi\left(\log L_i - \frac{X_i\beta}{1-\gamma} + \mu + \frac{\sigma^2}{2(1-\gamma)^2}\right)\right].$$

This is the loglikelihood function that will be maximized to obtain estimates of β, γ and σ.[13]

Table 2 shows the estimates in so far as they turn out significantly different from zero.[14] The estimates $\hat{\beta}$ show how regressors shift the entrepreneurial talent distribution.

TABLE 2
ESTIMATES OF THE STRUCTURAL MODEL

Coefficient	Variable	Estimate	|t-value|
Effects on log L:			
$\frac{\beta_1}{1-\gamma}$	Female	−1.256	21.22
$\frac{\beta_2}{1-\gamma}$	IQ at age 12	0.394	2.61
$\frac{\beta_3}{1-\gamma}$	Father self-employed	0.262	3.20
$\frac{\beta_4}{1-\gamma}$	Father unskilled work	−0.713	8.40
$\frac{\beta_5}{1-\gamma}$	Father manager	0.847	5.05
$\frac{\beta_6}{1-\gamma}$	Education (1–7)	0.190	9.98
$\frac{\beta_7}{1-\gamma}$	General intermediate level	0.819	9.99
$\frac{\beta_8}{1-\gamma}$	Vocational intermediate level	1.104	13.29
$\frac{\beta_9}{1-\gamma}$	Arts-oriented education	−0.701	9.14
$\frac{\beta_{10}}{1-\gamma}$	Science-oriented education	0.107	1.66
Effect on log c:			
$\frac{\sigma^2}{2(1-\gamma)^2}$	Risk attitude	1.529	13.25
$\frac{\sigma^2}{(1-\gamma)^2}$	Variance of log L	3.057	13.25
γ		0.592	25.74
loglikelihood		−1693	

Parental background

We find that entrepreneurial talent is higher if an individual comes from an entrepreneurial family. In particular, individuals whose fathers had managerial responsibilities in their jobs turn out to be more successful entrepreneurs. Entrepreneurial talent is reduced if the father is engaged in unskilled work.

Entrepreneurship is seen as a cultural inheritance which is passed on to following generations within families (Curran and Burrows 1989). The son of an entrepreneur often experiences daily (directly or through conversation) the challenges and difficulties of the tasks of entrepreneurship and management. This may give a great opportunity to learn the specifics of entrepreneurship. Moreover, having family members involved in (or previously involved) small-business ownership and management could provide easier access to capital or other necessary assets (office or plant space, or even the business itself) for entrepreneurship. It could also lead to free consultancy, access to business networks and a good reputation with (potential) clients in the (business) community. Our results confirm, among others, those of Stanworth *et al.* (1989), Magnac and Robin (1994) and Blanchflower and Oswald (1998).

Human capital: education and intelligence

Education is found strongly to influence successful entrepreneurship. The higher an entrepreneur's educational level, the bigger are the chances of success. And on top of this general effect, we found that education to intermediate levels has an additional positive effect on success, particularly if it is vocational training. These results are found, while IQ is controlled for. Intellectual capacity itself (as measured by IQ score) has a positive influence on entrepreneurial talent.

These findings are confirmed by several studies. Pickles and O'Farrell (1987) find that Irish entrepreneurs are more highly educated than non-entrepreneurs, but that people with the highest levels of education are less likely to start out as an entrepreneurs. Storey (1994) shows the result of many empirical studies to be that educational attainment of the entrepreneur is an important positive determinant of the growth of his firm.

Not only does the level of education affect entrepreneurial talent, the type of education is influential too. Analytical skills, signalled and/or obtained through a science oriented education, seem to enhance entrepreneurial talent somewhat (only marginally significant). The most probable explanation for the negative effect of an arts-oriented type of education is that people who choose this type of education are less interested in an entrepreneurial career.

This strong effect of education is notable. For wage-earners, this is often attributed to the use of educational level attained as a screening variable for intelligence (and perhaps for some other characteristics, such as perseverance) by employers when hiring employees. An entrepreneur is not screened by an employer, but education is found equally important for entrepreneurial success (even after controlling for intelligence). We conclude that additional research is needed to find out whether the 'screening device' applies to entrepreneurs as well, in the sense that the factors that make for educational success also determine success in entrepreneurship, or whether education itself is an investment in human capital for entrepreneurs.

Risk attitude

Risk attitude enters into the model via its effect on individual reservation labour demand. The more risk-averse are individuals, the higher their reservation labour demand, and the smaller their chance of becoming an entrepreneur. We did not measure the effect of risk attitude on entrepreneurial achievement. The empirical finding that risk aversion debars people from entrepreneurship is new. However, the theoretical arguments underlying this finding are far from new. The idea has been present for a long time among both academics and practitioners of entrepreneurship, in the disciplines of economics, (small business) management and (social) psychology.

Gender

Women are clearly at a disadvantage in their achievements as entrepreneurs (confirming the results by Blanchflower and Oswald 1998). The survey refers to a generation of women, born in 1940, who had many problems in entering the labour market (Storey 1994). These problems may result from their responsibilities at home (commitments to children), which may limit their input (time and effort) in the business to an extent that it is insufficient for the business to be healthy. Their possible lack of credibility with capital suppliers, may mean that they encounter difficulties in obtaining sufficient capital to start a business. Women could as well encounter discrimination in the product market.

Overall, the determinants of successful entrepreneurship are quite similar to the usual determinants of individual wages: gender, social background, education and intelligence. Risk attitude is found to be an additional determinant.

In order to establish whether these structural estimates are at all robust, Table 3 in the Appendix gives the estimates of a reduced-form equation, viz. a standard Tobit model labour demand without further restrictions on the coefficients. On the whole, the results are quite similar. The estimates of Table 2 have hardly been affected by the theoretical parameter restrictions of the structural model.

V. Summary and Conclusion

This paper explains business formation and labour demand from risk attitude and entrepreneurial ability, where the latter is modelled as a function of individual characteristics. The resulting equilibrium model is translated into an empirical structural model which explains whether or not one starts a business and, if so, how many people one will employ. The size of the workforce is regarded as an indicator of entrepreneurial success. The estimation results pertain to a sample of Dutch individuals for whom determinants of entrepreneurial ability as well as a measure of risk aversion have been observed. Employees working in large firms are excluded from the sample.

The results can be compared to the historical literature as briefly discussed in the Introduction. We find that risk aversion is a serious impediment to entrepreneurship. This confirms the views of several authors. Cantillon

(1755/1979) stated that a successful entrepreneur should be willing to bear risk. Say (1803/1971) added that a successful entrepreneur must not have only the motivation but also the ability to bear risk. And Marshall (1890/1930) mentioned that young risk-lovers are more inclined to start as an entrepreneur than others. Our findings do not support Schumpeter's (1911/1934) idea that risk-bearing is not a task of the entrepreneur and that therefore risk attitude does not play any role.

The other results are in line with Marshall's *Principles of Economics* (1890/1930): success in entrepreneurship requires intelligence and general ability; general ability, in turn, depends on family background, education and innate ability.

The main contribution of this paper is that it confirms a number of determinants of successful entrepreneurship that have been obtained before by either theory or empirics, but in most cases not by both. To our knowledge, we use a unique measure of success (labour demand) which has some interesting policy implications compared with other measures used in the literature (e.g. duration/survival in business, profit/earnings). We assess the impact of risk attitude on the decision to start as an entrepreneur. To our knowledge, this empirical result is new and confirms almost all recent and older theories developed.

The major limitation is that the empirical analysis is based on several unrealistic assumptions: a single wage rate, homogeneous employee productivity, full-time employment only, a closed economy in which all firms owe their existence to the talents of the entrepreneur. This is a serious limitation, though the same empirical results are found by means of a simple Tobit structured empirical analysis. Second, the causality of the correlation between risk attitude and entrepreneurship is not proven, since risk attitude is measured after occupations have been chosen. We assume risk attitude to be constant over time, but we are not in a position to prove that assumption.

It is hoped that these limitations may call forth further modelling and estimation so that these unrealistic assumptions may subsequently be relaxed, or a more sophisticated empirical measure of risk attitude, may be made available.

APPENDIX

Derivation of the threshold value of labour demand, log c_i, as in equation (6)

In the first period, people choose an occupation by comparing the (expected) utility level associated with entrepreneurship to the utility they can derive from wage employment. This comparison leads to the choice for entrepreneurship whenever $EU_i^e \geqslant U_i^w$, or

(A1) $\log(EU_i^e) \geqslant \log(U_i^w)$.

EU_i^e can be derived from equation (4), using the properties of the lognormal distribution (Mood *et al.* 1986, p. 117). We then take the log of the expectation and derive

$$\log(EU_i^e) = \frac{1-R_i}{1-\gamma} X_i\beta + \frac{1-R_i}{1-\gamma}\gamma \log\left(\frac{\gamma}{w}\right)$$

$$+(1-R_i)\log(1-\gamma) - \log(1-R_i) + \frac{(1-R_i)^2\sigma^2}{2(1-\gamma)^2}.$$

The RHS of inequality (A1) is given by equation (5). Solving the inequality to find a threshold value of entrepreneurial ability, i.e. a minimum value of the expectation of own ability at which an individual is just willing to start as an entrepreneur, we obtain the inequality

$$\text{(A2)} \qquad X_i\beta \geqslant \log w - \gamma \log(\gamma) - (1-\gamma)\log(1-\gamma) - \frac{(1-R_i)\sigma^2}{2(1-\gamma)},$$

which is a necessary and sufficient condition to start as an entrepreneur. The entrepreneurial ability required is a non-decreasing function of risk aversion and of the wage rate. This expression for the threshold value of (expected) entrepreneurial ability necessary to be willing to start as an entrepreneur can be related to, if you will, a 'reservation labour demand' c_i. This means that individuals will decide to start a business if and only if their expected labour demand exceeds c_i, owing to their specific preferences as expressed by the utility function. People choose for entrepreneurship whenever $E \log \hat{L}_i \geqslant \log c_i$. The expected value of $\log \hat{L}_i$ follows from equation (3). Multiplying both sides of inequality (A2) by $1/(1-\gamma)$ and adding the term $[1/(1-\gamma)]\log(\gamma/w)$ results in an inequality of which the RHS expresses the threshold value of $E \log \hat{L}_i$, the reservation labour demand ($\log c_i$):

$$E \log \hat{L}_i \geqslant \frac{\sigma^2}{2(1-\gamma)^2}(R_i - 1) + \log\gamma - \log(1-\gamma) = \log c_i.$$

This is equivalent to condition (A1) as specified in (A2). The proportion of entrepreneurs in the population α equals the fraction of individuals for whom this inequality holds.

Derivation of the equilibrium wage rate, w, as in equation (10)

$$\sum_{i \in I} L_i \equiv N,$$

where I is the group of entrepreneurs, size equal to αN. This, together with equation (2), implies

$$\sum_{i \in I} L_i = \sum_{i \in I} \left(\frac{\gamma}{w}\right)^{1/(1-\gamma)} (\theta_i)^{1/(1-\gamma)} \equiv N.$$

And, because $E\theta_i = \exp(X_i\beta + \frac{1}{2}\sigma^2)$,

$$E \sum_{i \in I} \theta_i^{1/(1-\gamma)} = \sum_{i \in I} E\theta_i^{1/(1-\gamma)} = \sum_{i \in I} \exp\left(\frac{1}{1-\gamma} X_i\beta + \frac{\sigma^2}{2(1-\gamma)^2}\right).$$

Replacing the LHS of equation (10) by its expected value gives

$$\exp\left(\frac{\sigma^2}{2(1-\gamma)^2}\right) \sum_{i \in I} \exp\left(\frac{X_i\beta}{1-\gamma}\right) = N\left(\frac{w}{\gamma}\right)^{1/(1-\gamma)}.$$

This yields the result

$$\log w = (1-\gamma)\log\left(\frac{\sum_{i \in I} \exp\left(\frac{X_i\beta}{1-\gamma}\right)}{N}\right) + \log\gamma + \frac{\sigma^2}{2(1-\gamma)^2}.$$

TABLE 3

ESTIMATION RESULTS OF A REDUCED-FORM TOBIT MODEL

Variable	Estimate	| t-value |
Constant	−2.148	8.64
Female	−1.171	19.47
IQ at age 12	1.827	7.60
Father self-employed	0.472	5.57
Father unskilled work	−0.473	5.19
Father manager	0.973	5.90
Education (1–7)	0.155	7.81
General, intermediate level	0.802	9.74
Vocational, intermediate level	1.180	13.93
Arts-oriented education	−0.688	8.71
Science-oriented education	0.134	2.03
Risk attitude	−0.679	10.06
σ	1.171	15.49
loglikelihood	−1622	

Substituting this result for log w into equation (7), we have

$$\log L_i = \frac{1}{1-\gamma}\log\theta_i - \log\left(\frac{\sum_{i\in I}\exp\left(\frac{X_i\beta}{1-\gamma}\right)}{N}\right) - \frac{\sigma^2}{2(1-\gamma)^2}$$

for the labour demand function.

Estimation results of the reduced-form (Tobit) model

These are included in Table 3.[15]

ACKNOWLEDGMENTS

We thank David Audretsch, Gerard van den Berg, Gerard Pfann, Joop Hartog and Coen Teulings for their helpful suggestions. Comments by two anonymous referees are also gratefully acknowledged.

NOTES

1. Returns to managerial coordination are decreasing in accordance with Kaldor (1934) and Coase (1937).
2. Necessarily, in order to represent entrepreneurship as a discrete choice, the minimum workforce of a firm is 1; we cannot allow for part-time entrepreneurship (or for part-time employment).
3. There is a technical inconsistency: L_i has earlier been defined as an integer variable while the optimal (potential) workforce defined here is clearly continuous. We shall return to this issue below.
4. As in Kanbur's model, the individual is motivated by expectations on the basis of the known distribution of his unknown entrepreneurial talents; but here this distribution is not the same for all individuals, but a function of their known characteristics x_i.
5. See the Appendix.
6. *In the aggregate*, we assume that the realized value of θ (and therefore of L and π) equals its expected value. It is realized that the resulting labour demand slightly underestimates the true

labour demand, since we do not correct for the cases where the true labour demand is below 1. The underestimate is quantified below.

7. The data do not permit an analysis in which individual employee wages are included: occupational choices pertain to various years. Wage data are available for 1983 and 1993 only.
8. The non-integer outcomes of $L_i > 1$, which are assumed to be integer, are supposed to cause no serious problem estimation errors: over- and underestimates most probably cancel each other out.
9. It has earlier been used (and described) by van Praag (1996).
10. For entrepreneurs who were still in business in 1993, the recorded number is of course the minimum of the maximum size they had ever attained.
11. Blanchflower and Oswald (1998) omit variables related to schooling because of their potential endogenous character. We include these variables as explanatory regressors in the model, as do more researchers of occupational choice, assuming that schooling decisions by pupils are hardly influenced by the later decision of whether to become employed or self-employed.
12. We thank Joop Hartog for this idea. Obviously, the fact that risk attitude is assessed in an interview, in most cases many years after the entrepreneurship decision has been taken, is a disadvantage. While we use the reported variable in retrospect to explain the entrepreneurship decision, the true causality between the two is unclear.
13. As I is endogenous, a manual iteration procedure was used to substitute μ in the likelihood function. Starting from an arbitrary value, iterations proceeded until the calculated μ was equal to the input value.
14. Variables that were found insignificant are: parental education level, family status and parental household composition; skills, as measured by knowledge and comprehension tests while in school; education attained, (number of years completed).
15. The point of truncation 0. R_i, risk attitude, is included as a simple regressor; since we here establish its effect on labour demand, not on reservation labour demand, this should be reversed in sign. Otherwise the results are directly comparable to those of Table 2. The loglikelihood of the Tobit model is higher than of the structural model. But since the two models are not nested the LR test does not apply.

REFERENCES

BLANCHFLOWER, D. G. and OSWALD, A. J. (1998). What makes an entrepreneur? *Journal of Labour Economics*, **16**, 26–60.

CALVO, G. and WELLISZ, S. (1980). Technology, entrepreneurs and firm size. *Quarterly Journal of Economics*, **95**, 663–78.

CANTILLON, R. (1755/1979). *Essai sur la nature du commerce en general*, ed. T. Tsuda. Tokyo: Kinokuya.

COASE, R. H. (1937). The nature of the firm. *Economica*, n.s., **4**, 386–405.

CURRAN, J. and BURROWS, R. (1989). *Enterprise in Britain: A National Profile of Small Business Owners and the Self Employed.* London: Small Business Research Trust.

EVANS, D. S. and JOVANOVIC, B. (1989). An estimated model of entrepreneurial choice under liquidity constraints. *Journal of Political Economy*, **97**, 808–27.

HOLMES, T. J. and SCHMITZ, A. (1995), On the turnover of business firms and business managers. *Journal of Political Economy*, **103**, 1005–38.

HOLTZ-EAKIN, D., JOULFAIAN, D. and ROSEN, H. S. (1994a). Entrepreneurial decisions and liquidity constraints. *Rand Journal of Economics*, **25**, 334–47.

——, —— and —— (1994b). Sticking it out: entrepreneurial survival and liquidity constraints. *Journal of Political Economy*, **102**, 53–75.

JOVANOVIC, B. (1994) Firm formation with heterogeneous management and labour skills. *Small Business Economics*, **6**, 185–91.

KALDOR, N. (1934). The equilibrium of the firm. *Economic Journal*, **44**, 60–76.

KANBUR, S. M. (1979). Of risk taking and the personal, distribution of income. *Journal of Political Economy*, **87**, 760–97.

KIHLSTROM, R. E. and LAFFONT, J. J. (1979). A general equilibrium entrepreneurial theory of new firm formation based on risk aversion. *Journal of Political Economy*, **87**, 304–16.

KIRZNER, I. M. (1973). *Competition and Entrepreneurship.* Chicago: University of Chicago Press.

KNIGHT, F. H. (1921/1971). *Risk, Uncertainty and Profit*, ed. G. J. Stigler. Chicago: University of Chicago Press.

LUCAS, R. E. (1978). On the size distribution of business firms. *Bell Journal of Economics*, **9**, 508–23.

MAGNAC, T. and ROBIN, J.-M. (1994). An econometric analysis of labour market transitions using discrete and tenure data. *Labour Economics*, **1**, 327–46.
MARSHALL, A. (1890/1930). *Principles of Economics*. London: Macmillan.
MOOD, A. M., GRAYBILL, F. A. and BOES, D. C. (1986). *Introduction to the Theory of Statistics*, 3rd edn. New York and London: McGraw-Hill.
PICKLES, A. R. and O'FARRELL, P. N. (1987). An analysis of entrepreneurial behaviour from male work histories. *Regional Studies*, **21**, 425–44.
SAY, J.-B. (1803/1971). *A Treatise on Political Economy, or the Production, Distribution and Consumption of Wealth*. New York: Augustus M. Kelley.
SCHUMPETER, J. (1911/1934). *The Theory of Economic Development*. Cambridge, Mass.: Harvard University Press.
STANWORTH, J., BLYTHE, S., GRANGER, B. and STANWORTH, C. (1989). Who becomes an entrepreneur? *International Small Business Journal*, **8**, 11–22.
STOREY, D. J. (1994). *Understanding the Small Business Sector*. London and New York: Routledge.
van PRAAG, C. M. (1996). *Determinants of Successful Entrepreneurship*. Amsterdam: Thesis Publishers.
—— (1999). Some classic views on entrepreneurship. *De Economist*, **147**, 311–35.