An Estimated Model of Entrepreneurial Choice under Liquidity Constraints

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Is the capitalist function distinct from the entrepreneurial function in modern economies? Or does a person have to be wealthy before he or she can start a business? Knight and Schumpeter held different views on the answer to this question. Our empirical findings side with Knight: Liquidity constraints bind, and a would-be entrepreneur must bear most of the risk inherent in his venture. The reasoning is roughly this: The data show that wealthier people are more inclined to become entrepreneurs. In principle, this could be so because the wealthy tend to make better entrepreneurs, but the data reject this explanation. Instead, the data point to liquidity constraints: capital is essential for starting a business, and liquidity constraints tend to exclude those with insufficient funds at their disposal.

I. Introduction

Do liquidity constraints hinder people from starting businesses? The answer to this question is important for several reasons. First, liquidity

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constraints may explain the finding by Evans and Leighton (1989) that the hazard into self-employment is constant in age.[1] This finding is not consistent with the occupational choice stories told by Johnson (1978), Jovanovic (1979), and Miller (1984), which imply that individuals will try riskier occupations such as entrepreneurship when they are younger. But entrepreneurship may in fact not be an option for younger workers because they will have had less time to build up the capital needed to start a business and, with liquidity constraints, will have difficulty borrowing enough start-up funds.

Second, the belief that capital markets do not provide adequate funds for new businesses is one of the rationales for government assistance programs to small business.[2] The U.S. Small Business Administration provides subsidized loans and loan guarantees to small businesses for start-up and expansion. Great Britain, France, Belgium, and the Netherlands have recently adopted financial assistance programs for unemployed workers who start businesses (see Bendick and Egan 1987). The U.S. Department of Labor plans to conduct an experiment in which a sample of unemployment insurance recipients will be given the option of receiving business start-up funds instead of unemployment benefits (see U.S. Department of Labor 1988).

Third, the liquidity constraint is central to the dispute between Frank Knight and Joseph Schumpeter over the nature of entrepreneurship. Knight (1921) argues that bearing risk is one of the essential characteristics of entrepreneurship.[3] He apparently recognizes that capital markets provide too little capital to entrepreneurs because of moral hazard and adverse selection problems (see LeRoy and Singell 1987). Consequently, entrepreneurs must finance themselves and bear the risk of failure. Schumpeter (1934, 1950), on the other hand, argues that the functions of the entrepreneur and the capitalist are quite separate:[4] The role of the entrepreneur is to identify arbitrage opportunities in the economy, while modern capital markets generally enable him to find a capitalist to bear the risks for him.[5]

[1] Data from the National Longitudinal Survey of Young Men indicate that the probability of entering self-employment is independent of both age and labor market experience for men who are under 40. Data from a much larger sample of individuals from the *Current Population Survey* indicate that the probability of entering self-employment is independent of age for those under 50.

[2] This is not to say that these programs are cost effective. As far as we know, there is no evidence on whether the Small Business Administration loan programs are efficient. Bendick and Egan (1987) suggest that the unemployment programs may not be efficient.

[3] See Kanbur (1979) and Kihlstrom and Laffont (1979) for models based on Knight.

[4] This view continues among the Austrians (see Kirzner 1973).

[5] For example, Schumpeter (1934, p. 77) says that "most economists up to the time of the younger Mill failed to keep capitalist and entrepreneur distinct because the manufacturer of a hundred years ago was both; and certainly the course of events since then

This paper examines the importance of liquidity constraints by estimating a model of entrepreneurial choice in which the tightness of the liquidity constraint is a parameter. People have endowments of entrepreneurial ability and assets that may be correlated. The financial capital that they can devote to a business is a multiple of these assets. This multiple is a measure of the degree of liquidity constraints. In Section II we present the model and discuss evidence for our assumption that individuals face an L-shaped liquidity constraint.

The model is estimated with data on roughly 1,500 white males who were wage workers in 1976 and either wage workers or self-employed workers in 1978. The data were drawn from the National Longitudinal Survey of Young Men. After discussing the data, in Section III we report reduced-form results and other evidence consistent with the model.

We present maximum likelihood estimates of the structural parameters of the model in Section IV. The key parameters are the degree of the liquidity constraint, the returns to capital in entrepreneurship, the mean and variance of the distribution of entrepreneurial ability in the population, and the correlation between entrepreneurial ability and assets. It is important to note that we find that a person cannot use more than 1.5 times his or her initial assets for starting a new venture. Thus we reject Schumpeter in favor of Knight: Most individuals who enter self-employment face a binding liquidity constraint and as a result use a suboptimal amount of capital to start up their businesses. Further work is needed to find out if these structural estimates are robust to alternative specifications and samples. Moreover, our findings have no normative implications without added assumptions on why liquidity constraints are there in the first place.

In Section V we summarize the results and present suggestions for further research. While we focus on liquidity constraints, we make several contributions of more general interest. First, we estimate the parameters of the entrepreneurial ability distribution, which we find to be nondegenerate. Thus we confirm Knight's conjecture (1921)—recently elaborated on by Lucas (1978) and Jovanovic (1982)—that one of the key determinants of entrepreneurship is the distribution of "business acumen" in the population. To our knowledge, this paper reports the first structural estimates of the distribution of this key parameter.

Second, the selection problem analyzed in this paper is not stan-

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has facilitated the making of this distinction." He notes that the entrepreneur and the capitalist are sometimes one and the same. But in his extensive discussions of the relationship between the entrepreneur and the capitalist, he shows no awareness that market forces might require the entrepreneur to be his own capitalist.

dard and may have applications in other areas. The interaction of selecuon on ability and liquidity constraints gives rise to a complicated set of selection conditions for which we derive the likelihood function. A similar problem would arise in, for example, the demand for durables with heterogeneous consumers subject to liquidity constraints.

II. The Model

The model is static. At the start of the period, the individual must decide whether to work for himself (i.e. become an entrepreneur) or continue to work for someone else (i.e. remain a wage worker). At the end of the period, self-employment opportunity will yield him a gross payoff equal to y, while wage work will yield him a wage of w. We assume away unemployment or withdrawal from the labor force.

A person takes up self-employment if his expected net income is higher there. Otherwise he chooses wage work. The wage equation is

$$w = \mu x_1^{\gamma_1} x_2^{\gamma_2} \xi. \tag{1}$$

Here x_1 is the person's previous experience as a wage worker, x_2 is his education, μ is a constant, and ξ is a disturbance whose logarithm has variance σ_ξ^2, independent across workers. Entrepreneurial earnings are[6]

$$y = \theta k^\alpha \epsilon. \tag{2}$$

Here θ is "entrepreneurial ability," k is the amount of capital invested in the business, ϵ is a lognormal disturbance whose logarithm has variance σ_ϵ^2, independent across entrepreneurs, and $\alpha \in (0, 1)$.[7] An abler entrepreneur has a higher total product and a higher marginal product of capital at all levels of capital. This restriction on the relationship between average and marginal products over entrepreneurs can be found in Lucas (1978) and Jovanovic (1982). It is consistent with the empirical finding that *total profits* increase with firm size when the latter is measured by assets.[8]

[6] Two exogenous observables were included in the wage equation but not in the entrepreneurial earnings equation; see the last paragraph of app. C (available from the authors).

[7] We assume that $E(\epsilon) = 1$ so that $E[\log(\epsilon)] = -\sigma_\epsilon^2/2$. The disturbance term ϵ reflects an independent and identically distributed productivity shock.

[8] Most studies of the relationship between firm size and the rate of return find that the rate of return either increases with firm size or is constant in firm size. See Scherer (1980) for a review of studies. Therefore, total profits must increase with firm size. A potentially important assumption here is that θ and μ are uncorrelated. We tried to model the case in which they are correlated but found that the resulting model was analytically intractable. A correlated θ and μ should not affect the theoretical implications of the model, although it would affect the characteristics of the constrained entrepreneurs and the likelihood estimates. If θ and μ were positively (negatively) correlated, we would expect that liquidity constraints would be less (more) empirically

Now a word about ϵ. This is the unforeseen component of his income from choosing to become an entrepreneur. Its time-series properties are, strictly speaking, of no import for the analysis. It could, for instance, be a permanent component that affects the entrepreneur's productivity for as long as he is self-employed, or it could represent an independent and identically distributed disturbance to his productivity over time. If ϵ did have a permanent component, revealed only ex post, then we would have a theory of exit as in Jovanovic (1982). The present paper will not explore this intuition any farther because of the great complexity that it would impose on the empirical analysis.

An entrepreneur's net income is

$$y + r(z - k). \tag{3}$$

Here r is *one plus* the rate of interest, and z is the entrepreneur's beginning-of-period wealth. If $z < k$, the entrepreneur is a net borrower, and $r(z - k)$ is the amount he repays at the end of the period. He cannot default, no matter how his business turns out. The latter assumption is not too implausible if people can borrow only a limited amount or have to put up collateral (as indeed appears to be the case as discussed below).[9] We shall assume that each person can borrow up to an amount that is proportional to his wealth; the factor of proportionality is denoted by $\lambda - 1$. Since the amount borrowed cannot exceed $(\lambda - 1)z$, the most that a person can invest in the business is $z + (\lambda - 1)z = \lambda z$.[10] The entrepreneur therefore faces the constraint

$$0 \leq k \leq \lambda z, \tag{4}$$

important. Entrepreneurs will tend to be high- (low-) wage people who are more (less) likely to have accumulated sufficient start-up funds. The results below provide some evidence that entrepreneurs may be relatively poor wage workers. The argument is that individuals who have accumulated a lot of assets will tend to be relatively good wage workers. Therefore, assets can be viewed as a proxy for wage ability. We find that entrepreneurial ability and assets are negatively correlated, which suggests that entrepreneurial and wage ability may be negatively correlated.

[9] The default rate among business exits appears to be fairly small. In 1976 the fraction of all concerns that defaulted was one-third of 1 percent. While comparable estimates on exits are not available, Evans (1987*b*) found that about 21 percent of manufacturing firms exited between 1976 and 1981, for an annual exit rate of about 4 percent per year. His sample was weighted toward larger manufacturing firms. The exit rate of all firms is likely to be higher.

[10] In a more realistic model, λ would depend not only on z but also on observed characteristics, x, since the latter affect y and, hence, the probability of repayment. Ando (1985) finds, e.g., that, for established businesses, the probability of having a loan application accepted increases with the amount of business experience of the applicant, the size of the firm, and the past credit record of the firm. These factors are probably less important for the new businesses considered here since most people starting a business have no previous business experience or credit history. Nevertheless, in future work it would be useful to explore whether the liquidity constraint and the interest rate depend on demographic characteristics.

where the parameter λ satisfies

$$\lambda \geq 1, \tag{5}$$

and it is equal for everyone. The constraint tells us the maximum amount of capital that the entrepreneur can control. The interest factor, r, is also equal for everyone. Moreover, for simplicity we assume that the lending rate equals the borrowing rate.[11]

This form for the liquidity constraint is analytically convenient. Moreover, evidence indicates that the liquidity constraint facing businesses is similar to the L-shaped constraint (4). Ando (1985, p. C.5) finds that most new businesses are likely to face even more severe constraints:[12] "Several conclusions emerge from these studies. One is the critical role of personal savings and loans from friends and relatives, particularly in business formation. It is by far the largest source of capital in new firms and in firms beginning to grow. Once the firm is established, the role of personal savings diminishes as institutional investors perceive less risk and become more willing to provide capital." A study by Scott and Dunkelberg (cited by Ando) for the National Federation of Independent Businessmen found that firms that had been in existence for less than 4 years reported that, on average, only 50 percent of their initial loan request was met. These findings suggest that new businesses are liquidity constrained and that the amount of capital available to them is limited by their personal assets.[13]

[11] The assumption of a constant interest rate is at least a crude approximation to reality. A significant portion of loan applications are rejected, and many new businesses claim difficulty in obtaining financing (see below). This suggests that the supply curve of capital is not upward sloping over a wide range. Banks do not appear to fine-tune risk premia to individual borrowers. For a theoretical discussion of credit rationing, see Stiglitz and Weiss (1981). For a recent study of consumer credit rationing, see Mariger (1987), who finds that almost 20 percent of his sample of families were liquidity constrained. Loans from friends and relatives may be one means to evade the liquidity constraint. There is some evidence, e.g., that the entrepreneurial success of some immigrant groups is due to their access to capital from family and communal networks. Koreans, e.g., participate in rotating credit associations for business start-ups. See Light (1972) for a discussion. Among the established male business owners surveyed by Ando (1985), loans from friends and relatives constituted about 10 percent of the start-up capital, while bank loans constituted about 41 percent.

[12] She reports that, of loans taken in the previous three years, 40 percent required personal collateral and 39.5 percent required business collateral. Although there is some ambiguity, if loans required either personal or business collateral, then 80 percent of the loans would have required some collateral. Of loans that had been rejected, 70.8 percent required personal collateral and 64.5 percent business collateral.

[13] Ham and Melnik (1987) find evidence of liquidity constraints even for firms much larger than those considered here. They report that most credit agreements place an upper limit on borrowing and that about 20 percent of the firms in their sample reached the maximum amount of their commitment size. See their discussion for an alternative interpretation, however.

The Entrepreneur's Investment Decision

At the time that the investment decision is made, the entrepreneur cannot foretell the realization of ϵ, although he does know θ. Under the assumption that he is risk neutral, his investment decision, k, solves

$$\max_{k\in[0,\lambda z]} [\theta k^{\alpha} + r(z - k)]. \tag{6}$$

At an interior maximum, the first-order condition is

$$\theta\alpha k^{\alpha-1} - r = 0, \tag{7}$$

which leads to the solution

$$k = \left(\frac{\theta\alpha}{r}\right)^{1/(1-\alpha)}, \tag{8}$$

which is valid as long as the right-hand side is no greater than λz. When the latter is true, we say that the entrepreneur is not constrained with respect to how much he can borrow, or is simply "unconstrained." For the entrepreneur to be unconstrained, his θ must satisfy

$$\theta \leq (\lambda z)^{1-\alpha}\frac{r}{\alpha}. \tag{9}$$

Otherwise he is constrained.

Since our data do not contain precise enough information on how much is invested, we shall substitute out from the entrepreneurial earnings equation (2) the optimal capital invested (as given by [8] for the unconstrained and by λz for the constrained). This leads to the following expression for entrepreneurial income:

$$y = \begin{cases} \theta^{1/(1-\alpha)}\left(\dfrac{\alpha}{r}\right)^{\alpha/(1-\alpha)}\epsilon & \text{if } \theta \text{ satisfies (9)} \\ \theta(\lambda z)^{\alpha}\epsilon & \text{otherwise.} \end{cases} \tag{10}$$

Clearly, if θ satisfies (9), y does not depend on z. If, on the other hand, θ does not satisfy (9), then $\partial y/\partial z = \alpha y/z$ and $\partial y/\partial\theta = y/\theta$, so that the slope of the indifference curves in figure 1 is $d\theta/dz|_{y\,\text{const}} = -\alpha\theta/z$.

Selection into Entrepreneurship

The would-be entrepreneur, we assume, knows θ *before* he commits himself on whether to start a business. In this we deviate from Jovanovic (1982) and instead follow Lucas (1978). Since the individual knows his θ, he will choose to start a business if and only if his ex-

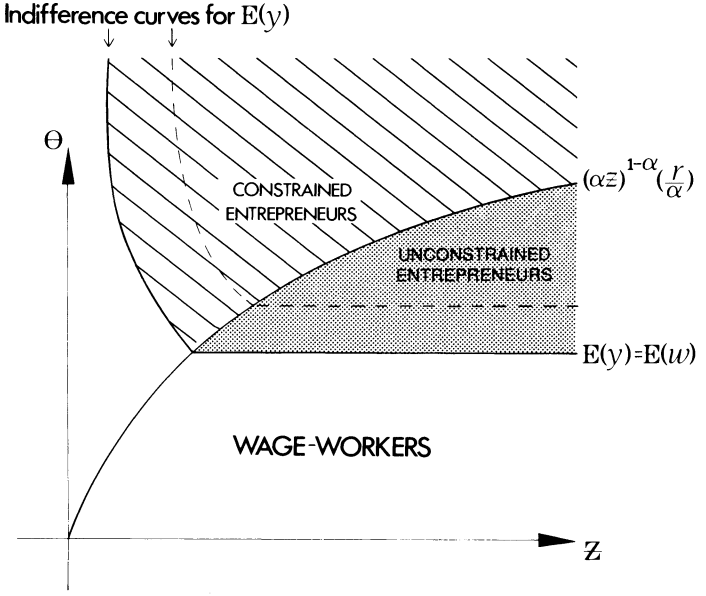

FIG. 1.—Nature of the selection into entrepreneurship

pected net income from doing so exceeds that from wage work:

$$\max[\theta k^{\alpha} + r(z - k)] \geq \mu x_1^{\gamma_1} x_2^{\gamma_2} + rz. \tag{11}$$

Since the left-hand side of (11) increases with θ while the right-hand side does not, we have the following proposition.

PROPOSITION 1: A person with characteristics (θ, z, x) chooses entrepreneurship if $\theta \in (f(z, x), \infty)$, where $f(z, x)$ is the value of θ that solves (11) as an exact equality.

That higher-θ people select into entrepreneurship and that the preferred region in θ-space is a half-open interval is a property that does not depend on the nature of the production function. All that matters is that output is increasing in θ at all levels of the capital stock. On the other hand, the shape of the three regions in figure 1 depends on our assumption that an increase in θ raises the marginal product of capital everywhere. That is, k and θ are gross complements.

Canceling the term rz from both sides of (11) and substituting the optimal k (from [8] for the unconstrained and from λz for the constrained) leaves us with the following *selection conditions*: (1) Equation (9) holds and

$$\theta^{1/(1-\alpha)}\left(\frac{\alpha}{r}\right)^{\alpha/(1-\alpha)} - r\left(\frac{\alpha}{r}\right)^{1/(1-\alpha)}\theta^{1/(1-\alpha)} \geq \mu x_1^{\gamma_1} x_2^{\gamma_2},$$

or (2) equation (9) does not hold and $\theta(\lambda z)^{\alpha} - r\lambda z > \mu^{\gamma}$. Appendix B (available from the authors on request, together with apps. A and C) shows that selection conditions 1 and 2 are equivalent to the following selection conditions:

$$\mu^{1-\alpha}\left(\frac{r}{\alpha}\right)^{\alpha}(1-\alpha)^{\alpha-1}x_1^{\gamma_1(1-\alpha)}x_2^{\gamma_2(1-\alpha)} \leq \theta \leq (\lambda z)^{1-\alpha}\left(\frac{r}{\alpha}\right) \quad (1')$$

or

$$\theta > \max\left[(\lambda z)^{1-\alpha}\left(\frac{r}{\alpha}\right), \mu x_1^{\gamma_1}x_2^{\gamma_2}(\lambda z)^{-\alpha} + r(\lambda z)^{1-\alpha}\right]. \quad (2')$$

If θ satisfies either constraint, the individual chooses self-employment. The complicated nature of these constraints stems from the wealth constraint on investment. The special case of *no* wealth constraints obtains when $\lambda = \infty$. Then the right-hand side of condition 2′ is ∞ as is the right-hand side of condition 1′, so that the selection rule takes on a simple one-sided form. Figure 1 shows the nature of the selection.

The Joint Distribution of θ *and* z

Since θ and z may be correlated in the population, we take the following steps to control for this. The parameter θ is assumed to be independent of everything except possibly z. We write

$$\ln \theta = \delta_0 + \delta_1 \ln z + \eta, \quad (12)$$

where $\eta \sim N(0, \sigma_\eta^2)$, so that $\ln \theta \sim N(\delta_0 + \sigma_1 \ln z, \sigma_\eta^2)$.

We shall not dwell too long on δ_1—the parameter determining the population correlation between θ and z. It may reflect greater past savings by those high-θ people who, knowing their θ, expected to become entrepreneurs one day. Or, if we stretch the interpretation a bit, it may reflect lower absolute risk aversion of wealthy people, making them more inclined to become entrepreneurs (as in Kihlstrom and Laffont [1979]).[14] Whatever the source of the correlation between θ and z, the parameter δ_1 will not, in general, be invariant to changes in other parameters of the model. We include it so as to avoid interpreting the apparent correlation between z on the one hand and entrepreneurial choice and success on the other as being caused entirely by the presence of liquidity constraints: A positive δ_1 would imply that, even in the absence of liquidity constraints (i.e., $\lambda = \infty$), wealthier people would be more likely to become entrepreneurs sim-

[14] We thank Larry Samuelson for this interpretation.

ply because of a "spurious" correlation between z and the unobservable θ. As it turns out, we find no evidence that δ_1 is positive.[15]

III. The Data and Reduced-Form Results

We use data from the National Longitudinal Survey of Young Men (NLS) to estimate the structural parameters of the model. This survey consists of a sample of 5,225 men who were between the ages of 14 and 24 in 1966 and who were queried periodically between 1966 and 1981. Individuals reported net family assets, the key variable for our purposes, in 1971, 1976, and 1981. We look at a subsample of 1,949 white males who were wage workers in 1976, who either were wage workers or were self-employed in 1978, and who were not unemployed, out of the labor force, in the military, or in school full-time in either 1976 or 1978.[16] Of these individuals, 89 (4.5 percent) entered self-employment. Unfortunately, we lost a number of other individuals who failed to report information we needed. Asset and income variables were often missing. For the maximum likelihood analysis we also had to delete some individuals who reported negative net worth or negative self-employment income (since we take the logs of these variables), leaving us with 1,443 white men for the actual estimation. Given that this subsample consists of less than half of the 3,918 white males who started in the survey in 1966, our results may not be representative of the population at large. For the reduced-form results reported below, we include all individuals for whom the relevant information is available. Table 1 reports variable definitions, summary statistics, and sample selection. Further details are discussed in Evans and Leighton (1987).

The men in our sample were between the ages of 24 and 34 in 1976. This age range covers a portion of the life cycle during which a large proportion of the men who will eventually become self-employed make the transition. According to *Current Population Survey* data, approximately 2.5 percent of 21–25-year-old males were self-

[15] In fact, δ_1 is negative and statistically significant. This result suggests that high-asset people tend to be relatively poor entrepreneurs. But it is also possible that this is a sign that the model is misspecified. Some of the results for the model with δ_1 negative are implausible, as we discuss below.

[16] Note that we have eliminated workers who were unemployed in 1976. Ongoing work by Evans and Leighton finds that unemployed workers are about twice as likely to switch into self-employment than other workers. A few of the individuals in our sample, however, did experience spells of unemployment between the 1976 and 1978 survey weeks and were not eliminated. Of the entrants, six (10 percent of the 59) experienced some unemployment, and of the nonentrants, 97 (7 percent of the 1,384 nonentrants) experienced some unemployment. In the reduced-form results reported below, we included a dummy variable for workers who experienced some unemployment between survey weeks but found that it had no substantive effect on the results.

TABLE 1

DEFINITION OF VARIABLES

Name	Mean (Standard Deviation)	Definition
Enter	.0409 (.2022)	Equals 0 if wage worker in 1976 and 1978 survey weeks and 1 if wage worker in 1976 survey week and self-employed in 1978 survey week; defined only for individuals who were employed in both survey weeks and who were not full-time students
Assets	20.0092 (50.0533)	Net family assets in 1976 survey week (in thousands of dollars)
Income	17.6553 (19.1731)	Individual wage earnings in 1978 for wage workers and individual self-employment earnings in 1978 for self-employed workers (in thousands of dollars)*
Work experience	11.9959 (12.5343)	Years of wage experience as of 1978 survey week†
Education	13.9390 (14.1546)	Years of education as of 1978 survey week

NOTE.—Data drawn from the National Longitudinal Survey of Young Men, 1966–81. The initial sample size consisted of 3,918 white young men aged 14–24 in 1966. Data were available for 2,536 in both 1976 and 1978. Of these men, 1,986 were employed in both survey weeks and were not enrolled in school full-time. The resulting sample consisted of 126 entrants and 1,860 nonentrants on the basis of the self-employment indicator variable available from the NLS. Of the 126 entrants, 37 were deleted because in 1978 they reported having been self-employed more than 2 years. Most of the deletions were incorporated self-employed who apparently reported themselves as wage workers in 1976 even though they were running their own businesses. Approximately 110 individuals had missing asset data, and 60 individuals had missing income data. The maximum likelihood estimation also deleted individuals who reported nonpositive assets or self-employment earnings.

* Two adjustments were made to self-employment income: (1) Some individuals who run incorporated businesses report self-employment income as wage and salary income. If an individual was incorporated, reported no self-employment income, and reported wage and salary income, we used his wage and salary income in place of self-employment income. (2) For individuals who had operated their businesses for less than a year (as measured by tenure as of the 1978 survey week), we prorated self-employment income by the length of time in business to obtain an estimate of annual self-employment earnings.

† Wage experience accumulated from 1966. An estimate of pre-1966 job experience was used for workers who had jobs prior to the start of the survey. See app. A to Evans and Leighton (1987) for details.

employed, 5.7 percent of 26–30-year-old males, 9.0 percent of 31–35-year-old males, and 11.2 percent of 36–40-year-old males. The population fraction of self-employment remains fairly constant between age 40 and retirement age.[17]

In 1978 the average self-employed man in our sample earned $15,746 compared with $16,760 for wage earners. The average increase in earnings was smaller for those who switched into self-employment than for those who remained wage workers.[18] Of the 89

[17] These results are based on averages for 1976–86. See Evans and Leighton (1987) for details on the data and Evans and Leighton (1989) for a discussion of the dynamics of changes in the stock of self-employed workers over the life cycle.

[18] A possible reason for the discrepancy is that self-employment income gets more favorable tax treatment.

TABLE 2

ESTIMATED PROBABILITY OF ENTERING SELF-EMPLOYMENT: REDUCED-FORM RESULTS, 1976–78

	PROBIT ESTIMATES*	
VARIABLE	(1)	(2)
Assets	.0053	.0075
	(.0282)	(.0032)
Assets^2/100	−.0010	−.0015
	(.0008)	(.0011)
Wage experience	.0248	.0320
	(.0144)	(.0148)
Education	−.0128	−.0038
	(.0163)	(.0174)
Married	−.4799	−.4491
	(.1162)	(.1183)
Urban	−.1511	−.0879
	(.1124)	(.1166)
Handicapped	−.1376	−1730
	(.2131)	(.2152)
Wage income in 1976/1,000	...	−.0222
		(.0104)
Constant	−1.3915	−1.3991
	(.3057)	(.3143)
Log likelihood	−330.0562	−327.4762
Observations	1,839	1,835

NOTE.—Standard errors are in parentheses.

* The F-statistic for assets and assets^2 was 2.24 (p-value of .0107) for the regression in the first column and 3.64 (p-value of .0264) in the second column.

individuals who switched into self-employment, 20 percent formed incorporated businesses.

Before we estimate the structural parameters of the model, it is useful to consider some simple tests of the model. If one assumes a zero correlation between assets and entrepreneurial ability, our model has two implications. First, there is a positive correlation between the probability of starting a business and assets *if and only if* there are liquidity constraints: Such constraints mean that a wealthier person can start a business with a more efficient capital level and thereby realize a greater return than a poorer one. Table 2 reports probit estimates of the relationship between the probability of entering self-employment and initial assets. The estimates in the first column control for education, experience, and several demographic characteristics. The effect of assets on the probability of starting a business is positive (at the sample mean) and is statistically significant at the 10 percent level. The estimates in the second column also condition on wage earnings in the previous period. The effect of

TABLE 3

ESTIMATED EFFECT OF LOG ASSETS ON LOG SELF-EMPLOYMENT EARNINGS: REDUCED-FORM RESULTS

VARIABLE	REGRESSION ESTIMATES	
	1978	1981
Log assets	.1424	−.0683
	(.0538)	(.1239)
Log experience	.2290	1.0010
	(.3534)	(1.0273)
Log education	−.3344	.4627
	(.5589)	(1.1865)
Married	−.1422	.1532
	(.2694)	(.5536)
Urban	−.0054	.2044
	(.2059)	(.4828)
Handicapped	.9884	−.9083
	(.5423)	(1.0332)
Constant	8.8066	1.2021
	(3.1708)	(8.6413)
R^2	.2267	.0806
F-statistic	2.54	.45
Observations	59	37

NOTE.—Dependent variable is log self-employment earnings. Semilog regressions yielded qualitatively similar results. Standard errors are in parentheses.

assets on the probability of starting a business is positive (at the sample mean) and is statistically significant at the 2 percent level.[19]

The second implication is that the correlation between entrepreneurial earnings and initial assets is positive since wealthier people will have started businesses with more efficient capital levels. Table 3 reports regression estimates that show a statistically significant positive correlation between log self-employment earnings and log assets after controlling for education, experience, and several demographic characteristics.[20]

A third implication is that people with smaller assets will be forced to devote a larger proportion of their assets to their businesses. Ando (1985) estimates that a 10 percent increase in assets leads to a 4 percent increase in the amount of personal savings devoted to a business. Thus poorer individuals do devote a larger proportion of their wealth to their businesses, just as our model implies.

Although the model is static, it suggests several dynamic implications. Constrained firms will start with a suboptimal amount of capital and therefore will be smaller than unconstrained firms. As a result,

[19] Evans and Leighton (1989) report similar results for 1980–81.

[20] We obtain similar results using a semilog regression and using only levels.

constrained businesses will have a greater tendency to reinvest earnings back into the business than unconstrained firms since the return on capital invested in the business is higher for the constrained firms. Therefore, smaller firms will grow faster than larger firms that entered at the same time. Evans (1987*a*, 1987*b*) and Dunne, Roberts, and Samuelson (1987) confirm that smaller firms do indeed grow faster than larger firms when business age and other characteristics are held constant.[21]

As firms grow over time, the importance of the initial liquidity constraint will diminish. We have checked this implication by comparing the effect of initial (1976) assets on entrepreneurial earnings in 1978 and 1981. The results reported in table 3 are consistent with the diminishing importance of assets over time.[22] The elasticity of earnings with respect to initial assets is positive and statistically significant for 1978 and negative and highly insignificant for 1981. This suggests that assets are not acting as a proxy for entrepreneurial ability, whose effect should persist over time.[23]

Recent attempts to subsidize small business start-ups by unemployed workers also provide some weak evidence for our model. Relaxing binding liquidity constraints by providing unemployment benefits in a lump sum or otherwise providing start-up assistance should increase business formations. Bendick and Egan (1987) report that the British Enterprise Allowance Program roughly doubled the formation of businesses among unemployed workers.[24]

IV. Maximum Likelihood Estimates

The likelihood function is derived in the appendix (available from the authors). The regressions reported above indicate that work experi-

[21] Another related implication of the model is that firms that face a tighter liquidity constraint will grow more rapidly. We tested this implication by regressing the growth of income between 1978 and 1981 for entrants who were self-employed in both years against the log of assets (35 observations were available). The relationship was negative, as predicted, but statistically insignificant.

[22] We might also expect that failures will experience smaller growth in assets than successes. The average change in nominal assets between 1976 and 1981 was 250 percent for successes and 111 percent for failures. The price level increased 159.7 percent between these years. Therefore, failures had negative asset growth and successes had positive asset growth.

[23] We also estimated the 1978 earnings equation using the 1981 sample to determine whether the change in the sign of the asset variable is due to self-selection. The estimated coefficient on assets was smaller for the restricted sample (about .6) but remained statistically significant at the 5 percent level.

[24] The Enterprise Allowance Program gave workers an operating subsidy for up to 1 year instead of unemployment benefits. Workers had to have $1,500 of their own to invest in the business before they could be eligible. Bendick and Egan note that workers received more from participating in the program than if they had remained unemployed.

ence and education were not substantively or statistically significant determinants of entrepreneurial earnings. Therefore, entrepreneurial earnings are assumed to depend only on assets. Wage earnings are assumed to depend on education and experience.[25]

Table 4 reports the maximum likelihood estimates. The estimated correlation between entrepreneurial ability and assets is negative and statistically significant. Thus we can reject the hypothesis that assets are a positive proxy for entrepreneurial ability. The key finding is that there are binding capital constraints. In the second column, which constrains δ_1 to be zero, the point estimate of λ is 1.44 with a 99 percent (plus or minus three standard deviations) confidence interval of (1.31, 1.59). Our results support Knight ($\lambda = 1$) over Schumpeter ($\lambda = \infty$).

The estimate of α in the second column means that a 10 percent increase in the capital devoted to a business leads to a 2.2 percent increase in earnings. This coefficient is highly significant.[26] The estimate of σ_θ is almost the same as the estimate of σ_ϵ. This means that entrepreneurs face considerable risk, not just as perceived by outsiders (who can see neither ϵ nor θ), but also as perceived by themselves since they cannot see ϵ until after they have committed their investment. Surprisingly, the distribution of unanticipated earnings shocks seems to be more variable for wage workers than for entrepreneurs.

[25] As mentioned in the appendix, α is constrained to lie in the unit interval (i.e., marginal product of capital is positive and diminishing) and λ is constrained to be positive. Our rough expectation is that α would be about a third—the share of capital in income (see n. 26 for more on this point). The assumption that $0 < \alpha < 1$ implies that there are diminishing returns to capital and that capital and ability are complements. The assumption that $\lambda > 0$ precludes the implausible implication that liquidity decreases with assets. Both assumptions are necessary because $\log(\alpha)$, $\log(1 - \alpha)$, and $\log(\lambda)$ appear in the likelihood function. It was not possible to keep all the parameter estimates within the permissible range during the likelihood estimation without these constraints. In order to ensure that the estimates reported are for a global maximum of the likelihood function, we perturbed the values of the key parameters and checked to see that the likelihood function was indeed lower and that the parameters moved toward the estimates at the maximum. We tried several high and low combinations of α and λ in this process. We also tried several alternative functional forms for the capital constraint (e.g., including higher-order terms in assets and allowing the capital constraint to depend on some of the exogenous variables) but had difficulty obtaining convergence.

[26] The estimates of α of .39 and .22 are not too far from those obtained elsewhere using the Cobb-Douglas production function. In models without liquidity constraints, α should equal capital's share in income, which is about one-third. In our model, however, α is the share of capital in the income of *unconstrained* entrepreneurs only. As for a constrained entrepreneur, he spends $r\lambda z$ on capital and expects $\theta(\lambda z)^\alpha$ in income. This yields a capital share of $r(\lambda z)^{1-\alpha}/\theta$. But since a constrained entrepreneur's θ violates (9), this means that $1/\theta < [(\lambda z)^{1-\alpha} r/\alpha]^{-1}$, which means that the empirical share of capital *exceeds* α for the constrained. Therefore, our estimate of α should be *less* than one-third, and on these grounds, again, the estimates in the second column of table 4 are more plausible than those in the first column.

TABLE 4

MAXIMUM LIKELIHOOD ESTIMATES OF ENTREPRENEURIAL SELECTION UNDER LIQUIDITY CONSTRAINTS FOR 1976–78

COEFFICIENT	NAME	ESTIMATE (1)	ESTIMATE (2)
Capital returns	α	.3862	.2186
		(.0822)	(.0200)
Capital constraint	λ	1.7263	1.4401
		(.0782)	(.0429)
Log entrepreneurial ability—constant	δ_0	2.3388	2.2732
		(.0498)	(.0404)
Log entrepreneurial ability—assets	δ_1	−.1160	...
		(.0343)	
Wage constant	μ	.2098	.1947
		(.2168)	(.2115)
Experience returns	γ_1	.3225	.3281
		(.0390)	(.0386)
Education returns	γ_2	.7200	.7207
Standard deviations for:			
Entrepreneurial ability	σ_θ	.2682	.2849
		(.0139)	(.0118)
Entrepreneurial earnings	σ_ϵ	.2666	.2797
		(.0222)	(.0163)
Wage earnings	σ_ξ	.4114	.4114
		(.0043)	(.0043)
Log likelihood		−954.0183	−959.8647
Observations		1,443	1,443

NOTE.—Estimation performed with the MAXLIK procedure in Gauss. Asymptotic standard errors are in parentheses.

Given the stringent functional form assumptions and the extensive attrition from our sample, the reader should regard the estimated structural parameters merely as suggestive of what more refined research will reveal. Nonetheless, let us take the estimates seriously and use them to evaluate the impact of liquidity constraints on business start-ups. We shall use the estimates from column 2 of table 4 for these calculations.[27]

The optimal amount of start-up capital for a white person with average education and experience is estimated to be $16,739 for someone with log entrepreneurial ability three standard deviations above the mean, $8,603 for two standard deviations above the mean, and $4,421 for one standard deviation above the mean. The geometric mean assets in our sample were $7,433. Someone with these assets could control business capital of $10,704. Thus only the

[27] Most of the results were similar if col. 1 is used instead, with the exception of the effect of removing the constraint. The correlated case predicts that removing the constraints leads to roughly a sixfold increase in the rate of entry, an implausible inference. Complete results are available from the authors on request.

ablest would not be able to obtain sufficient capital if they decided to start a business.[28] Most people are not constrained in the sense that, if they did decide to start a business, they would have sufficient capital according to our estimates.

Only high-ability/low-asset people are affected by the wealth constraint. But it is precisely these people who are most likely to want to switch to self-employment. Those with high ability can earn more in self-employment than in wage work, especially if they have poor wage earnings. But those with poor wage earnings are also likely to have accumulated relatively few assets. Indeed, compared with nonentrants, entrants had lower average wage earnings ($12,339 for entrants vs. $13,592 for nonentrants in 1976) and lower geometric mean assets ($5,927 for entrants and $7,504 for nonentrants in 1976).

Using the estimated structural parameters, we can calculate the fraction of the population that has values of θ (and of the other characteristics) satisfying constraints 1′ and 2′.[29] The average probability of being a constrained entrepreneur (i.e., satisfying 1′) is 3.75 percent, and the average probability of being an unconstrained entrepreneur (i.e., satisfying 2′) is 0.06 percent. Thus the liquidity constraint is binding for virtually all the individuals who are likely to start a business.

The liquidity constraint reduces the amount of capital flowing to entrepreneurship in two ways.[30] First, it will prevent some people from trying entrepreneurship. If the liquidity constraint were removed, the estimates indicate that the average probability of becoming an entrepreneur over the period would increase to 5.11 percent from 3.81 percent. Thus we estimate that the liquidity constraint deters 1.3 percent of the population from trying entrepreneurship.[31] Second, individuals who do try entrepreneurship use less capital because of the constraint. For example, an individual with $5,927 of assets (the geometric mean for entrants) and with log entrepreneurial ability two standard deviations above the mean uses $68 too little capital ($8,603 − 1.44 × $5,927). The difference between optimal and actual capital is lower for people with lower ability—an individual

[28] In fact, for individuals with average characteristics and assets, only those with log entrepreneurial ability 2.33 standard deviations above the mean would be constrained.

[29] These figures are obtained by taking the logarithmic values of the elements of the constraints and using the assumption that ln θ is normally distributed to calculate the probability that an individual with observed characteristics will satisfy the constraint. The sample mean of these individual probabilities is then taken.

[30] The figures reported below are in 1976 dollars. Prices have roughly doubled since 1976.

[31] This, of course, is a partial equilibrium result. Increasing the supply of entrepreneurs would decrease entrepreneurial rewards and thereby reduce the number of individuals who would like to switch.

with $5,927 of assets and log entrepreneurial ability three standard deviations above the mean would use the optimal amount of capital—and higher for people with less assets—an individual with $3,717 of assets and log entrepreneurial ability two standard deviations above the mean uses $3,250 too little capital.

The structural parameters also give a rough idea of the aggregate self-employment investment that might not be made because of the liquidity constraint. There were 50.3 million white male members of the labor force in 1976. The average annual entry rate into self-employment for the NLS sample between 1976 and 1978 was 2.25 percent. Therefore, 1.26 million whites are estimated to have entered self-employment annually. If we assume that each of these people used $68 too little capital (as would be the case for an individual whose log entrepreneurial ability is two standard deviations above the mean and who has assets of $5,917—the geometric mean for entrants), the total lost investment because of suboptimal investment by initial entrants is $86 million a year. Additionally, 1.30 percent of our sample were deterred from entering self-employment for a 2-year period (0.65 percent annually) or 0.3 million people annually. If we assume that these individuals would have invested the optimal start-up capital of $8,603 (the amount for a person with log entrepreneurial ability two standard deviations above the mean), the total lost investment because of deterred entry is $2,580 million. We thus obtain a total "lost" investment of $2.7 billion in 1976 dollars. By way of comparison, gross private domestic investment in 1976 was $174 billion. Again, it is important to emphasize that (1) these calculations are meant to be illustrative[32] and (2) without a better understanding of the nature of the liquidity constraints, the welfare implications of these calculations are unclear.

V. Conclusions

This paper develops and estimates a behavioral model of entrepreneurial choice under liquidity constraints. Several interesting results emerge. One can reject Schumpeter's view that capital markets allow a separation of the entrepreneurial and capitalist functions: Liquidity constraints bind. It is estimated that entrepreneurs are limited to a capital stock that is no more than about one and one-half times their wealth. As a result, almost all the entrepreneurs in our sample are estimated to devote less capital to their businesses than they would like to. Our findings are consistent with those of Fazzari, Hubbard,

[32] More accurate calculations would require integrating over the joint distribution of ability, assets, education, and experience.

and Petersen (1987), who find evidence of significant capital market imperfections even for publicly traded manufacturing corporations.

We conclude with several words of caution and some suggestions for further research. Our results are based on a simple static model of entrepreneurship. Further work on entrepreneurial selection and asset accumulation over the life cycle would be useful. The estimates rely on a sample that is subject to several potential selection biases whose correction could alter our conclusions. Because of sample attrition and missing values, only about half of the initial sample was used in the estimation. An interesting extension would have only a fraction q of 1976 wage workers observing a self-employment opportunity, and then q could be estimated; currently q is assumed to be one. The model also relies on a simple formulation of the liquidity constraints. Estimating more general liquidity constraints in which income and demographic characteristics play a role would enrich our understanding of the role that liquidity constraints play in entrepreneurial choice.

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