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e-companion

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E-companion to "Lean and Hungry or Fat and Content? Entrepreneurs' Wealth and Start-up Performance"

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This E-companion contains three appendixes to the paper. In Appendix A we derive formally the hypotheses from the Evans-Jovanovic (1989) model. Appendix B contains some additional discussion on the empirical relationship between wealth and start-up size. In Appendix C we analyze the relation between liquidity and, respectively, entrepreneurial wage and business survival. Appendix C contains Tables 5-7.

Appendix A: Theoretical framework

The theory of liquidity constraints of Evans & Jovanovic (1989) provides a useful reference point for the empirical analysis. In Evans-Jovanovic, individuals may have insufficient wealth to self-finance their venture, and can supplement their personal stake in the start-up by borrowing. Personal wealth plays the role of collateral. Entrepreneurs whose financing need exceeds the total available funds are defined as constrained, and entrepreneurs whose financing need is less than the available funds, and hence can establish a company at an efficient scale, are defined as unconstrained. We now analyze the Evans-Jovanovic model and derive its predictions on the relationship between founder wealth and start-up profitability.

Setup

Evans & Jovanovic (1989) attempts to explain entry into entrepreneurship by a risk-neutral individual using three key variables; opportunity cost (wage work), quality of idea/human capital, and liquidity constraints. The model is static where the individual makes two decisions simultaneously; whether to start up a business and the level of assets to put into the business.

Net profits conditional on entry equal,

$$y = \theta k^{\alpha}\epsilon - rk \tag{1}$$

where θ is entrepreneurial ability, a non-negative random variable known to the individual at the decision stage, k is the chosen level of assets, $\alpha \in (0,1)$ is a technological constant, ϵ is a noise term with non-negative support and mean equal to one, not known at the decision stage, r is the interest rate, and rk is the opportunity cost of assets deployed. We assume that α and r are deterministic. It is straightforward to extend the analysis to the case where α and r are random variables.

The individual becomes an entrepreneur if net profits exceed foregone wage income w,

$$y > w \tag{2}$$

where w is stochastic and depends upon the individual's age, education level, and so forth. Conditional on entry, the individual solves

$$\max_{\{k\}} y \tag{3}$$

Without liquidity constraints, the optimal level of investments is defined by the first order condition $\theta\alpha k^{\alpha-1} - r = 0$ with solution

$$k^* = (\theta\alpha/r)^{\frac{1}{1-\alpha}} \tag{4}$$

The individual has non-negative random wealth z and can borrow up to $(\lambda - 1)z$ at interest rate r. We say that an individual is capital constrained (liquidity constrained) if $\lambda z < k^*$ and not capital constrained if $\lambda z \geq k^*$. The optimal investment level conditional on entry must therefore equal,

$$k = \min(k^*, \lambda z) \tag{5}$$

Remark 1 *For given $(\theta, r, \lambda, \alpha)$, there exist constants z_L and z_H such that (i) individuals with $z < z_L$ will not enter, (ii) individuals with $z_L < z < z_H$ will enter and be constrained (i.e., $k < k^*$) and (iii) individuals with $z > z_H$ will enter and be unconstrained (i.e., $k = k^*$)*

Define $z_H = \{z : \lambda z = k^*\} = (\theta\alpha/r)^{\frac{1}{1-\alpha}}/\lambda$, i.e., the wealth level just sufficient to be unconstrained. Throughout we assume that θ is sufficiently high for $y(z_H) > w$ to hold (the reverse case is not interesting as nobody will enter). We now define z_L. First note that for $z < z_H$ then $\frac{\partial y}{\partial z} = \alpha\theta\lambda(z\lambda)^{\alpha-1} - r\lambda$ and $\frac{\partial^2 y}{\partial z^2} = (\alpha-1)\alpha\theta\lambda^2(z\lambda)^{\alpha-2} < 0$. By the concavity of $y(z)$, and since $\frac{\partial y}{\partial z} = 0$ for $z > z_H$, it must be the case that $\frac{\partial y}{\partial z} > 0$ for $z < z_H$. On the other hand, $y(z = 0) = 0$. It follows that there must exist a unique cutoff $z_L \in (0, z_H)$ such that $y(z_L) = w$. Thus (i) for $z < z_L$ the agent will not enter, (ii) for $z_L < z < z_H$ the agent will enter but be constrained, and for $z \geq z_H$ the agent will enter and be unconstrained.

Wealth and profitability

In this section we analyze the model's predictions on the relation between wealth and profitability conditional upon the individual becoming entrepreneur, i.e., conditional upon $z > z_L$.

Let us first define realized profitability R as,

$$R = \theta k^{\alpha}\epsilon/k = \theta\epsilon k^{\alpha-1} \tag{6}$$

R equals profits gross of financing costs divided by the level of assets. R corresponds to OROA in the empirical analysis. For unconstrained entrepreneurs we can substitute in for $k = k^*$. Taking logs we obtain,

$$\begin{aligned} \ln(R) &= \ln(\theta) + (\alpha-1)\ln(k^*) + \ln(\epsilon) \\ &= \ln(\theta) + (\alpha-1)\ln((\theta\alpha/r)^{\frac{1}{1-\alpha}}) + \ln(\epsilon) \\ &= \ln(r) - \ln(\alpha) + \ln(\epsilon) \end{aligned} \tag{7}$$

The prediction we obtain from (7) is straightforward. Running the following regression on a sample of unconstrained entrepreneurs,

$$\ln(R) = c_0 + c_z\ln(z) + c_\theta\ln(\theta) + \ln(\epsilon) + v \tag{8}$$

the predicted slope of both coefficients c_z and c_θ is zero. The constants $\ln(r)$ and $\ln(\alpha)$ will enter the constant term, c_0. The term ν is added to capture random noise.

Let us now consider constrained entrepreneurs. For these we can substitute in for $k = z$ in (6) and take logs. The constant λ plays no role in the analysis and is normalized to 1.[1] We then

[1] If λ is positively correlated with wealth, our estimated coefficient on wealth for constrained individuals will partly pick up that more wealthy individuals have more capital due to higher leverage. This point has no important implications for the interpretation of our results.

obtain,

$$\ln(R) = \ln(\theta) + (\alpha - 1)\ln(z) + \ln(\epsilon) \tag{9}$$

The prediction we obtain from (9) is the following. If we run the regression model (8) on a sample of constrained entrepreneurs, the predicted slope coefficient c_z equals $\alpha - 1 < 0$. Note that as long as θ is an observable variable, standard regression methods will yield consistent estimates of c_z even if θ and z are correlated. In the empirical application we proxy $\ln(\theta)$ with a set of human capital variables (age, education, and the pre start-up earnings history). This will give a consistent estimate for c_z to the extent that $\ln\theta$ has zero correlation with $\ln z$ once our set of observed human capital variables is partialled out.

Pooling the samples of unconstrained and constrained entrepreneurs, we have

$$\ln(R) = \begin{cases} \ln(r) - \ln(\alpha) + \ln(\epsilon) & \text{if } z \geqslant z_H \\ \ln(\theta) + (\alpha - 1)\ln(z) + \ln(\epsilon) & \text{if } z_L < z < z_H \end{cases} \tag{10}$$

In the empirical application, we are not able to identify exactly whether an entrepreneur is constrained or not since we do not know the cut-off value, z_H. We can still determine the shape of the graph in the $z - R$ plane since, for a given θ, all unconstrained individuals are located to the right of the constrained individual in the z-dimension. The partial derivative $\frac{\partial \ln(R)}{\partial \ln(z)} = (\alpha - 1)$ is negative, hence, $\ln(R)$ is falling in $\ln(z)$ up to $z = z_H = (\theta\alpha/r)^{\frac{1}{1-\alpha}}$ and flat thereafter at $\ln(r) - \ln(\alpha)$. In a regression this convex curvature is easily captured by a higher order polynomial in z. From this we conclude with the following remark:

Remark 2 *The EJ model predicts that estimating (8) should give a negative and convex relation between* $\ln(z)$ *and* $\ln(R)$ *conditional on* $\ln(\theta)$*.*

In the model, R is always positive since ε is assumed to be lognormal. In the data, however, OROA is sometimes negative and hence $\ln(R)$ is undefined. One common way to solve such problems in empirical applications is to replace $\ln(R)$ with $\ln(R+1)$. Note that this does not alter the main prediction since $\frac{\partial \ln(R+1)}{\partial \ln(k)} = \alpha - 1 < 0$ by (8).

To summarize, the Evans-Jovanovic model predicts a negative relation between wealth and profitability for the constrained entrepreneurs, and a zero relation between wealth and profitability for the unconstrained entrepreneurs. The first prediction relies on the Evans-Jovanovic assumption of decreasing returns to scale. The second prediction is very general and will hold in any theory of liquidity constraints that is based on profit maximization. We should finally point out that Evans-Jovanovic is not the only economic model that predicts a negative (and convex) relationship between liquidity and wealth. For example, Bernhardt (2000) and de Meza (2002) contain theoretical frameworks that can also produce these predictions.

Wealth versus start-up size

In this section we show that the Evans-Jovanovic (1989) model predicts a positive relationship between wealth and start-up size. First recall from (5) that conditional upon the individual becoming entrepreneur, i.e., conditional upon $z > z_L$, the investment into the start-up equals,

$$k = \min(k^*, \lambda z) \tag{11}$$

where $k^* = (\theta\alpha/r)^{\frac{1}{1-\alpha}}$ from (4). Let us first consider unconstrained entrepreneurs. For these $k = k^*$. Taking logs we get,

$$\ln(k) = \frac{\ln(\theta) + \ln(\alpha) - \ln(r)}{1-\alpha} \tag{12}$$

The prediction we obtain from (12) is that the relation between $\ln(k)$ and $\ln(z)$ is zero for unconstrained entrepreneurs. Hence, if running the following regression on a sample of unconstrained entrepreneurs,

$$\ln(k) = c_0 + c_z \ln(z) + c_\theta \ln(\theta) + v \tag{13}$$

the predicted c_z is zero and c_θ should be positive. The constant term c_0 will be determined by the constants r and α. The term ν is added to capture random noise.

For constrained entrepreneurs, $k = \lambda z$. On log form, and again normalizing λ to 1, we get

$$\ln(k) = \ln(z) \tag{14}$$

Running the regression (13) on a sample of constrained entrepreneurs, therefore, the predicted c_z is positive (unity with λ normalized to 1), and the predicted c_θ is zero.

Pooling the samples of unconstrained and constrained entrepreneurs, we have

$$\ln(k) = \begin{cases} \dfrac{\ln(\theta) + \ln(\alpha) - \ln(r)}{1-\alpha} & \text{if } z \geqslant z_H \\ \ln(z) & \text{if } z_L < z < z_H \end{cases} \tag{15}$$

We are not able to identify exactly whether an entrepreneur is constrained or not in the empirical application, i.e. we do not know the value of z_H. Note again, however, that we can determine the shape of the graph in the $z - k$ plane since, for a given θ, all unconstrained individuals have higher wealth than the constrained individuals. We see from (15) that $\ln(k)$ increases in $\ln(z)$ up to the breakpoint $z = z_H$ and is flat thereafter. Even though z_H is unknown in a regression, this concave curvature is easily captured by a higher order polynomial in z. We summarize with the following remark.

Remark 3 *The EJ model predicts that estimating (13) should give a positive and concave relation between* $\ln(z)$ *and* $ln(k)$.

Appendix B: The size-wealth relationship and liquidity constraints

The positive and significant relationships between wealth and start-up size in Table 2 are clearly consistent with liquidity constraints as in the Evans-Jovanovic (1989) model. In this appendix we discuss and report tests for alternative mechanisms that could drive the positive relationship, and we report the results from an analysis of liquidity constraints along the lines of Cabral & Mata (2003). For brevity, we report a summary of our analyses without presenting tables.

Blanchflower & Oswald (1998, p. 28) suggest that a positive relation between wealth and start-up size could be due to the fact that "inherently acquisitive individuals [may] both start their own businesses and forego leisure to build up family assets". This could cause wealth and start-up size to be correlated even in the absence of liquidity constraints. We would expect such an acquisitive trait to be a rather permanent characteristic of the individual and hence independent of the start-up opportunity. As argued by Buera (2003) and Hurst & Lusardi (2004), liquidity constrained founders, on the other hand, would be expected to accumulate wealth in the run-up to the formation of the start-up. In order to investigate this selection issue, we have analyzed the timing of the wealth accumulation. In this analysis, we found that founders have a marked wealth accumulation in the run-up to the start-up date, a result that also holds when comparing the founders to a control group of non-founders (see Appendix C for how this control group was constructed). Thus this evidence points in the direction of liquidity constraints being the mechanism behind the increasing relation between wealth and start-up size.

It is possible, however, that even if founders are liquidity-constrained at the starting date, once the firm is established outside investors quickly realize which companies are worth investing in, and provide capital to those. Under such an hypothesis, companies that start out small, but perform well will receive capital from external investors, while companies that do not perform well will continue to be small or fail to survive. To investigate this question, we have analyzed whether the relation between wealth and size continues to hold also after the first year, the idea being that the relation between wealth and size should be vanishing if liquidity constraints are transient. We ran yearly regressions on the size of the venture, using current profitability as an additional control to those used in Table 2, and found that profitability is an important explanatory factor for size. The importance of profitability for size increases over time. We also found, however, that wealth has an approximately constant effect on the size of the company over the first five years, which suggests that liquidity constraints at the start-up date are binding well into the life of the venture. Thus it seems unlikely that liquidity constraints that are present initially vanish fast.

The positive relation between wealth and start-up size may be due to omitted variable bias, and reflects that individuals with higher entrepreneurial ability start up larger companies, rather than that they are liquidity constrained. In Section 5.1, we followed Evans & Jovanovic (1989) and divided entrepreneurs into "constrained" and "unconstrained" depending on the relative magnitude of founder wealth and start-up size. In unreported analyses, we find that the relation between wealth and start-up size is much stronger for entrepreneurs that are defined as constrained. This suggests that omitted variable bias is less important than liquidity constraints in driving the positive relationship between wealth and start-up size.

As a final check we have used the approach of Cabral & Mata (2003) who develop a simple model showing that liquidity constraints will have implications for the firm size distribution over time. If a fraction of firms are below optimal size at birth due to liquidity constraints, and if these constraints become less binding over time, the firm size distribution of a given cohort of surviving firms should start out being right-skewed and over time become more symmetric. Inspired by e.g. Hoshi et al (1991) and Schiantarelli and Sembenelli (2000) we assume that new firms that are spin-outs from established firms are less constrained than new firms established by individual entrepreneurs. We find that firms established by individual entrepreneurs are much smaller than comparable new firms that are spin-outs from established firms, and – more importantly – that the firm size distribution for firms established by individual entrepreneurs is more skewed. This is true both in the first and fifth year of operations.[2] We also find that

[2] The firms established by individual entrepreneurs corresponds to the sample of start-ups that are described in the data section. The sample of spin-outs is constructed exactly the same way, i.e. as a random sample of limited liability firms that were incorporated between 1994 and 2002. Firms included are firms that survive for at least five years, and where we have information about the number of employees both in year one and five. Size is measured by the natural logarithm of the number of employees.

the change in skewness over the first five years is larger for firms established by individual entrepreneurs than for spin-outs. Hence, the approach of Cabral & Mata (2003) yields results that are consistent with liquidity constraints being present.

Appendix C: Other performance measures

This appendix analyzes the relation between liquidity, founder wages and start-up survival.

Entrepreneurial wages

In addition to generating a stream of profits, the start-up generates a stream of wage income for the entrepreneur, that is traceable with the tax data. To evaluate the relation between prior wealth and entrepreneurial wage, we construct a control group of individuals that are similar to the founders in terms of gender, wage, wealth, age and education. The idea behind the control group is that although estimates of the wealth coefficient may be biased, the difference in wealth effects between entrepreneurs and observably similar workers that do not become entrepreneurs is less likely to be biased.

The control groups are constructed by sorting the entire population of individuals by gender, wage (rounded to the nearest 20 000), wealth (rounded to the nearest 20 000), age and education, year by year. For each founder, we have selected the two closest neighbors in the start-up year ranking, excluding neighbors that are founders. Table 5 presents descriptive statistics of the founders versus the control group.

TABLE 5: Descriptive statistics

	Founders		Control group	
	Mean	Median	Mean	Median
Age at start-up date	41	40	42	41
	(9)		(10)	
Education in years at start-up date	12.8	12	12.9	12
	(2.6)		(2.7)	
Taxable wealth, 3-year average	1550	542	1240	517
before start-up date	(7614)		(3670)	
Net capital income, 3-year average	-9	-33	-5	-23
before start-up date	(121)		(117)	
Wage income, 3-year average	515	437	494	415
before start-up date	(555)		(502)	
Founder net capital income, 3-year	57	-6	12	-21
average after start-up date	(188)		(138)	
Founder wage income, 3-year	460	394	533	444
average after start-up date	(310)		(452)	

Krone values are expressed in 1000 2002 kroner. Standard deviations in parenthesis.

We see from Table 5 that the two groups are quite similar. The control group has slightly lower gross taxable wealth and net capital income before the start-up date, suggesting that it has slightly less debt. With respect to wage before the start-up date, we see that the two groups are very similar. After the start-up date, however, the control group has a wage increase while the founders have a wage decrease. This decrease is partly compensated for through a stronger increase in net capital income.

We now study the relation between wealth and entrepreneurial wages.

TABLE 6: The effect of prior wealth on entrepreneur wage

	(1)	(2)	(3)	(4)	(5)	(6)
		Wage for entrepreneurs			Wage for control group	
ln(wealth)	.073***	.015	.081	.111***	.039***	-.094
	(.017)	(.017)	(.171)	(.012)	(.011)	(.102)
ln(wealth)^2			-.003			.005
			(.007))			(.004)
ln(wage$_{t-1}$)		.156***	.156***		.295***	.295***
		(.033)	(.033)		(.039)	(.039)
ln(wage$_{t-2}$)		.178***	.179		.223***	.221***
		(.034)	(.033)		(.042)	(.039)
age	.045***	.005	.004	059***	.012	.014*
	(.013)	(.013)	(.013)	(.008)	(.007)	(.008)
age^2	-.0005***	-.0001	-.0001	-.001***	-.0002*	-.0002***
	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.00008)
education in years	.039***	.025***	025***	.071***	.046***	.044***
	(.007)	(.007)	(.007)	(.005)	(.004)	(.004)
R^2	.07	.15	.15	.19	.39	.39
N	6760	6760	6760	12593	12593	12593

The estimation method is ordinary least squares. t is the start-up year. The dependent variable is yearly ln(wage) for the entrepreneur after start-up, excluding the start-up year. Two digit industry dummies, time dummies and dummies for the age of the start-up are included, but not reported. We report Huber-White robust standard errors allowing for clustering of errors by individuals. *** Significant at the 1 % level ** Significant at the 5 % level * Significant at the 10 % level

In column (1) of Table 6, we regress wealth on wage controlling only for age and education. We find a significant positive relation between prior gross taxable wealth and entrepreneurial wages. Note, however, from column (4) that the wage effect is even stronger in our matched control group of non-entrepreneurs. A likely explanation is that wealth is correlated with unobserved human capital (ability). Introducing prior wage as a control for ability in column (2) we see that the effect of wealth on wages falls sharply and becomes insignificant. Prior wealth still has a significant effect in the matched control group of non-entrepreneurs, see column (5). This is probably because the sample size is larger and the wage variance smaller. Measured human capital has more explanatory power, and R-square is far higher for non-entrepreneurs than for entrepreneurs. We see from columns (3) and (6) that the quadratic term in wealth enters with a small and non-significant coefficient in the wage regressions. Thus there is no evidence of a non-linear relationship between log wealth and entrepreneurial wage. We have also tried to include third and fourth order polynomials in wealth, reaching the same conclusion. To further assess robustness, we have used median and robust regressions, but the results were still the same. The analysis suggests overall that prior wealth has no causal effect on entrepreneurial wages.

Start-up survival

Defining start-up survival to occur if a start-up has submitted a tax report for the fifth year of operations, we have the following results.

TABLE 7: Effects of log gross taxable wealth on survival

	OLS				Probit			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)
ln(wealth)	.066**	.287**	-.130		.202**	.749*	4.906	
	(.014)	(.130)	(7.614)		(.044)	(.404)	(22.039)	
ln(wealth)^2		-.009	-.008			-.022	-.674	
		(.005)	(.881)			(.016)	(2.558)	
ln(wealth)^3			.002				.042	
			(.045)				(.130)	
ln(wealth)^4			-.0001				-.001	
			(.008)				(.002)	
Dummy2				.145**				.147***
				(.038)				(.038)
Dummy3				.163**				.146**
				(.074)				(.058)
ln(wage$_{t-1}$)	.027	.029	030	.031	.083	.092	.102*	.031
	(.021)	(.020)	(.020)	(.021)	(.066)	(.062)	(.061)	(.021)
ln(wage$_{t-2}$)	-.004	-.006	-.008	.005	-.008	-.016	-.028	.006
	(.022)	(.021)	(.021)	(.022)	(.073)	(.071)	(.071)	(.023)
education in years	-.002	-.002	-.001	.000	-.004	-.005	-.003	.003
	(.007)	(.007)	(.007)	(.007)	(.020)	(.020)	(.020)	(.007)
age	-.024**	-.028**	-.028**	-.026**	-.089**	-.097**	-.098**	-.030**
	(.011)	(.011)	(.012)	(.012)	(.039)	(.040)	(.041)	(.013)
age^2	.0003**	.0003**	.0003**	.0003**	.001**	.001**	.001**	.0004**
	(.0001)	(.0001)	(.0001)	(.0001)	(.0005)	(.0005)	(.0005)	(.0002)
R^2	.08	.08	.09	.07	.06	.07	.07	.06
N	971	971	971		952	952	952	

The estimation method is OLS in (1)-(4) and probit in (5)-(8). The dependent variable is four-year survival. Two digit industry dummies, time dummies and dummies for the age of the start-up are included, but not reported. In column 6, dummy 2 represents percentiles 30-95 and dummy 3 represents percentiles 95-100. Low wealth individuals are the reference category in both columns. Huber-White robust standard errors allowing for clustering of errors by firms are reported in parenthesis. *** Significant at the 1 % level ** Significant at the 5

% level * Significant at the 10 % level

Table 7 provides estimates of the relation between founder wealth and business survival. Columns (1)-(4) use a linear probability model, and (5)-(8) a probit specification. (1) and (5) regress survival on log wealth, using the same controls as in Table 3. Columns (1) and (5) show that the log-linear relationship between wealth and survival is significantly positive. For example, (1) suggests that a one-log increase in founder wealth gives seven percentage points higher probability of five-year survival, which translates into a 1.4 percentage points higher yearly survival rate. As the average five-year survival rate is 73 percent across the sample, wealth does not seem to have a large effect on survival probability.[3] In columns (2) and (6) we use a quadratic specification, and in (3) and (7) we use a fourth-order polynomial specification. Across these specifications, we find a relationship between founder wealth and business survival that is initially increasing and then constant. In columns (4) and (8) we estimate average effects for founders in percentiles 30-95 and 95-100 respectively, relative to founders in percentiles 0-30. We find that founders in percentiles 30-95 have about 15 percentage points higher survival probability than founders in percentiles 0-30. The estimated survival probability for the founders in the 95-100 percentiles is very similar to the estimated survival probability in the 30-95 percentiles. Thus in spite of starting up larger companies and having access to more liquidity, the richest founders do not have a higher survival rate than the 30-95 percentiles. Overall, our results on survival are quite similar to our results on profitability in that wealth seems beneficial, but only up to a point.

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