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Signaling and the Valuation of Unseasoned New Issues: A Comment

JAY R. RITTER*

IN THE MARCH 1982 issue of this *Journal*, David Downes and Robert Heinkel [1] present an empirical examination of the role of signaling in the valuation of initial public offerings of common stock. For a large sample of unseasoned new issues, they examine the Leland-Pyle [2] signaling hypothesis that firm value should be positively related to the fraction of equity retained by the original shareholders. Downes and Heinkel conclude that the data are consistent with the Leland-Pyle signaling hypothesis.

In this comment, I present a more complete test of the Leland-Pyle signaling model. I also present two alternative explanations for the positive empirical relation between firm value and insider holdings, which I label the agency hypothesis and the wealth effect hypothesis. I find that the testable implications of the agency hypothesis are supported, while the evidence is ambiguous with respect to the testable implications of the wealth effect and signaling hypotheses.

I. The Theories and Their Predictions

A. *The Signaling Hypothesis*

In the Leland-Pyle [2] model, the fraction of post-offering equity retained by the owner-entrepreneur of a firm going public serves as a signal of firm value because higher insider holdings, *ceteris paribus*, mean that the personal portfolio of the risk-averse owner-entrepreneur is less well diversified. With some simplifying assumptions, Leland and Pyle formally derive a relation between the fraction of the firm retained by insiders, α, and the expected future firm value. This results in the following expression for the value of the firm:

$$V(\alpha) = I - [b/(1 + r)]\sigma_x^2(1 - \rho^2)[\alpha + \log(1 - \alpha)] \quad (1)$$

where I is the dollar value of investment to be undertaken, b is the coefficient of risk-aversion of the owner-entrepreneur, r is the riskless interest rate, $\tilde{x}$ is the unpredictable component of next period's cash flow with variance σ_x^2, and ρ is the correlation coefficient of the project and market returns. Thus, by observing

* Assistant Professor of Finance, Wharton School, University of Pennsylvania. This comment is based on Essay 2 of my Ph.D. dissertation at the University of Chicago. I am grateful to my committee, Merton Miller, Edward Prescott, and Lester Telser for their advice. Comments received from Harry DeAngelo, Wayne Ferson, Mark Flannery, Melanie Lau, Hans Stoll, and an anonymous referee have also been beneficial. The 1960s data have been generously provided by David Downes, who has also spent substantial time discussing the topic. An earlier version of this comment was circulated under the title "Insider Holdings and the Pricing of Initial Public Offerings."

α, and given knowledge of the other parameters, investors are able to discern the true value of the firm.

Equation (1) is graphed in Figure 1. Inspection of this equation shows that the level of investment only affects the intercept, and α only affects the slope. Thus, the equilibrium signaling schedule shifts vertically as investment changes. These parallel schedules provide the basis for the strong prediction that, holding α constant, as investment increases, the firm value should increase dollar for dollar with investment. In particular, note the following testable implications of the Leland-Pyle model.

The Leland-Pyle Hypothesis' Testable Implications—If α serves as a signal of firm value, then in a multiple regression with (post-offering) market value as the dependent variable: (i) an explanatory variable representing investment should have a coefficient of one and (ii) $[\alpha + \log(1 - \alpha)]$ should have a negative coefficient, or alternatively, since $[\alpha + \log(1 - \alpha)]$ and α are negatively related, α should have a positive coefficient.

These testable implications are more complete than Downes and Heinkel's interpretation of the Leland-Pyle hypothesis. Downes and Heinkel only focused on the implication regarding the coefficient on $[\alpha + \log(1 - \alpha)]$.

B. The Wealth Effect Hypothesis

While the signaling hypothesis provides a plausible rationale for a positive relation between insider holdings and observed firm value, there is another possible explanation for the observed correlation. This "wealth effect" explanation rests upon the fact that, to raise a given amount of money, the initial owners must sell a *smaller proportion* of the stock in a firm the greater the market value

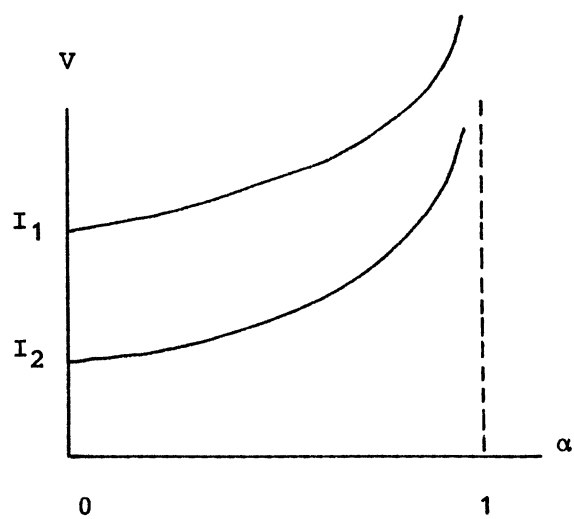

Figure 1. Graph of Equilibrium Signaling Schedule for Two Different Levels of Investment with Relevant Boundary Condition for Leland-Pyle Signaling Model Relating Insider Holdings (α) to Firm Value V

of the firm. Of course, a wealth effect of exactly the opposite kind might arise if the owners of successful firms choose to sell larger amounts of stock to raise large sums of money for investment (primary offerings) or due to strong diversification motives (secondary offerings). Whether this wealth effect accentuates or mitigates the positive relation between relative firm value and insider holdings is, therefore, an empirical question. However, there is a strong presumption that the wealth effect accentuates the relation, at least for secondary offerings. This is because capital gains taxes create a "locked in" effect for the original shareholders (the data used to examine the hypotheses are from the 1965–73 period during which capital gains taxes were higher than they are today). With highly successful firms, the market value of the equity will greatly exceed the book value. In the sample used in this comment, for instance, the *average* pre-offering ratio of market value to book value is 5.10. Since the original investment of the initial owners is approximately the book value of the stock, large capital gains have been incurred, and taxes might be substantial enough to outweigh portfolio rebalancing motivations. Furthermore, since the underwriter's discount averages over 8% for these initial public offerings, and since the offering price is on average below the after-market price, the opportunity costs of selling stock in an initial public offering are very substantial. Thus, it seems plausible that only strong reasons to sell, such as to pay taxes on estates or for immediate consumption, are sufficient to overcome the high costs involved. Because of this, it seems plausible that the elasticity of secondary sales with respect to firm value, both measured in dollars, is likely to be less than one, which is sufficient to generate a positive relation between market value and α due to the pure wealth effect. Thus, note the following important predictions of the wealth effect hypothesis.

The Wealth Effect Hypothesis' Testable Implications—If a wealth effect is present, then an ordinary least squares (OLS) or a weighted least squares (WLS) regression with firm value as the dependent variable and α as an explanatory variable will be subject to simultaneous equations bias.[1] Therefore, (i) a two-stage least squares (2SLS) regression should have a coefficient on α closer to zero than the comparable OLS or WLS regression. Furthermore, (ii) this coefficient should be positive.

C. *The Agency Hypothesis*

An agency problem exists when it is impossible to monitor costlessly the performance of a manager to whom decision-making authority has been delegated. In contrast to the signaling analysis, where true future firm value is not causally dependent on the owner-entrepreneur's holdings, the agency analysis assumes that the true relation, as well as the equilibrium perceived relation, relates α and firm value. Thus, while the signaling analysis takes true firm value

[1] An ordinary least squares or a weighted least squares regression is subject to simultaneous equations bias if one of the right-hand side variables is causally affected by the dependent variable. In this example, if relative firm value affects α, then the residuals of a WLS regression with firm value as the dependent variable will be correlated with one of the right-hand side variables, α. This correlation results in inconsistent parameter estimation, with a positive bias resulting for the coefficient estimate on α.

as exogenous and focuses on overcoming an assumed information asymmetry, the pure agency analysis views it as endogenous and assumes that there is no informational asymmetry between the manager and investors beyond that arising from the inability to observe the manager's actions. The idea underlying the agency hypothesis is that managerial compensation schedules do not induce managers to produce as much as would be the case with 100% owner-management. The implication is that the lower the fraction of insider holdings, α, the lower will be the firm value because the cash flows will be reduced due to managerial shirking. Because outside investors know that the manager will do less shirking the higher is α, the market value of the firm will be positively related to α, *ceteris paribus*.

Both the Leland-Pyle signaling hypothesis and the agency hypothesis predict that there will be a monotonic relation between insider holdings and firm value, although for different reasons. The agency hypothesis predicts undirectional causality in exactly the opposite direction to that implied by the wealth effect hypothesis. Thus, if there is an agency relation, OLS regressions using α as the dependent variable will be subject to simultaneous equation bias.

The Agency Hypothesis' Testable Implications—If the positive relation between insider holdings and relative firm value is due to an agency relation, then an OLS regression with α as the dependent variable and relative firm value as an explanatory variable will be subject to simultaneous equations bias. Therefore, (i) a 2SLS regression should have a coefficient on relative firm value closer to zero than the comparable OLS regression. (ii) In an OLS or WLS regression with market value as the dependent variable, the coefficient on alpha should be positive.

II. Description of the Data and Empirical Results

The sample of initial public offerings used to examine the testable implications of the signaling, wealth effect, and agency hypotheses is comprised of 559 firms that went public in the period 1965–73 in the United States. The sample contains only those offerings registered with the U.S. Securities and Exchange Commission (SEC) and having annual sales of $1,000,000, a book value of equity of at least $500,000 prior to going public, and positive earnings, where these are measured in 1980 dollars.[2] These criteria restrict the sample to relatively "established" firms.

I use the post-offering market value of equity as a measure of firm value.[3] In ordinary least squares (OLS) regressions using this as the dependent variable,

[2] All initial public offerings of common stock with gross proceeds in excess of $300,000 were required to file Form S-1 Registration Statements by the SEC until May 1971. After May 1971, this proceeds criterion was increased to $500,000. For offerings with gross proceeds less than the critical amount, the SEC allowed issuers to conduct "Regulation A" offerings, which have substantially less stringent and less costly disclosure requirements. The 1965–69 data were generously supplied by David Downes. I collected the 1970–73 data, approximately doubling the sample size.

[3] For the firms in this sample, there is very little difference between the post-offering market value of equity and the market value of debt and equity, in that the average post-offering debt-equity ratio is less than 0.05, computed using market values.

there is a heteroscedasticity problem. Consequently, I use weighted least squares (WLS) in the empirical work, deflating firm value and the explanatory variables by the pre-offering book value of equity. In these regressions, three explanatory variables are used. These are (i) a measure of the firm's investment, the net proceeds raised by the firm in the initial public offering, (ii) the annual earnings of the firm for the year prior to going public, and (iii) a measure of insider holdings, alpha, which is defined as the fraction of post-offering equity retained by pre-offering shareholders.[4] All three of these definitions are the same as those used by Downes and Heinkel.[5]

I also run an OLS regression with alpha as the dependent variable. This results in the two-equation system

$$\text{market} = \beta_0 + \beta_1 \text{ alpha} + \beta_2 \text{ earnings} + \beta_3 \text{ investment} + \epsilon$$

$$\text{alpha} = \gamma_0 + \gamma_1 \text{ market} + \gamma_2 \text{ earnings} + \gamma_3 \text{ log sales growth rate} + \eta$$

Earnings and the natural logarithm of (one plus) the growth rate of sales are included in the regression for alpha to reduce the effect of heterogeneity of the sample on the coefficients of interest. These two variables are also used in the first-stage regression to compute the instrumental variable for alpha. This simple two-equation system allows the testing of the implications of the Leland-Pyle signaling, agency, and wealth effect hypotheses.

The top line of Table I reports the results of a weighted least squares (WLS) regression with post-offering market value as the dependent variable. All right- and left-hand side variables have been divided by the pre-offering book value of equity. The coefficient on alpha of 6.27×10^7 is positive, consistent with all three hypotheses. The coefficient on investment is 2.59, far above the Leland-Pyle hypothesis' predicted value of 1.00.[6] The hypothesis that this coefficient is unity can be rejected at any conventional level of significance. While this is inconsistent with the Leland-Pyle signaling hypothesis, it should be noted that a joint hypothesis is being tested; that there is a coefficient of unity on investment, and that the net proceeds raised are an appropriate measure of investment. One possible interpretation of the investment coefficient being in excess of one is that it is a measure of the profitability ratio (the ratio of gross present value to investment). In the Leland-Pyle model, information about the profitability ratio should be conveyed entirely through α, however.

[4] Alpha is bounded by zero and one, and has been calculated assuming that any overallotment option granted to underwriters is not exercised. Any warrants or stock options outstanding have also been omitted in calculating alpha, unless they were exercised by the completion date of the offering. The sample mean of alpha is 0.72, with a standard deviation of 0.09 and a range of 0.43 to 0.95.

[5] Actually, Downes and Heinkel use the Leland-Pyle transformation of α, $\log(1 - \alpha) + \alpha$, in their regressions. The motivation for using this nonlinear transformation of α is contained in Equation (1), the Leland-Pyle equilibrium signaling schedule. For the sample range of α, a linear approximation does not fare poorly, however.

[6] The weighted least squares regressions are similar to those in Row c of Downes and Heinkel's Table I. (The parameter values for b_0 and b_2 that they report should be multiplied by a factor of 10^7.) They interpret the positive coefficient on α (negative on $\alpha + \log(1 - \alpha)$) as supporting the Leland-Pyle signaling hypothesis, but they do not examine the Leland-Pyle implication that the coefficient on investment should be one.

Table I

Structural Equation Estimates with Post-Offering Market Value as Dependent Variable

	$\times 10^7$ Constant	$\times 10^7$ Alpha	Earnings	Investment	R^2
Weighted Least Squares	−4.77 (1.05)	6.27 (1.46)	14.99 (0.28)	2.59 (0.18)	0.91
Two-Stage Weighted Least Squares	−19.68 (7.98)	27.98 (11.51)	11.39 (1.80)	2.54 (0.18)	0.91

Note: Standard errors in parentheses. The weighting factor is the pre-offering book value of stockholders equity. The first-stage equation for alpha, not reported here, had an R^2 of 0.15. All equations use 559 observations. All variables are expressed in terms of 1980 purchasing power, using the U.S. GNP Deflator. The mean value of the dependent variable is $34,617,000.

The second line of Table I reports a two-stage weighted least squares regression with the predicted value of alpha used as an instrumental variable. The first-stage regression for computing the predicted values of alpha uses the log of the sales growth rate and annual earnings as explanatory variables. In the second-stage regression, the coefficient on alpha of 27.98×10^7 is much higher than the WLS estimate of 6.27×10^7. It should be noted, however, that the standard error of the parameter estimate of 27.98×10^7 is so large that a two standard error confidence interval includes the WLS estimate. I attribute the large standard error to the inability to find a good instrument for alpha.[7] (The first-stage regression has a coefficient of determination of only 0.15.) The WLS parameter estimate for alpha does not appear to be subject to the simultaneous equation bias predicted by the wealth effect hypothesis.

In Table II, alpha is used as a dependent variable in an OLS regression with market value as an explanatory variable. This would be the relevant regression to run if a wealth effect was responsible for the positive correlation between alpha and firm value. The agency hypothesis predicts that the coefficient on market value in this regression is subject to simultaneous equation bias. In the bottom line of Table II, I report the results of a two-stage OLS (2SLS) regression where the first stage was estimated using WLS. The predicted market value used as an instrumental variable was constructed using earnings and investment as explanatory variables. In the 2SLS regression, the coefficient on market value is significantly closer to zero than in the OLS regression, consistent with the prediction of the agency hypothesis.

[7] The predicted value of α that is used as an instrument also suffers from multicollinearity with earnings. This is why the standard error on the earnings coefficient increases from 0.28 in the WLS regression to 1.80 in the two-stage WLS regression.

Table II

Structural Equation Estimates with Alpha as Dependent Variable

	Constant	$\times 10^{-9}$ Market Value	$\times 10^{-9}$ Earnings	Log Sales Growth Rate	R^2
Ordinary Least Squares	0.679 (0.007)	1.015 (0.183)	−1.763 (3.630)	0.056 (0.022)	0.19
Two-Stage Ordinary Least Squares	0.680 (0.007)	−0.028 (0.406)	16.737 (7.032)	0.073 (0.022)	0.15

Note: Standard errors in parentheses. The first-stage weighted least squares equation for market value, not reported here, had an R^2 of 0.91. All equations use 559 observations. Log sales growth rate constructed by taking the natural logarithm of one plus the inflation-adjusted growth rate of sales in the 3 years prior to going public.

III. Summary and Conclusions

This comment has developed testable implications of three explanations for the positive empirical relation between firm value and insider holdings. Of the three alternative, but not mutually exclusive, hypotheses, the agency hypothesis has fared the best. While the predictions of the signaling and wealth effect hypotheses are not fully supported, this could be due to misspecifications of the tests or other problems. In particular, other tests that I do not report here indicate that the evidence regarding simultaneous equation bias is not as robust to alternative instruments or specifications as I would like. Consequently, the conclusions of this comment should be viewed as tentative. Nevertheless, it does seem premature to accept Downes and Heinkel's evidence as demonstrating that signaling is occurring.

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