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Spinoffs and Information*

Michel A. Habib†

London Business School, Sussex Place, Regent's Park, London NW1 4SA, United Kingdom

D. Bruce Johnsen‡

School of Law, George Mason University, 3401 North Fairfax Drive, Arlington, Virginia 22201-4498

and

Narayan Y. Naik§

London Business School, Sussex Place, Regent's Park, London NW1 4SA, United Kingdom

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We present an information-based explanation for spinoffs. When the various divisions of a firm are spun off into several firms that have separate stock market listings, the number of traded securities increases. This makes the price system more informative. It improves the quality of the investment decisions made by managers and reduces uninformed investors' uncertainty about the value of the divisions. Both effects serve to increase the sum total of the market values of the spun-off divisions above the market value of the original firm. *Journal of Economic Literature* Classification Numbers: G14, G34.

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† E-mail: mhabib@lbs.lon.ac.uk.
‡ E-mail: djohnsen@osf1.gmu.edu.
§ E-mail: nnaik@lbs.lon.ac.uk.

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Recent years have witnessed a large number of spinoffs, whereby one or more divisions of a quoted firm are detached from the original firm to become independent entities that are separately quoted on the stock market, yet remain owned, at least initially, by the shareholders of the original firm. Examples of such spinoffs have been those of Sears, ITT, and Hanson Trust. The announcement of these and other spinoffs has generally been accompanied by an increase in the value of the original firm.[1]

We present an information-based explanation for spinoffs that focuses on the role of the prices of traded securities in transmitting information about the value of the various assets (or divisions) of a firm from informed investors to managers and to uninformed investors. As spinoffs transform a single firm into many firms that have separate stock market listings, they increase the number of traded securities and make the price system more informative. This has two distinct effects. First, it improves the quality of managers' investment decisions. Second, it reduces uninformed investors' uncertainty about asset values. Both effects lead to an increase in firm value.

For tractability reasons, we present these two effects in two different frameworks, both involving informational considerations. To see how spinoffs serve to improve the quality of managers' investment decisions, consider the case of a firm that consists of two divisions, each holding a different type of asset. Assume that the manager of each division must determine the extent to which he should expand his division, by acquiring further assets of the type held by the division. Each manager clearly will be guided by the share price of the firm in making his investment decision, for the share price of the firm reflects informed investors' private information about the value of the firm's assets. Prior to a spinoff, the information reflected in the share price of the firm pertains to both types of assets and is therefore of less value to the managers than would be information pertaining to each type of asset. By transforming each division into a separate firm that has its own share price, a spinoff serves to provide the manager of each division with information pertaining exclusively to the single type of asset held by his division. This improves the quality of the investment decisions made by the managers and consequently increases firm value.

The assumption that investors in a firm are better informed about the value of the assets of the firm than are the managers of the firm may, at first sight, seem surprising. However, it can be justified in the case of macroeconomic information that affects the value of the assets of the firm. It can also be justified in the case of firm-specific information, for one can argue, as do Allen (1993) and Boot and Thakor (1997), that while managers are likely to be better informed than any single investor, they are unlikely

[1] See for example Schipper and Smith (1983), Hite and Owers (1983), Miles and Rosenfeld (1983), Kudla and McInish (1989), Jongbloed (1994), Vijh (1994), and Daley *et al.* (1995).

to be better informed than all investors, whose separate information is aggregated into share prices.[2]

To see how spinoffs serve to improve the quality of the information inferred from prices by uninformed investors, ignore the investment problem described above, and consider two Grossman and Stiglitz (1980) economies with informed and uninformed investors and liquidity traders. These two economies are distinguished by the fact that a firm with two divisions is traded as a single entity in the first economy, whereas these divisions are traded as separate entities in the second economy. Uninformed investors clearly will infer more information from prices in the second economy, for they observe two market prices in place of one. This reduces their uncertainty about the value of the two divisions and increases their demand for shares. It consequently increases firm value.[3]

Our explanation of spinoffs is consistent with various comments which appear to imply the undervaluation, for informational reasons, of firms that consist of various divisions which operate in different businesses and have differing prospects, and to view spinoffs as serving to remedy this undervaluation. For example, "ITT's fast-growing leisure business" was said to be "submerged by the more staid manufacturing and insurance businesses" prior to ITT's decision to split itself into three parts.[4] It was similarly said of Chase Manhattan, whose estimated breakup value, ranging from $55 to $75 per share, was in sharp contrast to its market value of $35 per share prior to its merger with Chemical Bank, that "the trouble for Chase is that the virtues of its best businesses . . . have been shrouded in the lacklustre performance of the group. As a result, the value of the whole has failed to keep pace with the sum of the parts."[5] In contrast, Sears, Roebuck's spinoff of Dean, Witter has been described as "creat[ing] pieces that people will be able to understand so that the stock can fetch a fairer value."[6]

[2] We do not explicitly model the aggregation of information into prices, for this is well understood. See for example Hellwig (1980).

[3] The *intra*-firm problem we consider is thus to be contrasted with the *inter*-firm problem of equity carve-outs, in which investors are unable to distinguish between the same businesses of various firms (Nanda, 1991). It is very similar to the asset sell-off problem considered by Nanda and Narayanan (1996), from which it differs in considering the role of prices rather than cash flows in communicating information.

[4] See the Lex Column in *The Financial Times*, June 14, 1995.

[5] See the article "Chase under Pressure to Deliver the Goods" by Richard Waters, in *The Financial Times*, Apr. 10, 1995. Although Chase Manhattan was eventually merged with Chemical Bank, it is interesting to note that a break up of Chase, possibly through a spin-off, was among the solutions considered to its undervaluation problem. Thus the Lex Column in *The Financial Times*, Apr. 10, 1995 "so far, Mr. Price is not spelling out exactly what he thinks Chase's management should do to promote shareholders' interests. But a slowdown in acquisitions and an accelerated return of cash to investors would seem the minimum. *More radical options would be to break Chase up* or merge it with another bank."

[6] See the article "Sears Roebuck Holds a Multi-Billion Stock Clearance" by Patrick Harverson, in *The Financial Times*, Oct. 1, 1992.

Three main explanations of spinoffs have been presented in the literature. These have been based upon: (i) the desire to improve focus, (ii) the desire to improve managerial incentives, and (iii) the desire to facilitate the transfer of assets. The asset focus explanation has viewed spinoffs as improving the focus of a firm, thus serving to remedy the loss of focus inherent in a diversified conglomerate.[7] The managerial incentives explanation has viewed spinoffs as serving to provide the management of the various divisions of a firm with better incentive packages (Aron, 1991; John, 1991). Finally, the asset transfer explanation has viewed spinoffs as serving to facilitate the transfer of assets to those who value them most. A variant of the asset transfer explanation has been presented by Miller (1977), who argues that, in the presence of heterogeneous expectations, firms that represent ''pure plays'' on specific businesses and industries should be more highly valued than firms that do not, for the shares of the latter will be bought by those investors that are most optimistic about these businesses and industries.

All three explanations are reflected in the comments made regarding the spinoff of Hanson Trust. Indeed, it was said that ''head office was finding it increasingly difficult to assess the underlying performance of the electricity and chemical companies in the group, making it harder to set them tough but realistic financial targets,'' that ''[p]eople like the chairmen of Quantum and SCM [two divisions that were spun off] would be much more motivated, with their personal wealth linked directly to the performance of their businesses through share options,'' and that ''[s]eparately listed, [the chemical offshoot] will be an inviting target for a big European or American chemical group.''[8] The first comment may be viewed as illustrating the improved focus explanation, the second the managerial incentives explanation, and the third the asset transfer explanation.

Although the preceding explanations have generally been supported by empirical findings, they appear to be contradicted, to some extent at least, by those of Slovin *et al.* (1995).[9] These authors examine the effects of the announcement of a spinoff on the share price of the rivals to the spun-off division and its parent firm. They find a positive share price reaction in the

[7] See Matsusaka and Nanda (1996) for a formalization of the asset focus explanation based upon the role of focus in deterring entry.

[8] See the articles ''Widow Hanson's Children Leave Home,'' in *The Economist*, Feb. 3, 1996 and ''More Enthusiasm Inside the Company than Out,'' in *The Financial Times*, Feb. 1, 1996.

[9] The asset focus and managerial efficiency explanations are supported by the empirical findings of Schipper and Smith (1983), Hite and Owers (1983), Jongbloed (1994), Comment and Jarrell (1995), John and Ofek (1995), Lang *et al.* (1995), and Daley *et al.* (1995). The asset transfer explanation is supported by the empirical findings of Hite and Owers (1983), Kudla and McInish (1988), and Cusatis *et al.* (1993).

case of the rivals to the spun-off division. This finding may be viewed as being contradictory to the predictions of the asset focus and managerial incentives explanations of spinoffs, which motivates spinoffs by the desire to increase efficiency, and would therefore predict a negative share price reaction for the rivals of the division. This finding may also be viewed as being contradictory to the asset transfer explanation (Miller, 1977), as a greater supply of firms that offer ‘‘pure plays’’ on specific businesses or industries to investors should decrease the value of such firms, in view of the limited number of investors who are most optimistic about those businesses. Existing explanations of spinoffs may therefore be viewed as having some limitations.

The information-based explanation for spinoffs we present may however account for the findings of Slovin *et al.* (1995). Although we limit our model to a single firm, and do not model its rivals, it should be clear that the spinoff of a division of a firm increases the value of the rivals to the spun-off division, when the additional information provided by the spinoff pertains not only to the spun-off division but also to its rivals. The spinoff then improves the investment decisions made by the managers of the rivals and reduces uninformed investors' uncertainty about the value of the assets of the rivals. These two effects combine to explain the increase in the value of the rivals noted by Slovin *et al.* (1995).[10]

The decision to spin off part of a firm as a separate entity that has its own stock market listing can be viewed as an instance of security design, a subject that has been much studied in recent years. Harris and Raviv (1989) motivate the design of securities by corporate control considerations, Allen and Gale (1988, 1991) by risk-allocation considerations, Boot and Thakor (1993), Caballe and Krishnan (1994, 1996), Chowdhry and Grinblatt (1994), Gorton and Pennacchi (1990, 1993), Marín and Rahi (1996), Nachman and Noe (1994), and Subrahmanyam (1991) by informational considerations.[11]

Our paper is closely related to those of Gorton and Pennacchi (1990) and Boot and Thakor (1993) on the one hand, and Subrahmanyam (1991) and Gorton and Pennacchi (1993) on the other. In Gorton and Pennacchi

[10] An alternative explanation for the increase in the value of the rivals to the spun-off division may be the improved ability these have to compete with the spun-off division as a result of the revelation of more information about the division (see for example Yosha (1995) in the context of the choice between bilateral and multilateral financing). Should that be the case, the increase in the value of the rivals would be at the expense of the spun-off division. Both explanations nonetheless rely upon the increased informativeness of prices which we argue is the consequence of spinoffs.

[11] Also see Ross (1976), Grossman (1977), and Hakansson (1982). It should be noted, however, that whereas these papers examine the effects of such changes on the welfare of agents, our paper examines the effects of these changes on the prices of securities. These are not the same.

(1990) and Boot and Thakor (1993), two main types of securities are issued, which differ in their sensitivity to information. Information insensitive securities have values that do not depend on the private information of informed investors. These securities are held by uninformed investors who thereby decrease their losses to informed investors (Gorton and Pennacchi, 1990). Information sensitive securities are held by informed investors, who will have been induced to acquire costly information by the opportunity to profit from this information by trading the securities (Boot and Thakor, 1993). Our approach is similar in spirit to that of Boot and Thakor (1993) because it views the design of securities as serving to increase the informativeness of securities prices, and because it is driven by supply considerations. It differs from that of Boot and Thakor (1993) in two main respects. First, it examines how more informative prices can help improve the investment decisions of managers, an effect that is not explored in Boot and Thakor (1993). Second, in contrast to Boot and Thakor (1993), who motivate the issuance of different classes of claims on the combined cash flows from a number of assets, our approach motivates the issuance of a single class of claims on the distinct cash flows from the individual assets. The latter is representative of spinoffs, which are characterized by the issuance of equity claims on the cash flows from the assets of the spun-off divisions, in addition to the preexisting equity claims on the cash flows from the parent companies.

In the papers of Subrahmanyam (1991) and Gorton and Pennacchi (1993), baskets of securities serve to decrease the losses to informed traders sustained by liquidity traders. Baskets of securities have lower volatility than do individual securities, thus diminishing informed traders' ability to profit from their private information (Gorton and Pennacchi, 1993). They also diminish the value of private information which pertains to individual securities only (Subrahmanyam, 1991). The papers of Subrahmanyam (1991) and Gorton and Pennacchi (1993) may thus be viewed as presenting a rationale for the transformation of individual securities into a basket of securities, in contrast to ours which presents a rationale for the transformation of a basket of securities into individual securities, as a spinoff transforms what is essentially a basket of securities, the share price of a firm that consists of several divisions, into several individual securities. This difference is primarily a consequence of Subrahmanyam's (1991) and Gorton and Pennacchi's (1993) assumption that market-makers fail to observe order flows across markets, and of our assumption that informed investors behave competitively rather than strategically. The latter assumption implies that informed investors do not alter their trading to account for the greater propensity of multiple prices to reveal information, which consequently reveal more information.[12]

[12] The observation that spinoffs increase share prices suggests that informed investors behave competitively, in the case of spinoffs at least.

The paper proceeds as follows: Section 1 considers the transmission of information to managers and establishes the result that firm value is increased by the presence of two prices. Section 2 considers the transmission of information to uninformed investors and establishes a result that is similar to that of Section 1. Finally, Section 3 concludes.

1. THE TRANSMISSION OF INFORMATION TO MANAGERS

Consider a firm that has two assets, 1 and 2, which have values $\tilde{r}_1$ and $\tilde{r}_2$, respectively. Asset j, $j = 1, 2$, has value $\tilde{r}_j = \tilde{i}_j + \tilde{\varepsilon}_j$, where $\tilde{i}_j$ is a normal random variable with mean $E[\tilde{i}]$ and variance σ^2, and $\tilde{\varepsilon}_j$ is a normal random variable with mean zero and variance σ_ε^2.[13] $cov(\tilde{i}_1, \tilde{i}_2) = \rho\sigma^2$ and $cov(\tilde{i}_1, \tilde{\varepsilon}_1) = cov(\tilde{i}_2, \tilde{\varepsilon}_2) = cov(\tilde{i}_1, \tilde{\varepsilon}_2) = cov(\tilde{i}_2, \tilde{\varepsilon}_1) = cov(\tilde{\varepsilon}_1, \tilde{\varepsilon}_2) = 0$. Assume $\rho \geq 0$ without loss of generality.

Asset j is held by division j, which has risk-neutral manager j whose task is to expand the scale of the division. This expansion can be achieved by the acquisition of a number Q_j of asset j, at a cost $C(Q_j) = \frac{1}{2}cQ_j^2$.[14] Managers are assumed to know the distributions of the values of assets 1 and 2, but not to know the realizations i_1 and i_2 of the information that pertains to the values of the two assets. These realizations are, however, known by risk-neutral investors who make use of this knowledge to price the shares issued by the firm.

The problem solved by manager j is therefore

$$\underset{Q_j}{Max}\; Q_j E[\tilde{r}_j | \tilde{p} = p] - \tfrac{1}{2}cQ_j^2 \tag{1}$$

for $j = 1, 2$. A number Q_j of asset j has expected value $Q_j E[\tilde{r}_j | \tilde{p} = p]$, and cost $C(Q_j) = \frac{1}{2}cQ_j^2$. Manager j uses the share price p of the firm to guide his investment decision, for the share price reflects the information investors have about the value of the assets.[15] Problem (1) has solution

$$Q_j = \frac{E[\tilde{r}_j | \tilde{p} = p]}{c}.$$

[13] The assumption that the two assets have identical distributions is without loss of generality as regards the main result of Section 1. It is, however, essential to the analytical tractability of the analysis of Section 2.

[14] The formulation of the problem is adapted from Leland (1993).

[15] Papers that have also considered the provision of information by investors to managers are those of Boot and Thakor (1997), Dow and Gorton (1995), Dow and Rahi (1996), Fishman and Hagerty (1992), Leland (1993), and Titman and Subrahmanyam (1996).

The (net) value of expansion project j is therefore

$$\tilde{V}_j = \frac{E[\tilde{r}_j|\tilde{p} = p]}{c}\tilde{r}_j - \frac{E[\tilde{r}_j|\tilde{p} = p]^2}{2c}.$$

We can now show

LEMMA 1. *The price of a share p is a quadratic function of the information* $i_1 + i_2$. Specifically

$$p = i_1 + i_2 + \frac{(i_1 + i_2)^2}{4c}. \tag{2}$$

Proof. See Appendix.

Note that the price p of a share reflects the information $i_1 + i_2$ which pertains to both assets 1 and 2. This is to be expected, since the share price of the firm constitutes a claim on the total assets of the firm. Manager 1 is therefore unable to distinguish between the information i_1 which pertains to asset 1 and is important to his investment decision, and the information i_2 which pertains to asset 2 and would be of no importance to his investment decision if he knew the information i_1, for the correlation between the value of asset 1 and the information i_2 conditional on the information i_1 is zero ($cov[\tilde{r}_1, \tilde{i}_2|i_1] = cov[\tilde{\varepsilon}_1, \tilde{i}_2] = 0$). The same is true of manager 2.

Manager j's inability to distinguish between the two types of information distorts his investment decisions and lowers the value of expansion project j as compared to the case in which he knows the information i_j. Such knowledge can be achieved by a spinoff.

To see this, let division j be spun off into firm j, which has a separate stock-market listing. Manager j now makes use of the information reflected in firm j's share price p_j to guide his investment decision. We can then show

LEMMA 2. *Firm j has share price*

$$p_j = i_j + \frac{i_j^2}{2c} \tag{3}$$

Proof. The proof is identical to that of Lemma 1.

The observation of share prices now reveals the information i_1 and i_2 separately, in contrast to the case of a single firm in which it revealed only the information $i_1 + i_2$. The separate knowledge of i_1 and i_2 should make possible an improvement in the investment decisions made by managers 1 and 2, thus increasing the values of expansion projects 1 and 2, in turn leading to higher firm value. This is indeed the case, as is shown in Proposition 1.

PROPOSITION 1. *A spinoff increases the sum of the expected share prices of firms* 1 *and* 2 *above the expected share price of the single firm in the case of less than perfect correlation between the values of assets* 1 *and* 2 ($0 \leq \rho < 1$). *This increase is higher the lower the correlation between the values of the two assets.*

Proof. See Appendix.

Clearly, the separate knowledge of i_1 and i_2 would be of no advantage to managers in the case i_1 and i_2 were perfectly correlated, for it would provide no more information than would the knowledge of $i_1 + i_2$. Indeed, the lower the correlation between the two types of information, the higher the increase in firm value.[16] The empirical findings of Daley *et al.* (1995), which document positive abnormal returns in the case of cross-industry spinoffs but not in that of own-industry spinoffs, may be viewed as being consistent with the results of Proposition 1 if one associates the case of perfect correlation with that of own-industry spinoffs.

It is interesting to contrast the results of Proposition 1 with those of Ramakrishnan and Thakor (1991), who show that the gains from mergers are higher the lower the correlation between the values of the merging companies. This is because Ramakrishnan and Thakor (1991) focus on the role of mergers in allowing managers to coinsure each other, whereas we focus on the role of spinoffs in improving the informativeness of prices.

We now turn to the transmission of information from informed investors to uninformed investors.

2. THE TRANSMISSION OF INFORMATION TO UNINFORMED INVESTORS

Since our purpose is now to examine the transmission of information among investors, we can neglect the investment decisions faced by managers, but must introduce some heterogeneity among investors. We do so by assuming the existence of three different investors: an informed investor who knows i_1 and i_2, as was the case in Section 1, an uniformed investor who does not, but who can infer some information from the observation of share prices, and a liquidity trader. We assume that both the informed investor and the uninformed investor behave competitively, but preclude

[16] This is true for positive ρ, as has been assumed. The case of negative ρ is clearly symmetric: A spinoff increases the sum of the expected share prices of firms 1 and 2 above the expected share price of the single firm in the case of less than perfect negative correlation between the value of the two assets ($\rho > -1$). The increase in firm value is higher the less negatively correlated the values of the two assets. It is highest in the case of zero correlation between the value of the two assets.

fully revealing share prices by assuming that both investors are risk-averse. Our model is thus very similar to that of Grossman and Stiglitz (1980), but involves two assets rather than a single asset.[17]

Let the risk-free interest rate be zero. The informed investor and the uninformed investor, who are assumed to have CARA utility with risk-aversion coefficient a, can be shown to have demand

$$x_I = \frac{E[\tilde{r}_1 + \tilde{r}_2 | i_1, i_2] - p}{a\, var[\tilde{r}_1 + \tilde{r}_2 | i_1, i_2]} \tag{4}$$

and

$$x_U = \frac{E[\tilde{r}_1 + \tilde{r}_2 | \tilde{p} = p] - p}{a\, var[\tilde{r}_1 + \tilde{r}_2 | \tilde{p} = p]}, \tag{5}$$

respectively, where p denotes the price of a share. Note that the informed investor conditions his demand on the information i_1 and i_2 which he has, whereas the uninformed investor conditions his demand on the price p which he can observe. The informed investor need not condition his demand on price, for he already has the information i_1 and i_2 which pertains to the value of the assets.

Let the supply of shares be normalized to one, and the demand of the liquidity trader be a normal random variable $\tilde{x}$ with mean zero and variance σ_x^2. $cov[\tilde{i}_j, \tilde{x}] = cov[\tilde{\varepsilon}_j, \tilde{x}] = 0$, $j = 1, 2$. We then have

LEMMA 3. *The price of a share p is*

$$p = \frac{\dfrac{w}{a\alpha_1} + \dfrac{E[\tilde{r}_1 + \tilde{r}_2 | w]}{a\alpha_U} - 1}{\dfrac{1}{a\alpha_1} + \dfrac{1}{a\alpha_U}}, \tag{6}$$

where

$$w \equiv i_1 + i_2 + 2a\sigma_\varepsilon^2 x \tag{7}$$

$$\begin{aligned} \alpha_I &\equiv var[\tilde{r}_1 + \tilde{r}_2 | i_1, i_2] \\ &= 2\sigma_\varepsilon^2 \end{aligned} \tag{8}$$

[17] We do not, however, allow uninformed investors to become informed at a cost. Doing so would leave the main results of Section 2 unchanged in the case where some investors at least are initially endowed with the information.

and

$$\begin{aligned}\alpha_U &\equiv var[\tilde{r}_1 + \tilde{r}_2 | \tilde{p} = p] \\ &= var[\tilde{r}_1 + \tilde{r}_2 | w] \\ &= 2\sigma_\varepsilon^2 + \frac{2(1+\rho)\sigma^2(2a\sigma_\varepsilon^2)^2\sigma_x^2}{2(1+\rho)\sigma^2 + (2a\sigma_\varepsilon^2)^2\sigma_x^2}.\end{aligned} \tag{9}$$

Proof. Adapted from Grossman and Stiglitz (1980).

Note that the observation of the share price p reveals only the term w, which is a linear combination of the information i_1 which pertains to asset 1, the information i_2 which pertains to asset 2, and the demand of the liquidity trader x. Although the uninformed investor's inability to distinguish between i_1 and i_2 is of no concern in this case, for the uninformed investor need evaluate only the combined value $r_1 + r_2$ of assets 1 and 2, the garbling introduced by the presence of x does distort the conditional expectation and variance he forms of the value of the two assets, as compared to those formed by the informed investor. More specifically, we have

$$E[\tilde{r}_1 + \tilde{r}_2 | i_1, i_2] \neq E[\tilde{r}_1 + \tilde{r}_2 | w] \tag{10}$$

and

$$var[\tilde{r}_1 + \tilde{r}_2 | i_1, i_2] < var[\tilde{r}_1 + \tilde{r}_2 | w] \tag{11}$$

from the properties of the normal distribution. The garbled information of the uninformed investor implies his greater uncertainty about the value of the assets, thus his larger conditional variance. It also implies his different estimate of the value of the assets, thus his different conditional expectation. This last result may be viewed as confirming the view, expressed in the comments quoted in the introduction, that some investors at least appear to be unable to value correctly a firm that consists of various divisions which operate in different businesses.

It is interesting to note that the conditional expectation formed by the uninformed investor may be larger or smaller than that formed by the informed investor, depending on the realizations of the information $i_1 + i_2$ and the demand of the liquidity trader x. Unconditional expectations are, however, identical for both investors. The informed investor's lesser uncertainty about the values of the assets therefore implies that his expected demand for shares is larger than that of the uninformed investor: $E[\tilde{x}_I] > E[\tilde{x}_U]$.

We now examine the role of spinoffs in decreasing the garbling introduced by the demand of the liquidity trader, thus making possible an increase in firm value. Let asset j, $j = 1, 2$, belong to firm j, which has share price p_j and supply of shares equal to one (because the spinoff of a firm into two separate entities leads to the doubling of the number of shares of the original firm). Let the liquidity trader have demand $\tilde{x}_j$ for the shares of firm j. $\tilde{x}_j$ is a normal random variable of mean zero and variance $var[\tilde{x}_j]$. Assume $var[\tilde{x}_1] = var[\tilde{x}_2] = \sigma_x^2$, $cov[\tilde{x}_1, \tilde{x}_2] = \tau\sigma_x^2$, $cov[\tilde{i}_j, \tilde{x}_h] = cov[\tilde{\varepsilon}_j, \tilde{x}_h] = 0$, $j, h = 1, 2$, and $\tau \geq 0$ without loss of generality.

The informed investor can be shown to have demand for shares

$$x_{I,j} = \frac{E[\tilde{r}_j | i_j] - p_j}{a\, var[\tilde{r}_j | i_j]} \tag{12}$$

for $j = 1, 2$. The informed investor's two-asset portfolio allocation problem simplifies to two single-asset portfolio allocation problems because of the lack of correlation between the value of the two assets when conditioning upon the information i_1 and i_2 ($cov[\tilde{r}_1, \tilde{r}_2 | i_1, i_2] = cov[\tilde{\varepsilon}_1, \tilde{\varepsilon}_2] = 0$). This is not the case for the uninformed investor, who solves the problem

$$\underset{\underline{x}_U}{Max}\, E[-\exp[-a[\underline{\tilde{r}} - \underline{p}]'\underline{x}_U | \underline{\tilde{p}} = \underline{p}],$$

where

$$\underline{x}_U = \begin{pmatrix} x_{U,1} \\ x_{U,2} \end{pmatrix}, \underline{\tilde{r}} = \begin{pmatrix} \tilde{r}_1 \\ \tilde{r}_2 \end{pmatrix}, \underline{\tilde{p}} = \begin{pmatrix} \tilde{p}_1 \\ \tilde{p}_2 \end{pmatrix}, \text{and } \underline{p} = \begin{pmatrix} p_1 \\ p_2 \end{pmatrix}.$$

This problem has solution

$$\underline{x}_U = \frac{1}{a}((var[\underline{\tilde{r}} | \underline{\tilde{p}} = p])^{-1}(E[\underline{\tilde{r}} | \underline{\tilde{p}} = p] - p)). \tag{13}$$

Since our purpose is to compare the expected share price of the single firm to the sum of the expected share prices of firms 1 and 2, we need compute only the sum $p_1 + p_2$. This is done in Lemma 4.

LEMMA 4. *We have*

$$p_1 + p_2 = \frac{\dfrac{w_1 + w_2}{a\sigma_\varepsilon^2} + \dfrac{E[\tilde{r}_1 + \tilde{r}_2 | w_1, w_2]}{a(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2])} - 2}{\dfrac{1}{a\sigma_\varepsilon^2} + \dfrac{1}{a(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2])}} \tag{14}$$

where

$$w_j \equiv i_j + a\sigma_\varepsilon^2 x_j \tag{15}$$

Proof. See Appendix.

Note that the information revealed to the uninformed investor is now w_1 and w_2. As was the case in Section 1, the presence of two prices makes prices more informative and will be shown to increase firm value. Unlike the case of Section 1, however, the increase in firm value will be made possible not by the distinction between the information that pertains to each asset (w_j to asset j), but by the decrease in the garbling introduced by the demand of the liquidity trader.[18] This decrease in garbling is in turn made possible by the presence of what are essentially two realizations of this demand: x_1 and x_2. In the case these are less than perfectly correlated ($0 \le \tau < 1$), the uninformed investor has less uncertainty about the value of the assets than he did in the case of a single firm, as is shown in Lemma 5.

LEMMA 5. *A spinoff reduces the uninformed investor's uncertainty about the values of assets* 1 *and* 2 *in the case of less than perfect correlation between the demands of the liquidity traders* ($0 \le \tau < 1$). *Specifically,*

$$var[\tilde{r}_1 + \tilde{r}_2 | w] > var[\tilde{r}_1 + \tilde{r}_2 | w_1, w_2] = 2(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2]). \tag{16}$$

Proof. See Appendix.

We can now show

PROPOSITION 2. A spinoff increases the sum of the expected share prices of firms 1 and 2 above the expected share price of the single firm. Thus

$$E[\tilde{p}] < E[\tilde{p}_1 + \tilde{p}_2]. \tag{17}$$

Proof. See Appendix.

[18] The distinction between the information that pertains to each asset will be recalled to be unnecessary as it is the combined value of assets 1 and 2 that is to be determined.

Proposition 3. *A spinoff leads the informed investor to decrease and the uninformed investors to increase his expected demand for shares. The expected demand for shares of the informed investor nonetheless remains higher than that of the uninformed investor. Specifically,*

$$2E[\tilde{x}_I] > E[\tilde{x}_{I,1} + \tilde{x}_{I,2}] > E[\tilde{x}_{U,1} + \tilde{x}_{U,2}] > 2E[\tilde{x}_U], \tag{18}$$

where the multiplication of $E[\tilde{x}_I]$ *and* $E[\tilde{x}_U]$ *by two will be recalled to account for the doubling of the number of shares that follows the spinoff as each share of the original firm is replaced by a share of firm* 1 *and a share of firm* 2.

Proof. See Appendix.

Propositions 2 and 3 are immediate consequences of inequality (16): the uninformed investor's reduced uncertainty about the value of the two assets increases his expected demand for shares, thus increasing firm value.[19]

Much of the decrease in risk that makes the results of Propositions 2 and 3 possible is likely to pertain to firm-specific risk. Such risk would not be priced in a CAPM world in which investors were to diversify across all assets by holding the market portfolio. This suggests that the economic magnitude of the information-based explanation we present for spinoffs may be negligible. As noted by Lintner (1969), however, investors will not hold the market portfolio when they have heterogeneous expectations, as is the case of informed and uninformed investors. Indeed, some investors may well have chosen to concentrate their holdings in the equity of a few firms, perhaps because they have received favorable information about these firms, or for corporate governance purposes. Failure to diversify fully exposes investors to specific risk and suggests that spinoffs create value by decreasing the amount of such risk that is borne by investors.

The assumption that the demand of the liquidity trader for the shares of firms 1 and 2 is less than perfectly correlated has been essential to the results of Propositions 2 and 3. This assumption would be difficult to justify in the case where the single liquidity trader were to hold the shares of both firms, and to trade these proportionally in response to liquidity shocks. Such would be the case if all liquidity traders were always to hold and trade the market portfolio, for their demand for shares would then be

[19] The increase in firm value can further be shown to be decreasing in the correlation between the demands of the liquidity trader for the shares of firm 1 and 2, and to be increasing in the correlation between the values of assets 1 and 2. The former result is to be expected, the latter is opposite to the results of Proposition 1 and the empirical findings of Daley *et al.* (1995) and points to a clear limitation of the model of Section 2.

perfectly correlated across firms. Liquidity traders will generally not hold the market portfolio, however, because of their differing hedging needs.[20]

Our last result relates the increase in firm value to the changes in the expected demand for shares.

PROPOSITION 4. *The increase in expected share prices that results from a spinoff is proportional to the change in the expected demand for shares absent any change in the informed investor's uncertainty about the value of the assets.*

Proof. See Appendix.

The increase in expected share prices is related to the change in the expected demand for shares because both changes result from the uninformed investor's reduced uncertainty about the values of the assets. The reduction in uncertainty increases the uninformed investor's demand for shares at the initial share price p and leads to an increase in share prices unless offset by a decrease in the informed investor's demand for shares at the initial share price p. Such a decrease would occur in case the informed investor's uncertainty about the value of the assets were to increase.[21]

The empirical findings of Kudla and McInish (1988), which document a positive correlation between the increase in firm value observed upon spinoff and the trading in shares following the spinoff, may be viewed as being consistent with the result of Proposition 4.

3. CONCLUDING REMARKS

We have presented an explanation for spinoffs that is based upon informational considerations and have discussed some evidence, both casual and empirical, which supports this explanation.

The explanation that we have presented would suggest, if carried to its logical conclusion, that all divisions, and perhaps even all assets of a firm should be spun off, as such spinoffs would increase the information transmitted to managers and uninformed investors. Such a conclusion would of course be erroneous, for it ignores the costs of a spinoff, which we now

[20] On a related note, Dow and Gorton (1995) have argued that the possibility of profitable informed trading must imply a restriction on the ability of liquidity traders to hold the market portfolio.

[21] The results of Proposition 4 present some similarities to those of Brennan and Cao (1996) who show that, in the context of a multiperiod model with partial revelation of information over time, investors who have more precise information decrease their holdings of shares to the benefit of investors who have less precise information in the case of an increase in share price.

briefly discuss. First, spinoffs may exacerbate (Aron, 1988; Ramakrishnan and Thakor, 1991) the difficulty of correctly appraising managerial performance, by precluding the diversification of the specific risk that makes such appraisal difficult. Second, spinoffs may exacerbate the hold-up problem in the case of complementary assets, for such assets should be owned by a single firm rather than by separate firms (Hart and Moore, 1990). This last consideration suggests that, as noted in Proposition 1, it is those businesses that most differ from the main business of a firm that should be spun off from the firm. This is indeed the case, as is commonly observed in practice.

APPENDIX

Proof of Lemma 1. The proof is by simple verification. Since investors are risk-neutral, the price of a share is simply the expected value of the expansion projects considered, conditional upon the information i_1 and i_2. Specifically,

$$\begin{aligned}
p &= E[\tilde{r}_1 + \tilde{r}_2 + \tilde{V}_1 + \tilde{V}_2 | i_1, i_2] \\
&= E\left[\tilde{r}_1 + \tilde{r}_2 + \frac{E[\tilde{r}_1 | i_1 + i_2]}{c}\tilde{r}_1 - \frac{E[\tilde{r}_1 | i_1 + i_2]^2}{2c}\right. \\
&\quad \left. + \frac{E[\tilde{r}_2 | i_1 + i_2]}{c}\tilde{r}_2 - \frac{E[\tilde{r}_2 | i_1 + i_2]^2}{2c} | i_1, i_2\right] \\
&= i_1 + i_2 + \frac{E[\tilde{r}_1 | i_1 + i_2]}{c} i_1 - \frac{E[\tilde{r}_1 | i_1 + i_2]^2}{2c} + \frac{E[\tilde{r}_2 | i_1 + i_2]}{c} i_2 - \frac{E[\tilde{r}_2 | i_1 + i_2]^2}{2c} \\
&= i_1 + i_2 \\
&\quad + \frac{E[\tilde{i}] + \left(\frac{\sigma^2 + \rho\sigma^2}{\sigma^2 + \sigma^2 + 2\rho\sigma^2}\right)(i_1 + i_2 - 2E[\tilde{i}])}{c} i_1 \\
&\quad - \frac{\left(E[\tilde{i}] + \left(\frac{\sigma^2 + \rho\sigma^2}{\sigma^2 + \sigma^2 + 2\rho\sigma^2}\right)(i_1 + i_2 - 2E[\tilde{i}])\right)^2}{2c} \\
&\quad + \frac{E[\tilde{i}] + \left(\frac{\sigma^2 + \rho\sigma^2}{\sigma^2 + \sigma^2 + 2\rho\sigma^2}\right)(i_1 + i_2 - 2E[\tilde{i}])}{c} i_2
\end{aligned}$$

$$-\frac{\left(E[\tilde{i}] + \left(\frac{\sigma^2 + \rho\sigma^2}{\sigma^2 + \sigma^2 + 2\rho\sigma^2}\right)(i_1 + i_2 - 2E[\tilde{i}])\right)^2}{2c}$$

$$= i_1 + i_2 + \frac{E[\tilde{i}] + \frac{1}{2}(i_1 + i_2 - 2E[\tilde{i}])}{c}(i_1 + i_2)$$

$$-\frac{\left(E[\tilde{i}] + \frac{1}{2}(i_1 + i_2 - 2E[\tilde{i}])\right)^2}{c}$$

$$= i_1 + i_2 + \frac{(i_1 + i_2)^2}{4c},$$

where the second equality is true because manager j can infer the information $i_1 + i_2$ from the observation of the share price. Of the two possible solutions to the quadratic equation (2), only $(-1 + \sqrt{1 + p/c})/(1/2c)$ is appropriate, for $(-1 - \sqrt{1 + p/c})/(1/2c)$ is always negative, whereas $i_1 + i_2 - 2E[\tilde{i}]$ is not. Q.E.D.

Proof of Proposition 1. From Eqs. (2) and (3), we have

$$\begin{aligned} E[\tilde{p}] &= E\left[\tilde{i}_1 + \tilde{i}_2 + \frac{(\tilde{i}_1 + \tilde{i}_2)^2}{4c}\right] \\ &= 2E[\tilde{i}] + \frac{\sigma^2 + \sigma^2 + 2\rho\sigma^2 + 4E[\tilde{i}]^2}{4c} \\ &= 2E[\tilde{i}] + \frac{(1+\rho)\sigma^2}{2c} + \frac{E[\tilde{i}]^2}{c} \end{aligned} \tag{A1}$$

and

$$\begin{aligned} E[\tilde{p}_1 + \tilde{p}_2] &= E\left[\tilde{i}_1 + \frac{\tilde{i}_1^2}{2c}\right] + E\left[\tilde{i}_2 + \frac{\tilde{i}_2^2}{2c}\right] \\ &= E[\tilde{i}] + \frac{\sigma^2 + E[\tilde{i}]^2}{2c} + E[\tilde{i}] + \frac{\sigma^2 + E[\tilde{i}]^2}{2c} \\ &= 2E[\tilde{i}] + \frac{\sigma^2 + E[\tilde{i}]^2}{c}. \end{aligned} \tag{A2}$$

The inequality $E[\tilde{p}_1 + \tilde{p}_2] \geq E[\tilde{p}]$ is immediate, with strict inequality when $0 \leq \rho < 1$.

$$\frac{\partial(E[\tilde{p}_1 + \tilde{p}_2] - E[\tilde{p}])}{\partial \rho} < 0 \text{ by simple differentiation.} \qquad \text{Q.E.D.}$$

Proof of Lemma 4. Initially define $E^c[\tilde{r}_j] \equiv E[\tilde{r}_j | w_1, w_2]$, $var^c[\tilde{r}_j] \equiv var[\tilde{r}_j | w_1, w_2]$, $j = 1, 2$, and $cov^c[\tilde{r}_1, \tilde{r}_2] \equiv cov[\tilde{r}_1, r_2 | w_1, w_2]$ in order to simplify the notation, and note that $var^c[\tilde{r}_1] = var^c[\tilde{r}_2]$ from the assumption that the values of the two assets have identical distributions.

Now let p_1 and p_2 be the solution to the system of equations

$$\begin{pmatrix} \dfrac{1}{a\sigma_\varepsilon^2} + \dfrac{var^c[\tilde{r}_1]}{a(var^c[\tilde{r}_1]^2 - cov^c[\tilde{r}_1, \tilde{r}_2]^2)} & \dfrac{-cov^c[\tilde{r}_1, \tilde{r}_2]}{a(var^c[\tilde{r}_1]^2 - cov^c[\tilde{r}_1, \tilde{r}_2]^2)} \\ \dfrac{-cov^c[\tilde{r}_1, \tilde{r}_2]}{a(var^c[\tilde{r}_1]^2 - cov^c[\tilde{r}_1, \tilde{r}_2]^2)} & \dfrac{1}{a\sigma_\varepsilon^2} + \dfrac{var^c[\tilde{r}_1]}{a(var^c[\tilde{r}_1]^2 - cov^c[\tilde{r}_1, \tilde{r}_2]^2)} \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \end{pmatrix}$$
$$= \begin{pmatrix} \dfrac{w_1}{a\sigma_\varepsilon^2} + \dfrac{var^c[\tilde{r}_1]E^c[\tilde{r}_1] - cov^c[\tilde{r}_1, \tilde{r}_2]E^c[\tilde{r}_2]}{a(var^c[\tilde{r}_1]^2 - cov^c[\tilde{r}_1, \tilde{r}_2]^2)} - 1 \\ \dfrac{w_2}{a\sigma_\varepsilon^2} + \dfrac{-cov^c[\tilde{r}_1, \tilde{r}_2]E^c[\tilde{r}_1] + var^c[\tilde{r}_1]E^c[\tilde{r}_2]}{a(var^c[\tilde{r}_1]^2 - cov^c[\tilde{r}_1, \tilde{r}_2]^2)} - 1 \end{pmatrix}, \tag{A3}$$

where w_j, $j = 1, 2$, are as defined in Eq. (15). Note that (A3) has nonzero determinant. p_1 and p_2 can then be shown to be the solution to the market clearing conditions

$$x_{I,j} + x_{U,j} + x_j = 1, j = 1, 2$$

by substitution of p_1 and p_2 from the solution to (A3) and of $\underline{x}_I$ and $\underline{x}_U$ from Eqs. (12) and (13), and by noting that p_1 and p_2 are linear functions of w_1 and w_2, thus making conditioning on p_1 and p_2 equivalent to conditioning on w_1 and w_2.

To see that p_1 and p_2 are indeed linear functions of w_1 and w_2, note that the random variables $\tilde{r}_1$, $\tilde{r}_2$, $\tilde{w}_1$, and $\tilde{w}_2$ are jointly normal with common mean zero and variance

$$\sigma^2 \begin{pmatrix} 1+\gamma & \rho & 1 & \rho \\ \rho & 1+\gamma & \rho & 1 \\ 1 & \rho & 1 + (a\gamma)^2\sigma^2\sigma_x^2 & \rho + (a\gamma)^2\tau\sigma^2\sigma_x^2 \\ \rho & 1 & \rho + (a\gamma)^2\tau\sigma^2\sigma_x^2 & 1 + (a\gamma)^2\sigma^2\sigma_x^2 \end{pmatrix},$$

where $\gamma \equiv \sigma_\varepsilon^2/\sigma^2$. We therefore have, from the properties of the normal distribution

$$\begin{pmatrix} E^c[\tilde{r}_1] \\ E^c[\tilde{r}_2] \end{pmatrix} = \begin{pmatrix} E[\tilde{i}] \\ E[\tilde{i}] \end{pmatrix} + \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \begin{pmatrix} 1 + (a\gamma)^2\sigma^2\sigma_x^2 & \rho + (a\gamma)^2\tau\sigma^2\sigma_x^2 \\ \rho + (a\gamma)^2\tau\sigma^2\sigma_x^2 & 1 + (a\gamma)^2\sigma^2\sigma_x^2 \end{pmatrix}^{-1} \begin{pmatrix} w_1 - E[\tilde{i}] \\ w_1 - E[\tilde{i}] \end{pmatrix}$$

$$= \begin{pmatrix} E[\tilde{i}] \\ E[\tilde{i}] \end{pmatrix} + \frac{1}{D^2 - O^2} \begin{pmatrix} D - \rho O & \rho D - O \\ \rho D - O & D - \rho O \end{pmatrix} \begin{pmatrix} w_1 - E[\tilde{i}] \\ w_2 - E[\tilde{i}] \end{pmatrix}, \tag{A4}$$

where

$$D \equiv 1 + (a\gamma)^2\sigma^2\sigma_x^2 \text{ and } O \equiv \rho + (a\gamma)^2\tau\sigma^2\sigma_x^2.$$

We also have

$$\begin{pmatrix} var^c[\tilde{r}_1] & cov^c[\tilde{r}, \tilde{r}_2] \\ cov^c[\tilde{r}, \tilde{r}_2] & var^c[\tilde{r}_1] \end{pmatrix}$$

$$= \sigma^2 \begin{pmatrix} 1+\gamma & \rho \\ \rho & 1+\gamma \end{pmatrix} - \sigma^2 \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \begin{pmatrix} D & O \\ O & D \end{pmatrix}^{-1} \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \tag{A5}$$

$$= \sigma^2 \begin{pmatrix} 1+\gamma & \rho \\ \rho & 1+\gamma \end{pmatrix} - \frac{\sigma^2}{D^2 - O^2} \begin{pmatrix} (1+\rho^2)D - 2\rho O & 2\rho D - (1+\rho^2)O \\ 2\rho D - (1+\rho^2)O & (1+\rho^2)D - 2\rho O \end{pmatrix}$$

p_1 and p_2 are indeed linear functions of w_1 and w_2.

$p_1 + p_2$ can then be obtained by expanding (A3), adding the resulting equations and solving for $p_1 + p_2$ to get Eq. (14). Q.E.D.

Proof of Lemma 5. Make use of (A5) and (9) and of the assumption that the two assets have identical distributions to write

$$\begin{aligned} var[\tilde{r}_1 + \tilde{r}_2 | w_1, w_2] &= 2(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2]) \\ &= 2\sigma^2 \left(\gamma + \frac{(1+\rho)(a\gamma)^2(1+\tau)\sigma^2\sigma_x^2}{1 + \rho + (a\gamma)^2(1+\tau)\sigma^2\sigma_x^2} \right) \end{aligned} \tag{A6}$$

and

$$var[\tilde{r}_1 + \tilde{r}_2 | w] = 2\sigma^2 \left(\gamma + \frac{2(1+\rho)(a\gamma)^2\sigma^2\sigma_x^2}{1 + \rho + 2(a\gamma)^2\sigma^2\sigma_x^2} \right). \tag{A7}$$

It is then immediate that

$$var[\tilde{r}_1 + \tilde{r}_2 | w] > var[\tilde{r}_1 + \tilde{r}_2 | w_1, w_2] = 2(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2]) \tag{A8}$$

in the case of less than perfect correlation between the demands of the liquidity trader ($0 \leq \tau < 1$). Q.E.D.

Proof of Proposition 2. From Eqs. (6), (8), and (9), we have

$$p = \frac{\dfrac{w}{2a\sigma_\varepsilon^2} + \dfrac{E[\tilde{r}_1 + \tilde{r}_2 | w]}{a\, var[\tilde{r}_1 + \tilde{r}_2 | w]} - 1}{\dfrac{1}{2a\sigma_\varepsilon^2} + \dfrac{1}{a\, var[\tilde{r}_1 + \tilde{r}_2 | w]}}$$

$$= \frac{\dfrac{w}{a\sigma_\varepsilon^2} + \dfrac{E[\tilde{r}_1 + \tilde{r}_2 | w]}{\frac{a\, var[\tilde{r}_1 + \tilde{r}_2 | w]}{2}} - 2}{\dfrac{1}{a\sigma_\varepsilon^2} + \dfrac{1}{\frac{a\, var[\tilde{r}_1 + \tilde{r}_2 | w]}{2}}}.$$

We also reproduce Eq. (14) for convenience

$$p_1 + p_2 = \frac{\dfrac{w_1 + w_2}{a\sigma_\varepsilon^2} + \dfrac{E[\tilde{r}_1 + \tilde{r}_2 | w_1, w_2]}{a(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2])} - 2}{\dfrac{1}{a\sigma_\varepsilon^2} + \dfrac{1}{a(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2])}}.$$

Now taking unconditional expectations, we obtain

$$E[\tilde{p}] = 2E[\tilde{i}] - \frac{2}{\dfrac{1}{a\sigma_\varepsilon^2} + \dfrac{1}{\frac{a\, var[\tilde{r}_1 + \tilde{r}_2 | w]}{2}}} \tag{A9}$$

and

$$E[\tilde{p}_1 + \tilde{p}_2] = 2E[\tilde{i}] - \frac{2}{\dfrac{1}{a\sigma_\varepsilon^2} + \dfrac{1}{a(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2])}}. \tag{A10}$$

Inequality (17) is then an immediate consequence of inequality (16). Q.E.D.

Proof of Proposition 3. From Eqs. (4) and (12) we have

$$\begin{aligned}
E[\tilde{x}_I] &= \frac{E[\tilde{i}_1 + \tilde{i}_2 - \tilde{p}]}{2a\sigma_\varepsilon^2} \\
&> \frac{E[\tilde{i}_1 + \tilde{i}_2 - \tilde{p}_1 - \tilde{p}_2]}{2a\sigma_\varepsilon^2} \\
&= \frac{\dfrac{E[\tilde{i}_1 - \tilde{p}_1]}{a\sigma_\varepsilon^2} + \dfrac{E[\tilde{i}_2 - \tilde{p}_2]}{a\sigma_\varepsilon^2}}{2} \\
&= \frac{E[\tilde{x}_{I,1} + \tilde{x}_{I,2}]}{2},
\end{aligned}$$

where the inequality is true by Proposition 2. We have thus shown the first inequality in (18). The third inequality in (18) is then an immediate consequence of the assumption that the supply of shares is fixed.

From Eqs. (12) and (13), we have

$$\begin{aligned}
E[\tilde{x}_{I,1} + \tilde{x}_{I,2}] &= \frac{E[\tilde{i}_1 - \tilde{p}_1]}{a\sigma_\varepsilon^2} + \frac{E[\tilde{i}_2 - \tilde{p}_2]}{a\sigma_\varepsilon^2} \\
&= \frac{E[\tilde{i}_1 + \tilde{i}_2 - (\tilde{p}_1 + \tilde{p}_2)]}{a\sigma_\varepsilon^2} \\
&= \frac{2E[\tilde{i}] - E[\tilde{p}_1 + \tilde{p}_2]}{a\gamma\sigma^2}
\end{aligned}$$

and

$$\begin{aligned}
E[\tilde{x}_{U,1} + \tilde{x}_{U,2}] &= \frac{E[E[\tilde{r}_1 + \tilde{r}_2 | \tilde{w}_1, \tilde{w}_2] - (\tilde{p}_1 + \tilde{p}_2)]}{a(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2])} \\
&= \frac{2E[\tilde{i}] - E[\tilde{p}_1 + \tilde{p}_2]}{a(var[\tilde{r}_1 | w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2 | w_1, w_2])}.
\end{aligned}$$

The second inequality in (18) can then be established by noting from Eq. (A6) that

$$var[\tilde{r}_1|w_1, w_2] + cov[\tilde{r}_1, \tilde{r}_2|w_1, w_2] = \sigma^2\left(\gamma + \frac{(1+\rho)(a\gamma)^2(1+\tau)\sigma^2\sigma_x^2}{1+\rho+(a\gamma)^2(1+\tau)\sigma^2\sigma_x^2}\right)$$
$$> \gamma\sigma^2.$$

Q.E.D.

Proof of Proposition 4. The change in the informed investor's expected demand for shares is

$$E[2\tilde{x}_I - \tilde{x}_{I,1} - \tilde{x}_{I,2}] = 2\left(\frac{E[\tilde{i}_1 + \tilde{i}_2 - \tilde{p}]}{2a\sigma_\varepsilon^2}\right) - \frac{E[\tilde{i}_1 - \tilde{p}_1]}{a\sigma_\varepsilon^2} - \frac{E[\tilde{i}_2 - \tilde{p}_2]}{a\sigma_\varepsilon^2}$$
$$= \frac{1}{a\sigma_\varepsilon^2}E[\tilde{p}_1 + \tilde{p}_2 - \tilde{p}]$$

Noting that

$$2E[\tilde{x}_I + \tilde{x}_U + \tilde{x}] = 2 = E[\tilde{x}_{I,1} + \tilde{x}_{I,2} + \tilde{x}_{U,1} + \tilde{x}_{U,2} + \tilde{x}_1 + \tilde{x}_2]$$

as the supply of shares is fixed, we have

$$E[\tilde{x}_{U,1} + \tilde{x}_{U,2} - 2\tilde{x}_U] = E[2\tilde{x}_I - \tilde{x}_{I,1} - \tilde{x}_{I,2}]$$
$$= \frac{1}{a\sigma_\varepsilon^2}E[\tilde{p}_1 + \tilde{p}_2 - \tilde{p}].$$

Changes in $E[\tilde{x}_{U,1} + \tilde{x}_{U,2} - 2\tilde{x}_U] = E[2\tilde{x}_I - \tilde{x}_{I,1} - \tilde{x}_{I,2}]$ are proportional to those in $E[\tilde{p}_1 + p_2 - \tilde{p}]$ absent any change in σ_ε^2, which measures the informed investor's uncertainty about the value of the assets. Q.E.D.

REFERENCES

Allen, F. (1993). Stock markets and resource allocation, *in* "Financial Intermediation in the Construction of Europe" (C. Mayer and X. Vives, Eds.), Center for Economic Policy Research.

Allen, F., and Gale, D. (1988). Optimal security design, *Rev. Finan. Stud.* **1,** 229–264.

Allen, F., and Gale, D. (1991). Arbitrage, short sales, and financial innovation, *Econometrica* **59,** 1041–1068.

Aron, D. (1988). Ability, moral hazard, firm size, and diversification, *Rand J. Econ.* **19,** 505–518.

Aron, D. (1991). Using the capital market as a monitor: corporate spinoffs in an agency framework, *Rand J. Econ.* **22,** 505–518.

Boot, A., and Thakor, A. (1993). Security design, *J. Finance* **48,** 1349–1378.

Boot, A., and Thakor, A. (1997). Financial system architecture, *Rev. Finan. Stud.* [forthcoming]

Brennan, M., and Cao, H. (1996). Information, trade, and derivative securities, *Rev. Finan. Stud.* **9,** 163–208.

Caballe, J., and Krishnan, M. (1994). Imperfect competition in a multi-security market with risk-neutrality, *Econometrica* **62,** 695–704.

Caballe, J., and Krishnan, M. (1996). Security design with multiple projects and insider trading, mimeo, University of Minnesota.

Chowdhry, B., and Grinblatt, M. (1994). Information aggregation, security design, and currency swaps, mimeo, UCLA.

Comment, R., and Jarrell, G. (1995). Corporate focus and stock returns, *J. Finan. Econ.* **37,** 67–87.

Cusatis, P., Miles, J., and Woolridge, R. (1993). Restructuring through spinoffs: The stock market evidence, *J. Finan. Econ.* **33,** 293–311.

Daley, L., Mehrotra, V., and Sivakumar, R. (1995). "Corporate spinoffs: Trash or treasure," working paper May 1995, University of Alberta.

Dow, J., and Gorton, G. (1994). Stock market efficiency and economic efficiency: Is there a connection?, mimeo, London Business School.

Dow, J., and Gorton, G. (1995). Profitable informed trading in a simple general equilibrium model of asset pricing, *J. Econ. Theory*. [forthcoming]

Dow, J., and Rahi, R. (1996). Informed trading, investment, and welfare, mimeo, European University Institute and Birkbeck College.

Fishman, M., and Hagerty, K. (1992). Insider trading and the efficiency of stock prices, *Rand J. Econ.* **23,** 106–122.

Gorton, G., and Pennacchi, G. (1990). Financial intermediaries and liquidity creation, *J. Finance* **45,** 49–72.

Gorton, G., and Pennacchi, G. (1993). Security baskets and index-linked securities, *J. Business* **66,** 1–27.

Grossman, S. (1977). The existence of futures markets, noisy rational expectations, and informational externalities, *Rev. Econ. Stud.* **44,** 431–449.

Grossman, S., and Stiglitz, J. (1980). On the impossibility of informationally efficient markets, *Am. Econ. Rev.* **70,** 393–408.

Hakansson, N. (1982). Changes in the financial markets: Welfare and price effects and the basic theorems of value conservation, *J. Finance* **37,** 977–1004.

Hart, O., and Moore, J. (1990). Property rights and the nature of the firm, *J. Polit. Econ.* **98,** 1119–1158.

Hellwig, M. (1980). On the aggregation of information in competitive markets, *J. Econ. Theory* **22,** 477–498.

Hite, G., and Owers, J. (1983). Security price reactions around corporate spinoff announcements, *J. Finan. Econ.* **12,** 409–436.

John, T. (1993). Optimality of spinoffs and allocation of debt, *J. Finan. Quant. Analysis* **28,** 139–160.

John, K. and Ofek, E. (1995). Asset sales and increases in focus, *J. Finan. Econ.* **37,** 105–126.

Jongbloed, A. (1994). "Why Do Firms Split? Evidence from Spinoffs and Equity Carve-outs," doctoral dissertation, University of Rochester.

Kudla, R., and McInish, T. (1988). Divergence of opinion and corporate spinoffs, *Quart. Rev. Econ. Bus.* **28,** 20–29.

Lang, L., Poulsen, A., and Stulz, R. (1995). Asset sales, firm performance, and the agency costs of managerial discretion, *J. Finan. Econ.* **37,** 3–37.

Leland, H., 1993. Insider trading: Should it be prohibited?, *J. Polit. Econ.* **100,** 859–887.

Lintner, John. (1969). The aggregation of investor's diverse judgements and preferences in purely competitive securities markets, *J. Finan. Quant. Analysis* **4,** 347–400.

Matsusaka, J., and Nanda, V. (1996). Toward a theory of the diversified firm, refocusing, and divesture, mimeo, University of Michigan.

Marín, J., and Rahi, R. (1996). Information revelation and market incompleteness, mimeo, Universitat Pompeu Fabra and Birkbeck College.

Miles, J., and Rosenfeld, J. (1983). The effect of voluntary spinoff announcements on shareholder wealth, *J. Finance* **38,** 1597–1606.

Miller, E. (1977). Risk, uncertainty, and divergence of opinion, *J. Finance* **32,** 1151–1168.

Nachman, D., and Noe, T. (1994). Optimal design of securities under asymmetric information, *Rev. Finan. Stud.* **7,** 1–44.

Nanda, V. (1991). On the good news in equity carve-outs, *J. Finance* **46,** 1717–1737.

Nanda, V., and Narayanan, M. P. (1996). Disentangling value: Misvaluation and the scope of the firm, mimeo, University of Michigan.

Ramakrishnan, R., and Thakor, A. (1991). Cooperation versus competition in agency, *J. Law Econ. Organ.* **7,** 248–283.

Ross, S. (1976). Options and efficiency, *Quart. J. Econ.* **90,** 75–89.

Schipper, K., and Smith, A. (1983). Effects of recontracting on shareholder wealth: The case of voluntary spinoffs, *J. Finan. Econ.* **12,** 437–467.

Slovin, M., Sushka, M., and Ferraro, S. (1995). A comparison of the information conveyed by equity carve-outs, spinoffs, and asset sell-offs, *J. Finan. Econ.* **37,** 89–104.

Subrahmanyam, A. (1991). A theory of trading in stock index futures, *Rev. Finan. Stud.* **4,** 17–52.

Titman, S., and Subrahmanyam, A. (1996). Information, resource allocation, and the development of financial markets, mimeo, Boston College and UCLA.

Vijh, A. (1994). The spinoff and merger ex-date effects, *J. Finance* **49,** 581–609.

Yosha, O. (1995). Information disclosure costs and the choice of financing source, *J. Finan. Intermediation* **4,** 3–20.