Economic returns to education for entrepreneurs: The development of a neglected child in the family of economics of education?

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Summary

■ To what extent does formal schooling, one of the most prominent manifestations of human capital, affect entrepreneurship performance? And, how large are these returns to education for entrepreneurs relative to employees? These are the questions we address and answer in this paper. Based on a meta-analysis of studies analyzing the relationship between schooling and entrepreneurship, we demonstrate that the effect of formal schooling on entrepreneur performance has not yet been consistently measured, due to shortcomings in the empirical strategies applied so far. We discuss these shortcomings as well as some potential solutions. Then, we will discuss two recent applications of such more advanced empirical strategies. The first of these studies shows that in the US, the returns to education are much higher for entrepreneurs than for employees (14 and 10 percent, respectively). This difference in estimated returns has been insignificant when using OLS. The second study pertains to Europe, i.e. it deals with the Netherlands. It shows again that OLS-estimates of the returns to education are biased downwards. Moreover, the distinct and direct effect of human capital is usually obscured by its indirect effect through the extent of capital constraints. The total effect of approximately 14 percent is shown to consist of a direct effect of 12.7 percent and an indirect effect, through the extent of capital constraints, of approximately 1.3 percent. We conclude with several policy implications that are based on the novel finding that the returns to education are higher for entrepreneurs than for employees.■

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Entrepreneurship is becoming an increasingly prominent issue in both academic and policy circles. Entrepreneurs are often credited with innovating new products, discovering new markets, and displacing ageing incumbents in a process of "creative destruction". But it is also recognized that if entrepreneurs face constraints such as limited human capital, then these economic benefits might not be realized. This realization has prompted several governments to devise public programs to encourage entrepreneurship. Underlying most of these programs is a belief that human capital affects entrepreneurs' performance in practice. The measurement of the (determinants of the) return to entrepreneurial (human) capital is thus relevant for devising (government and lenders') programs to realize the optimal economic benefits from entrepreneurship. These are often larger than the private benefits accruing to entrepreneurs.

However, as we demonstrate in this paper, the effect of formal schooling, one of the most prominent manifestations of human capital, on entrepreneur performance has not yet been consistently measured, due to shortcomings in the empirical strategies applied so far.[1] We discuss these shortcomings as well as some potential solutions that we borrow from the technically more sophisticated literature on the returns to education for employees. Then, we will discuss two re-

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[1] The same holds for the presumably negative effect of capital constraints on performance, as well as for the inter-relatedness of human capital and financial capital constraints.

cent applications of such more advanced empirical strategies to consistently estimate the causal and distinct effect of formal education on entrepreneurial income. The first study, by Van der Sluis, Van Praag and Van Witteloostuijn (2004) (VVW hereafter) pertains to the US. It compares the rate of return to education for entrepreneurs to the rate of return for employees. The second study, by Parker and Van Praag (2004) (PvP hereafter) pertains to Europe (The Netherlands). It isolates the causal effect of education from the inter-related effect of capital constraints on the entrepreneur's performance. The final sections of this paper will discuss the results from those recent studies, and provide conclusions and policy implications.

1. Theory: The effect of education on entrepreneur performance

Human capital theory in general indicates that previous knowledge plays a critical role in intellectual performance. Previous knowledge assists in the integration and accumulation of new knowledge, as well as the integration and adaptation to new situations (Weick, 1996). Knowledge may be defined as either tacit or explicit. Tacit knowledge refers to "know how" which is the often non-codified components of a given activity (Davidsson and Honig, 2003). Explicit knowledge refers to "know what" and is knowledge conveyed in procedures, processes and institutions such as educational establishments.

According to the Mincerian specification of the determinants of individual earnings, the main factors affecting earnings are education and experience. Though tests of human capital theory have mostly been performed on the subset of employees, there is no reason to believe that the same relationship would not hold for the entrepreneurial sector of the labor market. As Davidsson and Honig (2003) indeed assert, solving complex problems and making entrepreneurial decisions utilizes, amongst other things, an interaction of both tacit and explicit knowledge. Individuals may increase their knowledge through formal education such as university education, while informal education is gained through work or "life" experience.

Accumulation of human capital, for instance by means of schooling or specific types of experience, is not only acknowledged for its productive effect on the quality or quantity of labor supplied, as assumed by Mincer, it also has a value as a signal of productive ability in labor markets without complete information (Spence, 1973; Wolpin,

1977; Riley, 2002). In signaling, the party with private information—i.e., the employee in the selection and hiring process by employers—takes the lead in adopting behavior that, upon appropriate interpretation, reveals information about his own type of productivity. The question is whether the existence of a signaling effect next to a productive effect of education is as likely for entrepreneurs as for employees.

Many of the empirical tests devised to quantify the signaling effect of education for employees (Wolpin, 1977) assume that entrepreneurs do not have a prospective employer and can therefore be treated as an unscreened control group. Under the so-called "strong screening hypothesis" (i.e. education would only have a signaling effect but no productive effect), this type of empirical test of the screening theory predicts that entrepreneurs do not have any returns to education while employees do. The weak screening hypothesis (WSH) on the other hand, states that the primary role of schooling is the acquisition of a signal, but that schooling also has some inherent productivity. An empirical test in support of the WSH would therefore demonstrate that entrepreneurs do have a significant positive return to schooling, but that this effect is smaller than for employees, since entrepreneurs are assumed to lack a signaling effect.

We question the assumption that such a signal would be useless for entrepreneurs, for at least two reasons. First, when acquiring education, the future entrepreneur might invest in education since he or she intends to first work for an employer. Second, there might be substantial screening from prospective capital suppliers, customers and other stakeholders. Education is then used as a signal to these clients and capital suppliers. The economic returns to education could thus very well be of similar levels for employees and entrepreneurs. A comparison of these returns is therefore largely an empirical matter.

2. Empirical evidence: The effect of education on entrepreneur performance

The relationship between schooling and entrepreneurship entry and performance has been measured in various empirical studies. Van der Sluis, Van Praag and Vijverberg (2003) (VVV, hereafter) provide an overview of such empirical studies of the impact of schooling on entrepreneurship selection and performance. They perform a meta-analysis in order to assess whether there are any consistent findings

from the vast empirical entrepreneurship and economic literature with respect to the impact of education on performance in and choice of entrepreneurship.

For the sake of this meta-analysis, VVV have first gathered all relevant studies that meet certain reasonable criteria from the large number of published and unpublished studies that have been produced by and distributed to the scientific community. Each of the 94 resulting studies measures, among other things, the impact of schooling on entrepreneurship entry, performance, or both for a specific sample, i.e. for a given country, time period, gender, occupation, and so on. All these studies pertain to industrialized countries,[2] which results in 299 observations in their database. Almost 50 percent of these observations pertain to the relationship between education and entrepreneur performance, the topic of this paper, whereas the remainder measures the relationship between education and entrepreneurship entry (or the more hybrid measure of whether or not an individual is an entrepreneur in a certain year). The 145 studies measuring the relationship between performance and education use various performance measures, but the majority (i.e. 58 percent) uses the entrepreneur's earnings, hence consistent with the focus of the current study.[3]

Furthermore, out of the set of performance studies, 38 percent use the most common measure of educational achievement in which we are interested, i.e. "years of schooling". Taking the intersection of these two subsets of the sample, only 34 observations appear to be measuring the returns to education, i.e. the effect of years of education on earnings, in the sense in which we are interested. Most of these studies pertain to the US. An additional condition should be met for a comparable measurement of the rate of return to education: earnings should be measured in logarithms. This additional requirement is met by 21 observations only, all pertaining to the US. Apart from concluding from this that the use of definitions of performance and education has been fairly scattered, we wish to pay attention to four important outcomes from this meta-analysis.

First, the impact of education on selection into an entrepreneurial position is mostly, i.e. in 75 percent of the cases, insignificant. The

[2] See Van der Sluis et al. (2004) for a meta-analysis pertaining to less developed countries.

[3] Twenty-four percent of these studies measure the effect of education on survival (exit). The remaining 18 percent are scattered over various measures such as duration, growth, employment and subjective measures of performance.

impact of schooling on performance, however, is unambiguous and significantly positive for 67 percent of the observations. For the sub-sample of observations that consider earnings as their performance measure, this percentage amounts to even more than 80. We conclude that entrepreneurship performance is significantly affected by schooling.

Second, the meta-analysis gives insight into the level of the returns to education for entrepreneurs. This insight, though, can only be based on the small sub-sample of 21 US observations that use similar measures for education and earnings. The return to a marginal year of schooling in terms of the income it generates turns out to be 6.1 percent on average. This estimate is probably at the high side of the spectrum. This can be inferred from VVV's analysis of variance: they analyzed (by means of ordered probit analyses) the factors that explain the variation in signs and significances of the returns to education amongst comparable studies in the sample. First, the analysis of variance shows that the performance measure "earnings" generates more significantly positive effects of education than do alternative performance measures. The earnings measure has been used to obtain the returns estimate of 6.1 percent. Second, the analysis of variances shows that the returns to education for entrepreneurs in the US are positive in a significantly larger proportion of the studies than returns to education in European or other countries studied. The estimate of 6.1 percent pertains to the US.[4] These two outcomes from the analysis of variance of the returns to education thus lead to the inference that the estimate of 6.1 percent is at the high side.

Third, the meta-analysis allows a comparison of the rate of return to education for entrepreneurs to the returns to education for employees. This comparison is based on the results from studies that compare the rates of returns of these two groups of labor market participants using one dataset and thereby, one set of definitions, time period, country, etcetera. Approximately twenty papers have actually measured the returns to education for entrepreneurs and employees in a comparable fashion. From these studies, the third result is obtained: the returns to education are at least as high for employees as

[4] The analysis of variances furthermore shows that the rate of return to education has not increased over time; and that a higher percentage of non-whites in the sample decreases the return to education. The latter effect might imply that education pursued in a different country generates lower returns than education pursued in the same country where the entrepreneur operates.

for entrepreneurs. More specifically, all studies pertaining to Europe indicate that the returns to education are slightly lower for entrepreneurs than for employees. However, the opposite result is found for studies pertaining to the US.

A smaller part of these twenty studies focuses on the screening function of education. One of the ways in which the (strong or weak version of the) screening hypothesis is tested empirically, is to compare the returns to education for employees to the returns for entrepreneurs, where the latter group is considered as an unscreened control group, see the previous section. Almost all screening studies reject the strong screening hypothesis: i.e. these studies find positive returns to education for entrepreneurs. However, the evidence related to the weak screening hypothesis (WSH) is mixed. Studies based on US data reject the WSH, (Fredland and Little, 1981; Tucker, 1985, 1987; Evans and Leighton, 1990; Robinson and Sexton, 1994), implying that the returns to education are not higher for employees than for entrepreneurs in the US. Studies using European data (UK, Italy, and The Netherlands) support the WSH (Rees and Shah, 1986; De Wit and Van Winden, 1989; Brown and Sessions, 1998; Brown and Sessions, 1999). The latter result implies that the returns to education are lower for entrepreneurs than for employees in Europe.

The majority of the twenty papers that compare returns to education for entrepreneurs to those for employees use the comparison to highlight differences in labor market participation and success factors between minorities and non-minorities and/or between females and males (e.g. Moore, 1982; Gill, 1988; Macpherson, 1988; Borjas and Bronars, 1989; Fairlie and Meyer, 1996; Lombard, 2001; Lofstrom, 2002). The results from these (exclusively US) studies are consistent with the results obtained in the screening literature: the estimated returns to education for entrepreneurs are at least as high, and usually higher, than for employees.

The fourth conclusion from the meta-analysis is quite striking: all results obtained so far are potentially biased. Estimation and identification strategies used to identify the effect of education on performance have merely measured the (conditional) correlation between education and performance, rather than the causal effect, which is the estimate of interest.

There are at least two possible sources of inconsistency when OLS is used to estimate this relationship. First, the schooling decision is probably endogenous in a performance equation, because individuals

are likely to base their schooling investment decision, at least in part, on their perceptions of the expected payoffs to their investment. Second, there may be unobserved individual characteristics, such as ability and motivation, that affect both the schooling level attained and subsequent business performance. The omission of these unobserved characteristics from a performance equation would also serve to bias OLS estimates, where the direction and magnitude of the bias depend on the correlation between these characteristics and the schooling level attained. Several methods for coping with these problems have recently been applied to estimate the returns to education for employees. The general conclusion is that OLS-estimates of the returns to education for employees are biased downwards (Ashenfelter et al., 1999).

The potential bias also makes the comparisons of returns to education for entrepreneurs and employees suspicious. Following Griliches (1977), the neglect of unobserved influential characteristics and not dealing with the endogenous nature of the education decision can have a different impact on the estimate of the returns to education for entrepreneurs and employees. As a result, the conclusion that the returns to education for employees is higher in Europe and lower or equal to the returns to education for entrepreneurs in the US should be re-evaluated. It can only be maintained when it would be supported by additional research that uses more recently developed estimation methods that account for endogeneity and unobserved heterogeneity.[5]

An additional concern we have about previous estimates of the effect of education on business performance is that the effect (or correlation) measured does not account for or measure the (extent of) substitutability between education and other factors such as financial capital constraints. The latter have prevented the measurement of the distinct effect of each separate factor.

The latter conclusion from the meta-analysis, i.e. that the causal and distinct effect of education on entrepreneur performance (or income) has not yet been measured, puts all other conclusions in a different perspective. The remainder of this paper is devoted to a short presentation of possible methods for obtaining more consistent estimates and the discussion of two very recent applications of such

[5] Moreover, previous studies have not acknowledged another potential source of inconsistency relating to the comparison of returns to education for entrepreneurs and employees: the self-selection of individuals into entrepreneurship/employment.

methods. This will be followed by a re-evaluation of the first three conclusions from the meta-analysis.

3. Identification strategies for measuring the causal effect of education on income

There are basically four methods to account for the potential problems of endogeneity and/or unobserved heterogeneity when estimating the returns to education. All four have been applied to the estimation of the returns to education for employees (Ashenfelter et al., 1999).

The first strategy for coping with unobserved ability is trying to make the unobservable observable. To this end, various proxies of intelligence and test scores have been added to equations from which estimates of returns to education result. Please note that this strategy, though perhaps effective to account for unobserved heterogeneity, does not cope with the endogeneity issue. The effects so far of adding ability controls to the estimated returns to education are negative for the US, positive elsewhere and (hence) ambiguous in total (see Ashenfelter et al., 1999, Table 3).

The second strategy for identifying causal effects is setting up a randomized experiment. This approach has not yet been much applied in labor economics research (Leuven et al., 2003). The evaluation of the causal effect of, for instance, a year of education requires a random assignment of individuals into a treatment group (participating in the education) and a control group (not participating). In this manner, endogeneity does not play any role since the relevant investment decision is forced. Moreover, unobserved heterogeneity can be expected to be absent, because assignment into groups is random such that the groups will be similar in terms of all their (observed and unobserved) characteristics.[6] Follow-up measurement should provide insight into individual levels of performance (or income), which is the cross-sectional variation to be explained.

The third strategy uses the variation in schooling, and income between monozygotic twins to estimate returns to schooling. This approach has been used to identify employees' returns to education (e.g. Ashenfelter and Krueger, 1994; Behrman and Rosenzweig, 1999; Rouse, 1999; Bonjour et al., 2003). The basic idea is that monozygotic

[6] Questionnaires usually provide empirical backing for the similarity of the observed characteristics.

twins share exactly the same genetic endowment and usually experience even more similar environments than non-twin siblings or dizygotic twins. It then seems that comparing monozygotic twins should thoroughly control for otherwise unobserved heterogeneity in intelligence, family background and the like. Bound and Solon (1999) critically discuss the potential pitfalls of this identification strategy: most twin studies rely on small samples that usually describe twins who volunteer to participate, twin strategies are most sensitive to measurement errors, they do not really cope with the endogeneity of the schooling decision, and it is not clear why twins who are genetically identical end up with different outcomes. In general, these studies render a higher estimate of the returns to education of employees than OLS (Ashenfelter et al., 1999).

The fourth strategy identifies causal effects using an instrumental variable (IV) approach. The idea is to imitate a field experiment where economic characteristics are randomly allocated among individuals to estimate their effects on income. This strategy therefore enables the unbiased measurement of the effect of, for instance, schooling, assuming a random allocation of schooling levels amongst individuals, independent of their expected pay-offs (endogeneity issue) or relevant unobserved background variables (unobserved heterogeneity). With IV, problems do not so much relate to the peculiarity of data, but rather to the availability and quality of identifying variables (Angrist and Krueger, 1991). In general, IV-estimates of the returns to an employee's education are higher than estimates obtained by means of OLS (Ashenfelter et al., 1999). The appendix shows the formal structure of IV-models in general.

In the following, we shall discuss two applications of the IV identification strategy to the estimation of the returns to education for entrepreneurs. The first study, pertaining to the US, compares these returns to the estimates obtained for employees within the same sample. The second application aims at estimating the returns to education for entrepreneurs in a European country. Moreover, it aims at identifying the distinct effects of education and capital constraints on the performance of entrepreneurs. Little research has yet focused on the methodological issue of identifying the causal effect of two potentially endogenous and inter-related variables.

4. Application A: Returns to education for entrepreneurs and employees in the US

The aim of the study "The returns to education: A comparative study between entrepreneurs and employees" by Van der Sluis, Van Praag and Van Witteloostuijn (2004) (VVW) is to measure the returns to education for entrepreneurs while accounting (and testing) for potential endogeneity, unobserved ability as well as selectivity into entrepreneurship. VVW estimate the returns to education for both entrepreneurs and employees. Using the same methodology for both samples allows them to compare the size of the biases resulting from omitted ability measures, the magnitude of the returns to education and the importance of sample selection for both groups. They estimate a Random Effects model using an IV approach to deal with the endogenous nature of the education decision. To investigate the effect of omitted ability bias, they moreover use a set of detailed ability proxies.

4.1. Data and methodology

VVW estimate the effect of education for both entrepreneurs and employees on a sample drawn from the National Longitudinal Survey of Youth (NLSY). They replicate several aspects of an earlier study, i.e. Blackburn and Neumark (1993) (BN hereafter) that estimated the rate of return to education for employees based on the same sample.

The NLSY is a rich panel. Individuals included in the sample were between 14 and 22 years old in 1979, the year of the first interview. These men and women have been interviewed annually up to and including 1994, and since then on a bi-annual basis. The NLSY includes sufficient employees and entrepreneurs and flows between these states to separately estimate their returns to education while controlling for selectivity. VVW use the representative part of the sample consisting of 6,111 young people. From these 6,111 people they extracted, per year observed, the hourly wage, the total years of education completed and various exogenous variables.

A particularly relevant background variable included in the NLSY is the *Armed Services Vocational Aptitude Battery* (ASVAB), which is an IQ-like test-score. This test-score was administered in 1979-1980 and can therefore be treated as exogenous. It is included in the income equations for both entrepreneurs and employees. In this manner, the difference between the returns to education resulting from merely

using OLS without such controls can be compared to estimates obtained upon the inclusion of such an (usually unobserved) ability measure. Consistent with BN, VVW adapt the ASVAB (administered in 1979-1980) test-score in two respects. First, they separate the test-score, which is composed of ten separate scores, into an "academic" and a "non-academic" component. Second, in order to remove the age effects from the ASVAB, as respondents are of different ages when the test is administered, they regress each normalized test score on a set of seven age dummies and use the individuals' residuals as the new test scores.

A second important feature of the NLSY is the presence of detailed family background variables. These variables were administered in 1979-1980, but their (hence recalled) values pertain mostly to the respondents' family backgrounds at the age of 14 (e.g. the presence of a library card in the household). Consistent with BN, VVW use some of these variables as identifying instruments for the respondent's education. These family background characteristics are possibly good predictors of the educational level of the respondent, while otherwise independent of their future wage. Indeed, as we shall see below, the resulting set of identifying instruments for education, which also includes a measure of parental education, passes the tests of quality and validity that VVW perform. However, critical evaluations of using family background as identifying instruments for education in an income equation have been expressed by Card (1999). He doubts the validity of instrument sets consisting of parental background variables. In other words, he postulates that parental background does have a separate and additional effect on an entrepreneur's (or employee's) income, even when the regression controls for the respondent's education and ability and various additional observed characteristics; see also footnote 9.

A third advantage of the NLSY data is its panel format. Twenty years of information on approximately 6000 individuals results in a large number of data-points. An additional advantage of panel data over cross-sectional data is the possibility to control for time-varying individual characteristics and economic fluctuations. The panel character of the NLSY is thus exploited by VVW to correct for cohort effects, age effects, and macroeconomic shocks. To this end, they use a decomposition technique (Deaton, 2000), not used by BN, to rescale cohort and time trends such that they become orthogonal to each other.

The panel character of the data set is further exploited by VVW to test, and if necessary account, for sample selectivity issues (Wooldridge, 2002). It may be the case that individuals with high education are selecting into (away from) self-employment. This might have an effect on the measured levels of the marginal returns to education, if these are not constant in the number of years of education. The finding that, for instance, entrepreneurs have a higher return to education than employees could thus be completely spurious: First, returns to education for entrepreneurs would be higher in the case of entrepreneurs being less educated than employees on average, and if returns to schooling are decreasing in general. Second, if entrepreneurs are more highly educated than employees on average, and if the returns to education do increase in general, the observed result would again be that entrepreneurs earn higher returns to their education on average. However, these effects would neither be causal, nor comparable amongst entrepreneurs and employees. It is therefore highly relevant to test (and if necessary account) for selectivity. VVW perform a variety of such tests, amongst others a method proposed by Nijman and Verbeek (1992).

4.2. Results

The estimation results that VVW obtain for the effect of education on income for both entrepreneurs and employees are reported in Table 1. The left half of the table pertains to entrepreneurs, the right half to employees. The first column in each of these segments shows OLS estimates without ability controls, as a kind of benchmark. The second (and fifth) columns provide OLS estimates obtained when controlling for an indicator of ability. The third (and sixth) columns show the (second stage) estimation results when using an IV-approach that VVW estimated by 2SLS.

4.3. Returns to education

The results in the first and fourth columns show that the OLS-estimate of the returns to education is 7.1 percent for entrepreneurs and 6.7 percent for employees. In accordance with previous studies using US data, the returns are slightly higher for entrepreneurs than for employees (Fredland and Little, 1981; Tucker, 1985, 1987; Evans and Leighton, 1990; Robinson and Sexton, 1994). The difference is not significant, though.

Table 1. Determinants of income for entrepreneurs and employees (1979-2000)

	Entrepreneurs			Employees		
	OLS	OLS	RE IV	OLS	OLS	RE IV
Log Hourly Pay	(1)	(2)	(3)	(4)	(5)	(6)
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Years of Edu-	0.071 ***	0.067 ***	0.142 ***	0.067 ***	0.059 ***	0.107 ***
Academic		0.026	-0.142		0.015	- ***
Non-academic		-	0.075		0.064 ***	0.113 ***
Male	0.668 ***	0.668 ***	0.648 ***	0.242 ***	0.229 ***	0.240 ***
Married	0.025	0.025	0.026	0.058 ***	0.058 ***	0.058 ***
Hispanic	-0.123	-	-0.094	-0.005	0.014	0.018
Black	-0.244 ***	- ***	-0.235 ***	-0.136 ***	- ***	- ***
Constant	-0.962	-	-1.59 *	0.048	0.145	- ***
R^2 Within	0.18	0.18	0.19	0.52	0.52	0.53
R^2 Between	0.33	0.33	0.32	0.47	0.48	0.43
R^2 Overall	0.28	0.28	0.27	0.49	0.5	0.47
N	3519	3519	2952	55769	55769	47152

Note. Each estimation controls for year effects, age effects and macroeconomic shocks (Deaton 2000). Other control variables included and not reported are "locus-of-control beliefs", health-status, regions, and levels of urbanization. **p*-values<=.10; ***p*-value<=.05; and ****p*-value<=.01.

Next, VVW control for the potential bias due to omitted ability measures in the returns to schooling estimate. To this end, they include the academic and non-academic ability proxies from the ASVAB test scores. Columns two and five show that the estimates for the return to education drop for both entrepreneurs and employees to 6.7 percent and 5.9 percent, respectively. All other results remain approximately the same. These results indicate that the returns to education are biased upward when ability is omitted. This is consistent with the findings that Ashenfelter et al. report and that we mentioned before. An additional observation here is that the bias is larger for employees than for entrepreneurs, as the drop in the schooling estimate

is smaller for entrepreneurs. Contrary to expectations, almost none of the results for the ability proxies are significant.[7]

Of course, there are many reasons why the number of years of schooling could be correlated with the disturbance term, and one of these is unobserved ability. In addition, the inclusion of IQ scores on the right-hand side of the earnings function does neither completely purge the estimated returns from ability bias (IQ scores are only proxies and academic ability is not necessarily perfectly correlated with on-the-job ability) nor is it sufficient to control for endogeneity, since ability is not necessarily perfectly correlated with time discounting behavior and/or the degree of risk aversion and similar factors. Therefore, next applying the IV procedure is extremely relevant.

Columns three and six of Table 1 show the IV estimation results. Applying IV results in significantly higher estimates of the returns to education. The increase from 6.7 percent to 10.7 percent for employees, i.e. an increase of 4 percent points or almost 60 percent, is comparable to increases resulting from applying IV instead of OLS in previous applications, such as BN. A novel observation is the even greater jump in the estimates pertaining to entrepreneurs: the IV-estimate is twice as high as the OLS-estimate of 7.1 percent and amounts to 14.2 percent. This leads to a remarkable result: the returns to education for entrepreneurs are estimated to be much higher than for employees in the US, i.e. 3.5 percentage points or 33 percent. Previous research that compared the returns to education for entrepreneurs and employees based on OLS-estimates resulted in much smaller and insignificant differences: the returns were only slightly higher for entrepreneurs than for employees in the US. The current finding would therefore lead to different insights: the returns to education for entrepreneurs are substantially higher, which would have policy relevant implications. Before discussing the remaining results in Table 1 as well as these policy implications, we first extend on the quality and validity of the instruments chosen and the relevance of taking account of the endogeneity of schooling at all. We then discuss two robustness checks as well as the issue of selectivity. These extensions are crucial for the assessment of the credibility of this result.

[7] Using one composite measure of (both academic and non-academic) ability would generate positive coefficients for this ability measure in both equations, while leaving all other coefficients unchanged.

4.4. Choice of instruments

For the instrumentation of the possible endogenous education variable, VVW follow BN and use an extensive set of background variables as identifying instruments.[8] They then propose suitable instrument sets for both the group of entrepreneurs and the group of employees that they test for their quality (see Bound et al., 1995), and validity (Sargan's F statistic, as in Davidson and MacKinnon, 1993). The quality criterion comes down to requiring a sufficient correlation between the set of instruments and the endogenous regressor, education in this case. Instruments are valid if they affect performance via the education equation only. A set of instruments therefore passes the validity test if it is not correlated with the error term in the performance equation. Variables proposed by BN as components of the set of identifying instruments were dropped if they turned out to be invalid. The resulting set of valid identifying instruments that is of sufficient quality only differs slightly between entrepreneurs and employees (see VVW, 2004).

Given the availability of a set of valid instruments that is of sufficient quality, it is possible to perform a Hausman test that answers the question: is schooling indeed endogenous in the income equations for entrepreneurs and employees? A positive answer to this question gives support to the idea that treating education as an exogenous variable is not econometrically admissible. The Hausman test that VVW perform indeed demonstrates the endogenous nature of the education variable in the income equations for both segments of the labor market.

[8] This choice of identifying instruments has recently been criticized. The idea is that family background variables are very likely to be correlated with a child's innate ability and hence, to affect her or his educational attainment choices, as well as expected returns from schooling. Such a set of instruments would therefore not be valid. We acknowledge this drawback of our choice of instruments. At the same time, we try to measure and minimize its potential negative effects by performing Sargan's validity test and including indicators for the child's ability into the regression.

4.5. Robustness checks[9]

We have to perform two robustness checks to see whether the returns to education are really higher for entrepreneurs than for employees. We then still need to address the selectivity issue as a third robustness check. First, the estimations suggest that the percentage gain in terms of income of an extra year of education for entrepreneurs is higher than for employees. The question is whether the returns to education are also higher for entrepreneurs in absolute terms: does a year of education generate more dollars per hour for an entrepreneur than for an employee?[10] To answer this question, we estimate the returns to education for entrepreneurs and employees using hourly pay as the dependent variable instead of log hourly pay, keeping all else equal. The results still provide support for the finding in terms of percentages: the returns to education in dollars are higher for entrepreneurs than for employees.

Our second robustness check concerns the assumed log normality of the distribution of hourly pay. The estimates in table 1 have been obtained under this assumption, both for entrepreneurs and for employees. Especially for entrepreneurs, this assumption might be questionable (see for example Blanchflower and Meyer, 1994). To this end, we re-calculate (in a slightly less precise way) the percentage returns to education for both groups using the results from the wage equation with hourly pay as the dependent variable. In this way, we circumvent using the results obtained under the assumption of log normality of the hourly earnings distribution. We divide the IV estimate education coefficient of the no log wage equation by the average wage (for entrepreneurs and employees separately). The outcome again supports our claim that the returns are higher for entrepreneurs than for employees (with returns to education of respectively 0.141

[9] Angrist et al. (1996) discuss the local average treatment effect nature of the IV approach, pointing out that the use of IVs leads to identifying the treatment effect only from the particular group affected by the instrument. When using IVs to separately estimate the returns to schooling for entrepreneurs and employees, the resulting estimates might not be comparable if the groups affected by the instruments are different with respect to some unobservable characteristics, which have different impacts on employment status and education. We do not check whether our finding is robust to this alternative explanation. More studies using various sets of identifying instruments are required to perform such a test.

[10] For instance, if entrepreneurs earned much less on average than employees, the higher percentage gain could correspond to a lower dollar gain.

and 0.127). This outcome is apparently invariant to the assumed log-normality of the hourly earnings distribution[11].

4.6. Selectivity issues[12]

VVW investigate two possible alternative explanations of their finding that entrepreneurs face higher returns to education than employees which are related to selectivity: (i) entrepreneurs are less educated and returns to schooling are decreasing; (ii) entrepreneurs are more educated and returns to schooling are increasing. Both combinations of findings would render the comparison of the returns to education for entrepreneurs and employees misleading. Hence, to investigate whether one of these alternative explanations is valid, they have to analyze: (1) whether the returns to education are increasing, decreasing or constant as a function of years of education. And (2) whether entrepreneurs have higher or lower education levels than their employed counterparts.

VVW analyze the sign of the second derivative of income with respect to education in two alternative manners. First, they split both the sample of entrepreneurs and that of employees into two equal parts: one with higher than median education levels, the other with below median education levels. A comparison of the resulting (four) IV estimates of the returns to education shows that, if anything, the returns to education are increasing: they are higher for the better educated halves of both samples. Second, to check this result, they re-estimate the wage equations as shown in Table 1 by means of IV, and include education squared as an additional regressor.[13] For entrepreneurs, the returns to education turn out to follow a U-shaped distribution with its minimum at 8.2 years of education completed. For employees, the returns to education have a U shaped distribution with

[11] There is some evidence that entrepreneurs underreport their actual income. In this study, we do not correct for this bias. However, this bias would only influence the estimation results if the relationship between education and underreporting income were different for entrepreneurs than for employees.

[12] Throughout, we assume that individuals decide upon their educational investments and then choose to become employees or entrepreneurs. In reality, these decisions might be made simultaneously or individuals might choose their employment status and then, the most compatible educational stream.

[13] They account for the potential endogenous character of education squared by including the residuals of the first-stage education equation and the first-stage squared education equation.

its minimum at 4.7 years of schooling. This means that for the most relevant part of the education distribution, the returns to education are an increasing function of education in both the sample of entrepreneurs and of employees. This gives VVW a second indication of increasing returns. Selectivity would therefore only be a possible spurious explanation for the higher returns for entrepreneurs in case more highly educated individuals are selected into entrepreneurship.

VVW use several methods to investigate the possibility that education positively determines the selection into self-employment. A first indication of this can be found by inspection of the descriptive statistics. The mean education levels for entrepreneurs and employees are almost equal. Second, they analyze whether education level is a significant determinant of the (time varying) employment status by estimating a random effects probit model. The results show that the effect of education on the decision to become an entrepreneur is insignificant. A third method to test for sample selection bias is based on work by Nijman and Verbeek (1992) who suggest that a lag of the employment status be included in the wage regression. The underlying assumption to this approach is that sample selection is related to idiosyncratic errors only. The test results indicate that the lag is insignificant in both the income equation of entrepreneurs and that of employees. So again, sample selection is rejected. A fourth, quite similar, test is to include the fraction of time the respondent has been an entrepreneur in the wage equation. In this way, a more precise measure of state dependence is created. With this test, VVW show that the selection effect is insignificant for entrepreneurs and significant for employees. However, the disadvantage attached to including a lag or the fraction of labor market experience gathered as an entrepreneur, is the possible productive effects of such indicators on income. This would obscure the test of the presence of sample-selectivity. A solution to this problem is to include a lead instead of a lag of employment status into the wage equation. Current wages are unlikely to be affected by the future decision to be an entrepreneur. Including a lead in the wage equation results in the rejection of the presence of selectivity for both entrepreneurs and employees, which leads VVW to the overall conclusion that self-selection is not a disturbing factor that would render their result invalid. This finding is actually consistent with previous findings that showed that the decision to become an entrepreneur is not significantly affected by education (VVV, 2003).

4.7. Remaining effects

Some of the effects of the control variables that Table 1 shows are notable. Males earn statistically and economically significantly higher incomes than females. This confirms previous findings for both segments of the labor market. Moreover, the extent of the gender effect differs largely across labor market segments. Male wage employees earn 24 percent more than female wage employees. The comparable difference between male and female entrepreneurs is 67 percent. This large difference of the gender effect between entrepreneurs and employees is also visible in other studies (Moore, 1982; Robinson and Sexton 1994; De Wit and Van Winden, 1989; Dolton and Makepeace, 1990; Tucker, 1987).

Interestingly, the correlation between being married and income is higher for employees than for entrepreneurs: it is more than twice as large for employees and insignificant for entrepreneurs. The income of married employees is 6 percent higher than the income of single employees, whereas this difference is an insignificant 2.5 percent for entrepreneurs. This is supported by previous findings (Moore, 1982; Gill, 1988; Evans and Leighton, 1990; Dolton and Makepeace, 1990; Tucker, 1987).

A striking result is that the effect of race, i.e. being black, is much larger for entrepreneurs than for employees: 24 versus 10 percent. The support for this difference in previous literature is less clear. Fairly and Meyer (1996) and Moore (1982) support this finding while Fredland and Little (1981) and Rees and Shah (1986) find that the effect of race is smaller for entrepreneurs than for employees. Evans and Leighton (1990) and Dolton and Makepeace (1990) even find ethnicity to be positively related to the incomes of entrepreneurs. A side remark should be made about these other studies. The VVW study explicitly distinguishes "blacks" as an ethnic group. Doing this ensures that the different effect of Hispanics and other ethnicities is observed. The other studies reporting race effects have neglected this differentiation and are therefore less clearly interpretable.

Comparing the explanatory power of both equations leads to the observation that a much larger proportion of the variance in earnings of employees can be explained by the observed factors than that of entrepreneurs.

4.8. Preliminary conclusion

Using an instrumental variables approach to identify the causal effect of education on the earnings of both entrepreneurs and employees gives novel insights into the returns to education for entrepreneurs relative to those for employees: US entrepreneurs seem to benefit more from an additional year of education than their employed counterparts: the returns to education are shown to be much higher for entrepreneurs (14 percent and 10 percent, respectively). As the difference in estimated returns is much smaller and insignificant when using OLS, we conclude, but do not yet understand, that the bias resulting from not accounting for endogeneity is larger for entrepreneurs than for employees. The next section will show whether this high IV-estimate of the return to education for entrepreneurs is maintained in a different application of IV to estimate the returns to education for entrepreneurs. This application pertains to Europe and controls for the inter-related effect of capital constraints. Please bear in mind that the literature overview showed the returns to education for entrepreneurs to be lower in Europe than in the US.

5. Application B. The effects of education and capital constraints on entrepreneur income: Dutch evidence

The objective of the study "Schooling, capital constraints and entrepreneurial performance: the endogenous triangle' by Parker and Van Praag (PvP) is to answer the question: To what extent is the performance of a small business venture, once started, affected by capital constraints at the time of inception and the business founder's investment in human capital? In particular, can we (PvP) measure the distinct contribution of each of the factors human and financial capital, taking account of the possibility that human capital might also have an indirect effect on performance by making financial capital easier to access and thus diluting any capital constraint? Using a sample of data from a rich survey of entrepreneurs conducted in the Netherlands in 1995, they empirically test three propositions that follow from a theoretical model[14]:

[14] Parker and Van Praag (2004) extended an existing model of Type I credit rationing, by Bernhardt (2000), to deal with human capital and entrepreneurs' performance.

- Capital constraints have a decreasing effect on average on entrepreneurs' performance.
- Greater human capital has an increasing effect on average on entrepreneurs' performance.
- Greater human capital decreases capital constraints.

The empirical contribution of the study is threefold. First of all, PvP model entrepreneurs' capital constraints as an endogenous variable (measured on a continuous scale), and assess the causal effect of these constraints on entrepreneurs' performance. This is novel, as previous empirical research has explored the effects of financial capital, rather than of capital constraints per se; and has moreover tended to treat it as exogenous.[15] PvP argue that treating capital constraints as endogenous yields useful insights into their composition, while enabling the effects of these constraints on entrepreneurs' performance to be consistently estimated. After all, it is to be expected that the extent of capital constraints is endogenous because both actual and desired amounts of start-up capital will be positively related to the prospect of high business performance. And there might also be unobserved individual characteristics, such as ability and motivation, that affect both the extent of capital constraints (for instance, via banks' loan application selection procedures) and subsequent business performance. The omission of these unobserved characteristics from the performance equation would render OLS biased, where the direction and the magnitude of the bias would depend on the correlation between these characteristics and the extent of capital constraints.

To this end, it is necessary to recognize the potential endogeneity of the capital constraint. Following their empirical results that confirm the endogeneity of capital constraints, PvP employ an instrumental variable (IV) estimator to explicitly take account of this problem.

The second contribution of PvP is to treat education, a form of human capital, as an additional endogenous variable that also helps explain entrepreneurs' performance. In this respect, they generate comparable estimates to VVW (2004), the only entrepreneurship study that acknowledges the endogenous character of education so far (see above). The relevance of this acknowledgement is empirically supported in this application as well. Once again, IV is used to pro-

[15] For instance in Holtz-Eakin et al. (1994), Cressy (1996), Lindh and Ohlsson (1996), Taylor (1996, 2001) and Johansson (2000).

vide consistent estimates of the impact of this variable on entrepreneurs' performance.

PvP's third contribution is to estimate the combined effects of education and capital constraints on performance, while controlling for a possible relationship between these explanatory variables. By disentangling the various inter-relationships, more reliable estimates of the determinants of entrepreneurial performance can be obtained.

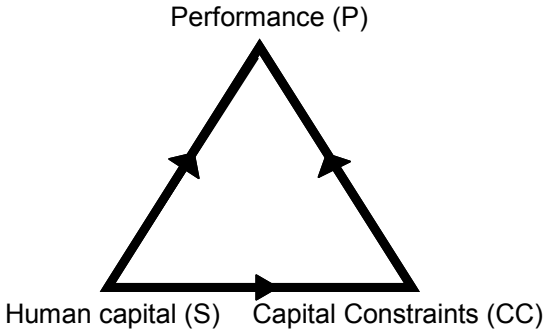
5.1. Empirical methodology

In order to take data to the three propositions resulting from their theoretical model, PvP develop an empirical model that simultaneously estimates the effects of education (S) and capital constraints (CC) on performance (P), as well as the relationship between education and capital constraints. As discussed, Instrumental Variables (IV) is a potential appropriate method for identifying the causal effects they desire to measure; see the appendix. PvP use a two-stage least squares (2SLS) estimation procedure, which renders the reduced form estimates of schooling and the extent of capital constraints in the first stage, and uses the first-stage results in the second stage to obtain a consistent IV-estimate of the returns to schooling and the effect of capital constraints on performance in entrepreneurship.

Figure 1 illustrates the "endogenous triangle" structure (between human capital, capital constraints and performance) of the resulting empirical model, consisting of two first-stage equations (S) and (CC) and one second-stage equation (P).[16]

[16] Schooling is taken to be exogenous in the extent of the capital constraints equation. The theoretical case for endogeneity is weaker in the capital constraint context, because (although possible) it seems unlikely that individuals acquire schooling in order to bypass capital constraints. Although the problem of unobserved heterogeneity is perhaps more plausible, PvP found no empirical support for this possibility when testing for it, as discussed below.

Figure 1. The endogenous triangle



5.2. Data

The data set used in this empirical application is a random cross-section sample of Dutch entrepreneurs. Entrepreneurs were defined as individuals who started their own business from scratch or who took over an existing (family) business. The sample of more than 450 valid observations was generated as part of a public-private joint project, commissioned by RABO bank, a large Dutch cooperative bank, and the General Advisory Council of the Dutch Government. The data set contains a range of economic and demographic variables including ones relating to human capital, financial capital, and business performance. A unique aspect of the data set is its detailed coverage of start-up finance information, necessary to construct a continuous capital constraint variable, combined with personal characteristics of the entrepreneur dating back to the date of start-up and earlier.

In order to clearly define the study's measures of entrepreneurial performance (P), human capital (S) and financial constraints (CC), we next describe these key variables of interest. Particular attention is paid to the constraint variable (CC), which is a novel one that improves over other measures utilized in the literature to date.

5.3. Endogenous variables

Entrepreneurial performance (P) is measured as the natural log of one plus total gross annual business income from the venture in 1994

Dutch guilders (1.85 guilders = one USD in 1994).[17] Hence, this variable approximates gross personal income, consistent with entrepreneurs' and employees' measures of income in VVW.

The next endogenous variable to be empirically defined is human capital or education in this case (S).[18] Education is measured as the number of years of schooling, such that the marginal return to a year of schooling will result from the analyses, in a manner comparable to VVW.

The third endogenous variable is capital constraints. This is a more broadly defined variable than borrowing constraints because, unlike the latter, capital constraints also take into account the possibility that some individuals use their own personal equity to fund their start-ups, either in part or in whole. In fact, personal equity is widespread in the sample. More than 80 percent of the respondents injected at least 1000 guilders of their own savings into their business, and 66 percent at least 3000 guilders. To construct a measure of capital constraints, let A be the amount of an entrepreneur's assets used as personal equity in the business; let k^e be the total amount of capital borrowed from (possibly multiple[19]) lenders; and let k^* be the desired amount of borrowing, given A. Also, define K^e and K^* as the total amounts of capital used and required, respectively. Clearly $K^e = A + k^e$ and $K^* = A + k^*$. The extent to which an individual is capital constrained can thus be measured as:

$$CC = 100\Delta = 100(1 - \frac{K^e}{K^*}) = 100(1 - \frac{A + k^e}{A + k^*}) \in [0,100] \qquad (1)$$

Every term in (1) has been empirically measured.[20] Arguably, CC more precisely captures the notion of constraints than do measures of

[17] Business income is defined as all income from the business, before deducting tax and social security contributions but after deducting business-related costs.

[18] It was felt that trying to endogenize alternative dimensions of human capital, such as years of experience, would entail too many theoretical and empirical complexities, which go beyond the scope of this study.

[19] Sample data are available on several finance sources to compute the total amount borrowed. These include banks, venture capitalists, government loan agencies, and trade credit.

[20] In particular, values of K^e were given as responses to the questionnaire question "How much capital did you need at the start of your current business?", and those of K^* as responses to the question "What was the amount of money that you actu-

financial capital used in many previous studies, such as savings, assets, inheritances, or lottery outcomes.[21] This is because it measures the divergence between requested capital and capital actually obtained, which more directly captures the notion of a constraint. Another advantage of CC is that it is a continuous variable, and it will therefore possess greater information content than dummy variables (used by, e.g., Astebro and Bernhardt, 2003) that indicate whether an entrepreneur believes herself to be credit constrained.

A drawback of CC is that it is based on self-reported data. Individuals might give biased estimates of their required and actual initial capital values (a problem that might also be shared by some previous empirical studies utilizing self-reported asset values). On the other hand, entrepreneurs might exaggerate capital requirements when approaching lenders, as a negotiating tactic. If so, then at least it seems plausible that responses obtained from an anonymous questionnaire, as in the sample used here, will be more accurate than those obtained from bank file data.

5.4. Exogenous variables

The endogenous variables are not only related to each other, as already discussed, but may also depend on several exogenous variables. Exogenous variables that are likely to affect the decision to pursue a specific number of years of formal schooling include early childhood factors such as number of siblings, current age (capturing cohort effects), the father's education level, and gender.

As well as (endogenous) years of schooling, several exogenous initial human capital variables (i.e., dated from the year in which entrepreneurial ventures were started) are likely to affect the extent of capital constraints and incomes. These include the entrepreneur's initial age; years of general work experience; years of same industry experience; previous business experience prior to start-up; and whether the

ally started with?". Values of A were given as responses to the question "How much of your own money did you invest in the company at the start?"

[21] Previous empirical research has established a robust positive relationship between financial capital and entrepreneurship performance. But these studies do not measure capital requirements at all, so such a relationship is not necessarily indicative of capital constraints. For example, the empirical relationship might simply reflect decreasing absolute risk aversion (Cressy, 2000), a positive competition externality (Black et al, 1996), or rational avoidance of borrowing premiums in imperfect capital markets.

individual switched from paid employment, PE (in the public or private sector) just prior to start-up.[22] All of these variables are expected to be positively associated with income and negatively associated with capital constraints.

Income and capital constraints might furthermore be affected by entrepreneurs' initial financial circumstances. These circumstances are reflected by indicators of entrepreneurs who continued to receive some wage income at the time of start-up, or who had a spouse or partner that earned sufficient income at that time for the venture to survive poor performance. Such "external" (i.e., non-entrepreneurial) income sources can be expected to relax an entrepreneur's capital constraint. Their effects on performance might go either way, however (see PvP, 2004). Furthermore, from (1), the extent of capital constraints is a decreasing function of personal equity, A, and an increasing function of total capital required, K^*. But both variables might have additional effects by also affecting capital obtained from lenders. To avoid complications caused by (arbitrary) specifications of non-linear forms, but to nonetheless capture the main idea, both variables (which are measured at the time of start-up) are entered in the capital constraint equation, both in levels and squares. It does not, however, seem likely that the origin of one's start-up capital, given a certain level of capital constraints, would affect the venture's performance. This reasoning is borne out by later empirical results, which show that this is indeed the case.

Additional control variables that are likely to affect entrepreneurs' current performance include the age of the firm; firm size (FTE); and the average weekly number of hours worked in the first year of the venture. None of these control variables are expected to exogenously influence either years of schooling or capital constraints.

5.5. Results

This section is divided into three parts. The first demonstrates the importance of treating years of schooling and capital constraints as endogenous variables, and provides empirical backing for the "endogenous triangle" structure of the model. It also shows the choice of

[22] The last of these dummy variables takes the value of zero for 43 per cent of the entrepreneurs. This comprises self-employed (9 percent), students (13 percent), unemployed (16 percent), or otherwise classified (5 percent).

instruments used. In the second and third parts, the estimated capital constraint and performance equations are presented.

Instruments

It has been suggested that both years of schooling and capital constraints are likely to be endogenous variables in the entrepreneurial performance equation, while schooling is less likely to be endogenous in the capital constraint equation. PvP directly test the relevance of correcting for endogeneity in each of these three cases by applying Hausman's (1978) t-test. The test statistics indeed support all three initial suggestions, motivating the use of IV estimators for schooling and capital constraints in the performance equation, thus justifying the triangular structure of the model.

Having established that years of schooling and capital constraints are endogenous variables, they then test their proposed instrument sets for their quality (see Bound et al, 1995), and validity (Sargan's F statistic, as in Davidson and MacKinnon, 1993).

In the years of schooling equation, the identifying instruments "the respondent's father's education" and "number of siblings in the respondent's family" pass these tests (see Blackburn and Neumark, 1993, and Card 1999 for a critical discussion). In the capital constraint equation, the set of identifying instruments that pass these tests consists of initial personal equity (and its square), the total amount of start-up capital initially required (and its square) and the indicator variable for whether the respondent switched from paid employment (PE) just prior to starting.[23]

Explaining the extent of entrepreneurs' capital constraints

The first column of Table 2 presents estimates of the capital constraint equation. The first key result is that extra years of schooling

[23] Current performance is unlikely to be affected by initial personal equity or the size of the initial capital requirement, given that the extent of capital constraints is controlled for. This justifies their assignment as identifying instruments, as is supported by the tests of the validity of these identifying restrictions. The reason for selecting a switch from paid employment as an identifying instrument is that such a switch might send a better signal to lenders than does a (possibly involuntary) switch from another job in self-employment or from nonparticipation. At the same time, a switch from paid employment should not affect current performance in entrepreneurship, which is likely to depend more on experience in entrepreneurship and past experience generally.

significantly decrease the capital constraints. The estimated coefficient is large in absolute terms and statistically significant with a *p*-value of 3 per cent. This result, which implies that an extra year of schooling relaxes the capital constraint by 1.175 per cent, is consistent with Proposition 3. It implies that lenders are more willing to provide funds to more highly educated entrepreneurs, all else equal.

It is also of interest to interpret the other coefficients in the column. Strikingly, females appear to suffer less from capital constraints (ceteris paribus) than males, holding the amount of required start-up capital constant. Another characteristic that appears to mitigate capital constraints is having switched into entrepreneurship from paid employment just prior to startup. Such experience might serve as a positive signal to lenders, thereby encouraging them to offer more finance. As expected, the amount of personal equity injected at the start has a strongly negative (and non-linear) effect on the extent of capital constraints. The absolute size of this effect decreases as the amount of private business capital increases. The effect of the total amount of capital required by an entrepreneur on the extent of capital constraints is significantly positive (for 97 per cent of the sample), whereas the marginal effect decreases at increasing values of the total capital required. This might reflect lenders' unwillingness to over-extend themselves on risky investment projects. Every other variable in the equation is statistically insignificant, including other "initial" human capital and financial variables. The R^2 of 12 per cent indicates that PvP only have had limited success in explaining the extent of capital constraints.[24]

[24] No doubt, the poor fit might also provide encouragement to those who argue that many bank decisions on offering start-up finance are arbitrary, and predominantly based on intangible factors like "first impressions" and prejudice rather than tangible observable characteristics. However, this conclusion must be tempered to the extent that their specification suffers from omitted variable bias. In fact, their data set contains detailed personal and financial information that encompasses what is typically found in bank file data (c.f. Cressy, 1993); and checks confirmed that none of these extra variables were significant in the capital constraint equation. The possibility of mis-specification in this equation justifies the use of single equation estimators, rather than a systems estimator like 3SLS or FIML.

Table 2. Performance, schooling and capital constraints: a triangular system

	Capital constraints eq.			Performance eq.			Performance eq.		
	OLS			OLS			IV		
	Coef.		t-value	Coef.		t-value	Coef.		t-value
Years of schooling	-1.175	**	2.13	0.069	**	2.45	0.127	*	1.93
Capital constraint				-0.004	*	1.85	-0.021	**	2.29
Current age				0.241	***	3.91	0.198	***	2.96
Current age squared				-0.004	***	2.50	-0.003	***	3.39
Age at start-up	0.575		0.44						
Age at start-up squared	-0.012		0.68						
Female	-7.875	**	1.96	-0.260		1.24	-0.365		1.63
Years general experience	0.303		0.95	0.062	***	3.25	0.055	***	2.88
Years industry experience	-0.358		1.45	0.013		0.95	0.015		1.03
Has previous business experience	4.392		1.03	0.172		0.99	0.293		1.52
Earned wage at start-up	1.155		0.35	-0.200		1.32	-0.211		1.36
Partner had sufficient income	2.804		0.69	-0.018		0.09	-0.020		0.10
Firm age				0.095	***	4.73	0.087	***	4.33
# Employees				0.012	***	3.11	0.013	***	3.22
Weekly hrs. at start				0.015	***	4.16	0.014	***	3.85
Spouse input				0.441	***	2.59	0.371	**	2.20
Switched from PE	-8.722	***	2.78						
Personal equity	-0.348	***	4.94						
Personal equity squared	0.001	***	3.98						
Capital required	0.136	***	3.19						
Cap. required squared	-0.0001	***	2.80						
Intercept	35.326		1.48	-3.083		2.47	-2.925		2.06
R^2	0.12			0.25			0.26		
N	425			390			371		

Notes: Dependent variables are defined in the text. Regressions reported with robust standard errors. * *p*-value less than 0.10; ***p*-value less than 0.05; *** *p*-value less than 0.01. *k* is the number of parameters and *n-k* is the degrees of freedom. Method of estimation is given at the head of the table.

Explaining entrepreneurs' performance

The remaining columns in Table 2 present the determinants of entrepreneurs' performance, as estimated by OLS, the benchmark, and IV, respectively. The foremost findings relate to the returns to schooling and provide strong support for proposition 2. The OLS-estimate shows an average rate of return to schooling of 6.9 per cent in terms of entrepreneurs' gross incomes. A comparison with other OLS estimates of the return to schooling in entrepreneurship reveals that this estimate is a little higher than, but broadly comparable with, previous findings (cf. VVV, 2003). The third column presents the results using IV estimation. Like previous comparisons between IV and OLS conducted for employees, the IV estimate is substantially higher than the OLS estimate, being 12.7 per cent as compared with 6.9 per cent. The magnitude of this direct effect of education on performance is a little lower than the IV estimate pertaining to the US from VVW.

The OLS-result shows that the (biased) estimate of the effect of capital constraints on entrepreneurs' business incomes is numerically small, and significant only with a Type I error of 10 per cent. However, the IV estimate given in the next column is five times larger and highly significant. It implies that a 1 percent point relaxation of capital constraints increases entrepreneurs' average business incomes by (a significant) 2.1 per cent. This finding strongly supports Proposition 1.[25]

Next, the indirect effect of schooling on performance via the capital constraint is measured as 2 percent *1.175=2.4 percent, i.e. the product of the effect of capital constraints on performance, on the one hand, and the effect of education on capital constraints, on the other hand. This suggests a total rate of return from schooling for entrepreneurs of 15 per cent. A different estimate of the indirect effect can be obtained by re-estimating the performance equation, but excluding the capital constraint variable. The total return to schooling is then estimated as 13.5 per cent (*t*-statistic=2.13). The implied indirect effect according to this estimate is therefore "only" 0.8 percent.

[25] While the size of this effect looks substantial, it should be borne in mind that the average extent of capital constraints faced by entrepreneurs in our sample is only 19 per cent. Thus, a 10-per cent increase in (average) capital constraints would generate a lower average business income of 4.0 (= 21*0.19)×100 per cent only.

Nevertheless, the range of 0.8–2.4 per cent adds to the importance of human capital for entrepreneurial success.

PvP also find some interesting effects of a couple of the control variables. Hours worked by the entrepreneur and having a spouse work input in the business, and human capital as measured by age and general experience, are two important sets of variables that significantly and substantially enhance entrepreneurs' performance. The positive and concave relationship between age and performance, with a peak at 34, is consistent with estimates reported in other work (VVV, 2004). The remaining control variables also have the expected effects on performance. Entrepreneurs' log incomes are higher on average for older (and larger) businesses. These findings are consistent with Jovanovic's (1982) theory of industry evolution, reflecting survival by both the most able and also the most knowledgeable about their innate abilities in entrepreneurship. Finally, female entrepreneurs earn lower incomes on average than their male counterparts. But this effect is not significant.

6. Discussion of results

We argue, on the basis of a meta-analysis, that the returns to education for entrepreneurs need to be measured with the same methodological rigor as the studies on employees. Especially, the neglect of the endogenous nature of schooling is a problem. We discussed two recent studies that have applied IV to deal with this endogeneity problem. The results from both studies imply that the OLS estimates so far have been biased downwards. Do these results then shed an entirely new light on the four conclusions from the meta-analysis by VVV?

The first conclusion, i.e. that education has a significantly positive impact on entrepreneurs' performance, is supported and thus maintained. The second conclusion was that the estimated rate of return to education for entrepreneurs was 6.1 percent on average. This conclusion is not supported by the currently discussed results that account for endogeneity and unobserved heterogeneity. The return to education for entrepreneurs turns out to be much higher, and comparable, in the two applications discussed: VVW estimate a return of 14.2 percent; PvP's estimate of the total return to education turns out to be between 13.5 percent and 15 percent.

The third conclusion of the meta-analysis was that the returns to education are slightly higher for entrepreneurs than for employees in the US, whereas the opposite was found for Europe. This conclusion is not supported by the results from the first application discussed: the returns for entrepreneurs in the US are shown to be much higher than the returns for employees (14.2 percent and 10.7 percent, respectively).[26] The result of this study, and therefore assumedly most previous studies, is not plagued by problems of selectivity. This turn around finding must be somewhat puzzling in the light of the traditional studies that test screening hypotheses: apparently entrepreneurs cannot be maintained as an assumedly unscreened control group. This might explain why PvP find that capital constraints for entrepreneurs are relieved when the level of education is higher.

The fourth conclusion from the meta-analysis was that all previous studies, utilizing OLS, had generated potentially biased results. This potential bias, as was argued, is due to the neglect of problems related to endogeneity and unobserved heterogeneity. Previous studies that account for such problems when estimating the returns to education for employees had indeed pointed out that this bias generated by OLS estimation was significant in the case of employees. The studies presented in this paper are the first in the field of entrepreneurship that apply IV techniques and thereby account for potential endogeneity. As it turns out in both applications, the bias is significant in the entrepreneurs' case too. To put it more strongly, the bias is even larger in the case of entrepreneurs. We do not yet understand why this is the case.

Of course, the use of instrumental variables is not without critique, neither is the choice of the instruments that were applied by VVW and PvP. The use of family background characteristics as instruments has been criticized by Card (1999). He states that it could be possible that family background variables have an additional and separate effect on income. We therefore argue that, in order to validate the results found by PvP and VVW, more analyses in this spirit should be performed with different sets of instruments. Besides the use of dif-

[26] The second study does not generate such a result for Europe, because it analyzes a sample of entrepreneurs only.

ferent instruments, the use of other identification strategies such as twin studies and field experiments is of utmost relevance[27].

The result from the PvP study further implies that the distinct and direct effect of human capital is usually obscured by its indirect effect through the extent of capital constraints. The total effect of approximately 14 percent that they find is shown to be a direct effect of 12.7 percent and an indirect effect, through the extent of capital constraints, of approximately 1.3 percent. This indirect effect is due to the finding that an extra year of schooling relaxes the capital constraint, thus implying that lenders are more willing to provide funds to more highly educated entrepreneurs, by 1.2 per cent. The extent of capital constraints, in turn, affects an entrepreneur's income negatively, leading to this significant indirect effect. Further studies that explore the distinct effects of the manifestations of human, social or financial capital that are presumably inter-related could increase our understanding of the inter-relatedness and substitutability of such types of entrepreneurial capital.

One other, but related, issue of concern is the low "explanatory power" of the determinants in the entrepreneurs' income equation. VVW can explain only 28 percent of the variance in entrepreneurial income by the observed factors compared to almost 50 percent in the employee part of their study. Likewise, PvP explain 26 percent of the variance in entrepreneurial income. It is therefore possible that we are missing some important determinants of entrepreneurial performance. The full exploitation of human, social and financial capital as determinants of entrepreneur performance should therefore make a start. Human capital, for instance, has almost exclusively been defined as the level of education. Future research should also focus on the specific direction and compilation of the education followed (vocational studies, technical studies, subjects studied, or specific entrepreneurship orientated courses, etc.).

Concluding this discussion, the steps taken by VVW and PvP are a first contribution to the measurement of the causal and distinct effect of education on the performance of entrepreneurs. By using more recently developed estimation strategies, they find results that lead to enormously different conclusions than previous research based on OLS. However, these outcomes should be interpreted with great cau-

[27] Ashenfelter et al. (1999) have found that the usage of different estimation techniques like IV and Twin studies result in different estimations of the returns to education for employees. This could also be true for entrepreneurship studies.

tion since n=2, which is a bit meager to use an understatement. Further studies using IV, with various sorts of instruments, twins and field experiments need to be performed to validate these results.

7. Conclusion

In this paper, we have provided an overview of past and current research in the field of the economics of education for entrepreneurs. We concluded that entrepreneurship has so far been a neglected child in the family of the economics of education. Two studies were presented that both try to make a step forwards in developing this child to become a bit more like her brother, i.e. studies of employees. We think studies like these are of intrinsic interest for the academic field of entrepreneurship. Moreover, the policy implications resulting from these studies might bear even more importance.

Before we discuss the policy implications that follow from our results, it is important to elaborate on the assumptions we require for these implications to follow from our results. First, we assume that the social return of entrepreneurial activity is larger than the private return that accrues to the entrepreneur himself.

Second, we assume that the difference between the social and private benefits of entrepreneurial activity is larger than is this difference for employees. A successful entrepreneur is, for example, more likely to influence the competition in a market than an employee. Moreover, entrepreneurs can more easily bring new and innovative ideas into the market than employees[28].

Third, we assume that individuals invest in schooling at a stage in their lives when they do not yet know, in general, whether they will become entrepreneurs, or employees, or a (sequential) combination of both. As a consequence, investment in schooling is not motivated by the specific expected return when belonging to the group of entrepreneurs, but by some (weighted) average return of both employment modes.

Our fourth assumption is that individuals, as well as policy makers, bankers and other parties involved, have no more insight into the returns to education than we have as researchers. This implies that indi-

[28] In addition to these positive external effects of entrepreneurial activity, entrepreneurs are often credited for their impact on labor demand. However, this is rather a short-term than a long-term effect: In the absence of new firms, their demand for labor would be effectuated by growing incumbent firms instead.

viduals and policy makers share the knowledge (and common opinion) that the returns to education are similar for entrepreneurs and employees.

Our fifth assumption relates to the question of whether the difference in returns to education between entrepreneurs and employees can be attributed to a risk premium obtained by more highly educated entrepreneurs. It could be the case that more highly educated individuals require higher risk premia for being an entrepreneur, and thereby having a less secure income position than would lower educated entrepreneurs. The motivation for this explanation of the higher rate of return for entrepreneurs than for employees would be the following. More highly educated individuals experience more additional income risk as an entrepreneur as compared to an employee, than would individuals with a lower education. However, our (fifth) assumption is that this is not the case. This assumption is based on the following observations from our data: First, regressing the (time) variance of the incomes[29] of individual entrepreneurs on their education levels and some control variables renders no significant education effect. Hence, the variance of the entrepreneurial income is not higher for more highly educated individuals, all else equal. Second, estimating the same equation for employees reveals a significant positive coefficient for education. Third, the variance in earnings is lower for employees than for entrepreneurs, at all possible education levels. These three observations imply that entrepreneurs are exposed to more income risk than employees, but that the difference is a decreasing, rather than an increasing, function of education. Based on this, we can safely assume that the higher returns to education for entrepreneurs are not a kind of risk premium.

So why is education more valuable for entrepreneurs? We propose a simple explanation, namely that entrepreneurs have more freedom to optimize their use of education. Entrepreneurs are not constrained by rules from superiors and can decide on how to implement their education in such a way that its productive effect is the highest. In contrast to the entrepreneur, the organizational structure surrounding an employee makes it difficult for the employee to optimize the productive effect of education. Next to that, the organization cannot adapt its structure to every individual due to organizational inertia and

[29] To be more precise, the variance of the residuals of the income equations as presented before is the dependent variable in this case

inflexibility. This difference in ability to optimize the productivity of education for entrepreneurs and employees might therefore be an explanation for the higher returns to education for entrepreneurs than for employees. We conclude that education is a relevant instrument for influencing employee and, especially, entrepreneur performance.

The knowledge that the returns to education are high and that education is therefore a key input in a starting enterprise, is informative for the design of educational policies and policies with respect to (selecting) starters designed by bankers and other capital suppliers. Moreover, the adequate design of tax and subsidy measures towards starters and their capital suppliers (mostly by the Ministry of Economic Affairs) might also benefit from these insights.

Policy makers should be aware that the returns to education for entrepreneurs are higher than those of employees. Governments could take two actions regarding this new knowledge. They could invest in higher schooling for (prospective) entrepreneurs, or they could invest in stimulating more highly educated individuals to opt for entrepreneurship. The first action will ensure that entrepreneurs will perform better, and that they will thereby generate more benefits, that will not only accrue to the entrepreneur himself but to society as a whole. This will decrease the social costs pertaining to bankruptcy accordingly. The second action appeals to the fact that, at least in Europe, entrepreneurship does not seem to be a favored option, or even be part of the choice set, amongst young people with higher education. They usually favor working in a large multi-national company and do not even think about self-employment. We strongly believe in the benefits of governmental programs to stimulating the awareness of the option of entrepreneurship to college and university students.

The execution of further research into the character of the most beneficial types of education will lead to practically useful insights for the design of schooling tracks recommended to entrepreneurs. These types of education can then further be used to recruit entrepreneurs from, for instance the Ministry of Economic Affairs and to further stimulate and facilitate these entrepreneurs, financially or otherwise, for instance by means of subsidies and (loan) guarantees.

Finally, we believe that the PvP results offer backing for the dual track approach to promoting entrepreneurship adopted by many governments. The dual track approach involves attempting to soften capital constraints while developing initiatives to deepen human capi-

tal. The PvP findings suggest that duality is especially important when human capital and financial capital are interrelated and endogenous. Thus, the power of extra education to improve entrepreneurs' performance seems to be greater when capital constraints exist, because education helps relax these constraints as well as having a direct effect on performance. But the inter-relatedness of these phenomena prevents us from here pronouncing on the correct balance between government programs that promote human as opposed to financial capital.

The result of improved policy measures will be the decrease of barriers to entry for potentially successful starters, and the increase of useful support to those starters. This will reduce the social costs of bankruptcy and increase the social benefits of innovative enterprises.

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Appendix

Consider the simple linear model

$$\gamma = \beta_0 + \beta_1 x_1 + \ldots + \beta_{J-1} x_{J-1} + \beta_J x_J + u, \tag{A.1}$$

where y denotes entrepreneurial performance, x_J through x_{J-1} are exogenous variables (including past experience), and x_J denotes years of schooling, where $E(u)=0$ $\text{cov}(x_J, u)=0$ for $J=1, 2,\ldots,J-1$ but where x_J might be correlated with the disturbance term u. In other words, the explanatory variables $x_1,\ldots x_{J-1}$ are exogenous, but x_J is potentially endogenous. Instrumental Variables (IV) is known to be an appropriate estimator in the presence of these problems. The IV approach (see Wooldridge, 2002) exploits the existence of an identifying instrument, possibly a vector, z_1, not in (A.1) that satisfies two conditions: (i) $\text{cov}(z_1, u)=0$ and (ii) $\theta_1 \neq 0$ in the reduced form equation for the endogenous explanatory variable x_J:

$$x_J = \eta_0 + \eta_1 x_1 + \ldots + \eta_{J-1} x_{J-1} + \theta_1 z_1 + v, \tag{A.2}$$

where $E(v) = 0$ and v is uncorrelated with the x_j ($j=1,\ldots,J-1$) and z_1. Condition (i) above relates to the validity of the (identifying) instrument(s); condition (ii) relates to the quality of the instruments. The structural equation (A.1) and the reduced form equation (A.2) can be estimated by two-stage least squares (2SLS), which renders the reduced form estimate of β_J in (A.1) a consistent estimate of the returns to schooling in entrepreneurship. We use a similar model to deal with the endogenous financial constraints.