Measuring Share Price Accuracy

Merritt B. Fox

This Article concerns how to measure share price accuracy. It is prompted by the fact that many scholars believe that the prices established in the stock market affect the efficiency of the real economy. In their view, more accurate prices increase the amount of value added by capital-utilizing enterprises as these enterprises use society’s scarce resources for the production of goods and services. More accurate share prices help improve both the quality of choice among new proposed investment projects in the economy and the operation of existing real assets currently in corporate hands.

The proposition that more accurate share prices improve the efficiency of the real economy implies that promoting share price accuracy is a worthy goal of public policy. It would therefore be helpful to be able to measure whether the policies adopted in fact accomplish this aim. A wide variety of policy
measures are implicated here. Does issuer disclosure increase share price accuracy? What is the effect of various restrictions on insider trading and tipping? What is the effect of selective disclosure by issuers to institutional investors or analysts? Should analysts be regulated in some fashion? All of these questions are subjects of unresolved theoretical debates. Good empirical input could be of great value.

Developing a practical measure of share price accuracy, however, is tricky. As will be discussed below, a share price is more accurate if it is a better predictor of a firm's dividends and other distributions to its shareholders over the rest of the life of the firm. How well a firm’s share price scores in this regard cannot be determined definitively until the firm’s life ends and it liquidates. To be useful for policy making, a measure of share price accuracy must be able to be made earlier, while firms are still operating. Thus, scholars have looked for proxies for the definitive measure that can only be made after liquidation.

Traditionally share price variance over time has been used as such a proxy. A smaller variance has been interpreted as suggesting a more accurate price. More recently, some scholars have adopted a different measure, called $R^2$, which reflects the extent to which a firm's share price moves with the prices of all the other firms in the economy. A lower $R^2$, meaning less co-movement, is taken by these scholars to mean a more accurate price. I will argue here, through a combination of theoretical and empirical analyses, that $R^2$ is in fact a better proxy for share price accuracy than share price variance.

I. SHARE PRICE ACCURACY

The first step in considering how best to measure share price accuracy is to discuss with greater precision exactly what it means to say that prices are more accurate. The concept of share price accuracy used here relates to how good a share’s price is as a predictor of the future cash flows (dividends and any other distributions) that will be received by whoever holds the share over the rest of the life of the issuing firm. This approach to share price accuracy is functional because the roles that share prices can play in the functioning of the real economy relate to their capacity to signal which firms’ proposed new real investment projects promise the highest returns and which firms’ managers are doing a good job at operating existing facilities. The better share prices can predict future firm cash flows to shareholders, the better they can perform these roles.


4. See infra Part III.
Measuring Share Price Accuracy

A. Precise Definitions of "Actual Value" and "Share Price Accuracy"

The first step in understanding share price accuracy is to define a share's "actual value," which at any point in time is the aggregate future stream of income—dividends and other distributions—paid out from then on to whoever holds the share over the lifetime of the firm (discounted to present value). This definition of actual value requires an ex post view to be operative. The actual value of a share at \( t_0 \), a point during the ongoing life of the firm, cannot be determined until the moment of the firm's liquidation, \( t_{\text{liq}} \). The moment of liquidation is the end of the firm's life, by which time the issuer has paid out its last distribution. Only then can it be determined definitively how close the share price at \( t_0 \) was to the share's actual value. Until \( t_{\text{liq}} \), the amounts, if any, of the remaining distribution or distributions are uncertain. Thus, at \( t_0 \), which is prior to \( t_{\text{liq}} \), even the best-informed real-world investor can only make an estimate of the share's actual value.

What can one say about the relationship at \( t_0 \) between the market price of a publicly traded share and its actual value? The efficient market hypothesis (EMH) suggests that the market price of a share at \( t_0 \) is an unbiased estimate of the share's actual value at \( t_0 \). In other words, as best anyone can tell who knows all information publicly available at the time, the price at \( t_0 \) is, ultimately, equally likely to turn out to be below the share's actual value at \( t_0 \) as above it. By itself, however, the conclusion that a share price is unbiased says nothing about how close the price is likely to be—one way or the other—to actual value. Share price is relatively "accurate" if it is likely to be relatively close, whether above or below, to the share's actual value. When a price has a high expected accuracy, the deviation of the price from actual value is on average relatively small.

5. There is a large body of financial economics literature evaluating the market reaction to the affirmative public announcement of various kinds of events affecting particular issuers. For a classic review, see KENNETH GARBADE, SECURITIES MARKETS 240-59 (1982). An event study involves a large number of issuers, each of which has experienced at one point of time or another the announcement of a particular kind of event, for example a stock split. The typical study shows that the shares of the affected firms as a group experience statistically significant abnormal returns at the time of the announcement and, starting almost immediately thereafter, normal returns for the duration of the study, which is sometimes as long as several years. Thus, while some issuers' share prices go up in the periods following the immediate reaction to the announcement and others go down (each compared to the market as a whole), the average change is near zero. Assuming that longer term prices are themselves unbiased measures of actual value, the results of the studies are thus consistent with the concept that the market's evaluation of the significance of the event for the actual value of each issuer's shares, while it may have sometimes been too high and sometimes too low, was unbiased.

6. Put in statistical terms, price can be considered a random variable generated by a distribution function that, because price is unbiased, has a mean equal to the share's actual value and a variance that can be considered a measure of the expected accuracy of the price. Throughout this Article, when I refer to price accuracy, I am referring to this concept of expected price accuracy.
B. The Core Determinants of Share Price Accuracy: The Existence of Information and Its Reflection in Price

Share price accuracy is a function of two core determinants. One is the amount of information concerning a firm's future distributions that exists in the hands of one or more persons in the world relative to what would need to be known to predict these distributions with perfect accuracy. The other is the extent to which price reflects this information. A number of considerations influence these two core determinants of share price accuracy.

1. Length of Time before Distributions

Consider first a firm that makes no distributions to its shareholders prior to its liquidation. The closer in time an issuer is to its liquidation, the more accurate, everything else being equal, is its share price. This proposition becomes obvious by looking at an issuer's share price when the issuer is taking its last breaths immediately prior to liquidation (i.e., when \( t_0 \) is at a moment immediately prior to \( t_{\text{liq}} \)). The market price is likely to be very close to the amount of the liquidating distribution paid to the holder of each of its shares, whether zero or some positive amount. This is because of the way both determinants of share price accuracy work at this point. As for the amount of information, it is relatively easy for at least some people to be highly informed concerning the size of the final distribution. This information is then very likely to become fully, or nearly fully, reflected in price, either through public disclosure of what the liquidating distribution will be or, unless prevented by effective rules imposed by the legal system or norm structure applicable to the holders of the information, through trading by insiders or others informed via tipping or selective disclosure.\(^7\)

Now consider a company that makes one or more distributions prior to its final liquidating distribution, for example in the form of a dividend. Each distribution can be viewed as a partial liquidation of the firm. At any point in time, the discounted present value of each distribution contributes its portion to the total actual value of a share of the firm. In accord with the foregoing analysis, the closer that point in time is to the time of any given distribution, the more accurate is the portion of the market price that corresponds to the portion of actual value relating to this distribution. The same is true for each other distribution of the firm, including its final liquidating distribution, if any. Thus, with multiple distributions, the conclusion continues to hold that the closer in time to a firm's moment of liquidation, the more accurate is the price. Another

---

\(^7\) Because the information provides a near certain prediction of the amount of the distribution, the economic risk associated with trading on the information is very low. Absent effective legal or normative restraints on such trading, the volume of trades by insiders, tipees and selective disclosure recipients is therefore likely to be high.
Measuring Share Price Accuracy

Implication of this analysis is that a firm that has a policy of paying out a larger portion of its earnings in dividends is likely, ceteris paribus, to have a more accurate share price.

2. Economic and Legal Incentives to Gather, Share, and Trade on Information and Their Interaction

When a possible cash distribution by an issuer to its shareholders is further in the future, share price accuracy is affected by the fact that, inherently, it becomes increasingly difficult for persons to gather and analyze information about the factors determining the amount of the distribution. How much information is in fact gathered and analyzed by anyone depends on the economic incentives to do so. It also depends on laws, to the extent they exist, that effectively require such collection and analysis (such as a rule requiring a public company to undergo an audit by an independent accountant). The extent to which such information is then reflected in price depends on the economic and legal incentives, both positive and negative, for persons who have gathered and analyzed such information to disclose it to others (publicly or selectively). It also depends on the economic and legal incentives, both positive and negative, of anyone possessing such information—whether a generator or a receiver—to trade on it.

Assessing the effect of existing economic and legal incentives on price accuracy is made more complex by the fact that there is an interaction between the considerations determining how much information is gathered and analyzed, and the considerations determining how much of what is gathered and analyzed gets reflected in price. On one hand, the opportunity to trade on information that is not required to be disclosed to others creates incentives to gather and analyze such information. On the other hand, the more widely held information is by persons who can trade on it, the more likely it is to be reflected in price. Moreover, when someone receives, whether by selective or

8. See Ronald Gilson & Reinier Kraakman, The Mechanisms of Market Efficiency, 70 VA. L. REV. 549, 568-69 (1984); Eugene F. Fama, Random Walks in Stock Market Prices, 21 FIN. ANALYSTS J. 55 (1965) (describing how information is incorporated into price). The simplest models of price formation suggest that price is the product of the weighted average of expectations of all investors. See, e.g., John Lintner, The Aggregation of Investors' Diverse Judgments and Preferences in a Purely Competitive Economy, 4 J. FIN. & QUANTITATIVE ANALYSIS 347. This would mean that the trading of a small number of arbitrageurs acting on a piece of information could not by itself move price sufficiently to reflect fully the import of the piece. Indeed, contrary to the EMH, in such a model, the price would not fully reflect the information until all active investors knew the information. See Merritt B. Fox, Finance and Industrial Performance, in A Dynamic Economy: Theory, Practice, and Policy 36-43 (Eli Noam ed., 1987) [hereinafter Industrial Performance] (demonstrating the inadequacy of arbitrage to correct prices fully due to the risk that arbitrage adds to an arbitrageur’s portfolio because of the dediversification it involves). More sophisticated models recognize that investors are aware that price may reflect information known by other investors. Hence, price is not just a constraint, it can affect investor demand for securities and as a result information known by only some traders can influence price as if more investors knew it. Sanford J. Grossman, On the Efficiency of Competitive Stock Markets Where Investors Have Diverse Information, 31 J. FIN. 573 (1976). This is not a complete substitute for
public disclosure, information gathered by someone else, the recipient may find it more worthwhile herself to gather and analyze yet additional information on her own. This is because the information that is received may constitute a valuable input to the process of further discovery. Thus, for example, it may be more worthwhile for an investor to gather and analyze information (not yet gathered and analyzed by others) concerning the market for the product of an issuer that has disclosed basic financial information about itself, than to gather and analyze information concerning the market for the product of a firm that has not engaged in such disclosure. In addition, when a small number of people are able to trade regularly on relatively precise material information in advance of others, it becomes less profitable for persons outside that circle to gather and analyze information for trading purposes. The complexities of these interactions is what makes it difficult to determine at a theoretical level whether share price accuracy is enhanced or diminished by any of the standard tools of securities regulation, such as: mandatory disclosure, insider trading regulation, the regulation of selective disclosure, broker-dealer regulation, or regulation of analysts.

broader distribution of the information, however, because of the existence of noise (and other things affecting price). As a result of noise and these other factors, investors not possessing information known by others cannot “decode” share price effectively enough to be in the same position as if they knew the information themselves. Sanford J. Grossman & Joseph E. Stiglitz, On the Impossibility of Informationally Efficient Markets, 70 AM. ECON. REV. 393 (1980).

9. There are good theoretical reasons for thinking this to be true. The discovery of information not yet discovered by others and hence not reflected in market price is more likely to hold the promise of greater arbitrage profits in the case of a firm that has disclosed basic financial information about itself than in one that has not. The firm that has not disclosed the basic financial information is likely to have, for the relevant time period, more risk associated with it than would the firm that has disclosed this information. The risk is firm specific, though, and so it will not affect the riskiness of a fully diversified portfolio. Each purchase, based on the difference between current price and what is indicated by the newly discovered information, is an inherently delverisfying transaction, however. Taking on an additional share of the firm that has not disclosed will add more to the riskiness of the investor’s portfolio than taking on an additional share of the issuer that has disclosed. Thus, compared to the firm that has disclosed, fewer shares of the firm that has not disclosed will be added to the investor’s portfolio before the additional arbitrage gain from purchasing an additional share is not worth the added risk. See Industrial Performance, supra note 8, at 36-43. This prospect of smaller arbitrage profits will reduce the incentive to gather and analyze information about the firm that does not disclose. More generally, John Coffee has made the argument that mandatory disclosure constitutes a subsidy to the investment analyst industry that increases that amount of analyst activity. John C. Coffee, Jr., Market Failure and the Economic Case for a Mandatory Disclosure System, 70 VA. L. REV. 717, 728-29 (1984). Coffee’s point is consistent with the theoretical point by Grossman and Stiglitz that if the cost of gathering and analyzing private information is lower (which it would be with more free publicly available information to use as feedstock for research) there will be a higher intensity of trading by the smart money speculators, which will lead to “more informative pricing.” Grossman & Stiglitz, supra note 8, at 405. There is some empirical support for the theory that more disclosure leads to more gathering and analysis of yet additional information. Lang and Lundholm find that a firm that discloses more is followed by more analysts and that the analysts’ forecasts are more accurate. Mark Lang & Russell Lundholm, Cross Sectional Determinants of Analyst Ratings of Corporate Disclosure, 31 J. ACCT. RES. 246 (1993).

C. "Speculative Noise" versus "Fundamental Information"

Share price accuracy will be diminished if the price is affected by what financial economists refer to as speculative noise. The model of share pricing described so far excludes speculative noise. It assumes that whatever information share prices do reflect, it is of a kind that will help in predicting future distributions more precisely (i.e., it is "fundamental information"). Thus, the model implicitly assumes that smart money speculators focus exclusively on future distributions and that their arbitrage activities fully counteract any trading by naive speculators, whose trading is activated by fads, fashions, or irrational psychological predispositions toward behaviors such as chasing trends. Many financial economists believe, however, that the arbitrage activities of the smart money speculators, even if they focus exclusively on future distributions, do not always fully counteract the actions of these naive speculators. As a result, share prices will be further from actual value than they would have been absent the trading by the naive speculators, the difference being speculative noise. The more speculative noise in the market, the less accurate are share prices.

Moreover, there are reasons to believe that, at least in some part, if less fundamental information is gathered and reflected in share price, the smart money speculators will not focus exclusively on future distributions and their attention will turn in part to the direction of speculative noise. If, relative to fundamental information, this noise plays a larger role in determining future

---

11. See, e.g., Fisher Black, Noise, 41 J. FIN. 529 (1986). In the view of these economists, speculative noise can occur even if there are smart money speculators in the market who trade knowing a stock's fundamental value (the price that would prevail if the market consisted entirely of rational investors who possessed all available information—i.e., the price that would prevail in a truly efficient market). The smart money speculators are limited in their ability to arbitrage away the difference between what the share's market price would be, based on the trades of the noise traders and the share's fundamental value. To start, unless the smart money speculators have an infinite time horizon, the uncertainty created by the possibility of continued noise trading makes taking such a position inherently risky even if the smart money speculators know for certain a stock's actual value. This is because they know at the time they are contemplating a purchase that because of noise, price at the end of their time horizon may still deviate from actual value. See J. Bradford De Long et al., Noise Trader Risk in Financial Markets, 98 J. POL. ECON. 703 (1990). Furthermore, smart money speculators in fact do not know a stock's actual value with certainty; rather, they only know its fundamental value, which is the value implied by the available fundamental information. Thus, fundamental value is just a more accurate guess concerning actual value than is the noise trade influenced market price. This uncertainty as to the stock's actual value adds to the smart money speculators' risk of arbitrage. See Andrei Schleifer & Lawrence Summers, The Noise Trader Approach to Finance, 4 J. ECON. PERSPECTIVES 19 (1990); Industrial Performance, supra note 8, at 36-43, 55-59. It should also be noted that the very fact that gathering and analyzing information privately is costly means that despite the existence of smart money speculative traders, space exists for noise trading to occur. This is because of the "efficient market paradox" noted by Grossman and Stiglitz, who observe that "because [acquiring private] information is costly, prices cannot perfectly reflect the information which is available, since if it did, those who spent resources to obtain it would receive no compensation." Grossman & Stiglitz, supra note 8, at 405. An excellent survey in the legal literature of the work of the noise theorists, together with an analysis of its legal implications, is found in Donald Langevoort, Theories, Assumptions, and Securities Regulation: Market Efficiency Revisited, 140 U. PA. L. REV. 851 (1992).
share prices, speculators will get more reward for trying to figure out future noise and less reward for trying to figure out future cash distributions to shareholders. This reward structure makes the effort to design social institutions that encourage the gathering and analyzing of fundamental information and its reflection in price doubly important in terms of share price accuracy. It thus makes more critical the determination of the effectiveness of mandatory disclosure, for example.

II. SHARE PRICE INFORMEDNESS

A. The Concept

Share price informedness is a concept closely related to share price accuracy. A share price is more informed at a given time if it reflects a larger portion of all the fundamental information known, or, through sufficient effort, knowable, by one or more persons in the world. Thus, a fully informed price would reflect all information that is knowable at the time. Any fact that is at a given time unknowable will by definition have an unpredictable (i.e., random) effect on future shareholder distributions. Because of this, a fully informed price, while not perfectly accurate, would be both unbiased and the most accurate price possible at the time. Therefore, all of the factors discussed above that make a share price more accurate make it more informed as well.

Share price accuracy and informedness can be pictured as follows. Consider an analogy between the process by which bits of information are incorporated into share price and sampling from a large urn containing 1000 balls. Assume that somewhere between zero and 1000 of the balls are red and the rest are green. Prior to any sampling of the urn, nothing is known about the ratio of red to green balls in the urn. A share’s actual value is analogous to the actual ratio of the green to red balls. A random sample of the urn’s balls is equivalent to the bits of information that are incorporated in price. Even a small sample of balls provides an unbiased estimate of the actual ratio of red to green balls. Similarly, in an efficient market, share price is an unbiased estimate of a share’s actual value even if there is not a great deal of information available. The impact on the estimate of drawing another ball from the urn is unknowable—it could increase or decrease the estimate of the actual ratio—but the more balls that are drawn from the urn (i.e., the larger the sample)—the greater the expected accuracy of the estimate. Similarly, the impact of a new bit

12. JOHN MAYNARD KEYNES, THE GENERAL THEORY OF EMPLOYMENT, INTEREST AND MONEY 157 (1936). Grossman and Stiglitz make the inverse of this point, suggesting that if the cost of gathering and analyzing private information is lower, there will be a higher intensity of trading by the smart money speculators, which will lead to "more informative pricing." Grossman & Stiglitz, supra note 8, at 404.

120
Measuring Share Price Accuracy

of information on share price is unknowable prior to its availability—it could increase or decrease price—but its incorporation in price will increase the price's expected accuracy as an estimate of the share's actual value. The ratio of green to red balls in the largest sample possible at any point in time will provide the most accurate possible estimate of the actual ratio in the urn. Similarly, a fully informed price at a given point in time is the most accurate estimate possible at that time of the actual value of the share.

While the concept of share price accuracy allows a simpler, more direct story concerning the relationship between share prices and the real economy, the concept of share price informedness serves two useful functions in fully understanding this relationship. First, it avoids the discomfort that some may feel about the deterministic nature of the model behind the concept of share price accuracy. More importantly, as will become clear when I discuss immediately below the use of the $R^2$ methodology to measure share price accuracy, the concept of price informedness highlights the fact that price movement can be a sign of share price accuracy rather than inaccuracy. This is because price movement may indicate, at least in part, an ongoing process by which new fundamental information is being reflected in price.

B. Relationship of Share Price Accuracy to Price Movement

In essence, there are two countervailing considerations at work in terms of the relationship between price accuracy and price movement. The first force relates to the expectation discussed above that the deviation between the portion of an issuer's share's actual value derived from the discounted present value of any given expected future distribution, and the corresponding portion of the share's price, will tend to decrease as the length of time before the distribution decreases. Taking account of just this first consideration, at any given point in time, the more accurate the price is, the less share price movement one would expect to see thereafter as price eventually approaches actual value. Thus, if only this consideration were at work, where one observes over a period of time relatively little movement in the price of an issuer's shares, one would assume that on average its share price was more accurate than the share price of an issuer displaying more movement.

The second consideration is the amount of new information relevant to an issuer's future cash distributions that on an ongoing basis is being gathered, analyzed, and reflected in price. This second consideration can potentially work in the other direction. Just taking account of the second consideration, more movement may suggest greater accuracy. Consider firms A and B. Assume that A and B will each make a single distribution of the same amount, at liquidation, on the same date sometime in the future. Thus, at any point in time, the shares

of the two firms have the same actual value. To control for the first consideration, assume that at the beginning of the period of observation, A’s and B’s prices are equally distant from the respective shares’ actual values. After this, substantial amounts of new information about firm A is, on an ongoing basis, being gathered, analyzed and reflected in its share price. Less of this updating is occurring with respect to B.

Each newly arriving bit of information will on average move price closer to actual value but will, as appears to be the case in the real world, include a significant amount of random noise. The random noise I refer to here is not the speculative noise discussed earlier. It simply reflects the idea that any new piece of information is not perfect. While, on an expected basis, each bit of information moves price toward actual value, it contains a random element that in any given case may move price in the opposite direction. In terms of the analogy above comparing the incorporation of information into securities prices with sampling from an urn containing 1000 red and green balls in an undetermined proportion, the new bit of information is like a collection of balls, some of which are from the urn and the rest of which are randomly added from a side collection that is half red balls and half green balls. The person doing the sampling knows the average number of balls drawn from the side collection but no more. Each sample adds to the accuracy of the estimate of the ratio of red to green balls in the urn despite the noise from the balls drawn from the side collection.

Information bit by information bit, price may move one way or the other, but the total effect of the cumulating bits will on average be moving price closer and closer toward actual value. One would expect firm A to have, during the period of observation, a more informed, and hence more accurate, price than firm B because the updating information is on average moving its share price closer to actual value. If the random noise element of each bit is sufficiently large, however, A’s share price will display more price movement on average than B’s, given that new bits of information arrive more frequently and with the arrival of each bit comes random noise that can shift price.

Consider the following example to demonstrate the plausibility of the proposition that firm A, whose price is more frequently updated by new information than that of firm B, will have on average a more accurate price, but will have price changes displaying a greater variance than will firm B’s price changes. Suppose that firms A and B will each pay out a single shareholder distribution, which will occur at liquidation. Each will liquidate at t5. See supra Part I.C.

This model, in which new information, on the one hand, helps to bring price toward actual value but, on the other hand, is less than perfect, follows in the tradition of R.W. Holthausen & R.E. Verrecchia, The Effect of Sequential Information Releases on the Variance of Price Changes in an Intermiemporal Multi-Asset Market, 26 J. ACCT. RES. 82 (1988); and K.R. Subramanyam, Uncertain Precision and Price Reactions to Information, 71 ACCT. REV. 207 (1996).
Measuring Share Price Accuracy

pay out $10 per share at that time, its only shareholder distribution. Assuming for simplicity a zero discount rate (i.e., pricing is in accordance with CAPM and there is no time value of money or systematic risk), each firm’s shares will have an actual value of $10 throughout the life of the firm. Suppose also that at t₀ each firm has a price of $15 and so each starts out with an equally inaccurate price.

Firm A’s price is updated in each of the five periods by a new bit of information. The bit of new information in each of periods t₁, t₂, t₃, and t₄ contains two elements. One element is like an accurate missing piece in the puzzle and moves the price $1 closer toward actual value. The other element is noise: it is random and has an expected value of zero. Investors can only observe the aggregate implications of the two elements combined. Thus, on an expected basis, A’s price becomes more accurate after the receipt of each bit of information, but the observable aggregate implication of the bit involves variation around what would be implied by the accurate-piece-of-the-puzzle element alone. The bit of new information at t₅ is the announcement of the liquidating distribution. The price at t₅ is therefore $10 and is perfectly accurate. Firm B’s price is not updated at all until t₅, but, for it too, the bit of information at t₅ is the announcement of the liquidating distribution. Its price at t₅ is therefore also a perfectly accurate $10.

The following prices provide an example consistent with this story. Firm A has a price at t₀ of $15. At t₁, the price is $12.50 (the result of a noise element of -$1.50, which when combined with the accurate-piece-of-the-picture element, moves the price in aggregate down by 2.50). At t₂, the price is $14.50 (the result of a noise element of +$3.00, which when combined with the accurate-piece-of-the-picture element, moves the price in aggregate up by $2.00). At t₃, the price is $10.50 (the result of a noise element of -$3.00, which when combined with the accurate-piece-of-the-picture element, moves the price in aggregate down by $4.00). At t₄, the price is $11.00 (the result of a noise element of +$1.50, which when combined with accurate piece of the picture element, moves the price in aggregate up by $.50). At t₅, the price equals the share’s actual value of $10 (the result of the noiseless announcement of the liquidating distribution, providing the last missing piece of the picture). Thus the noise element in this example has a mean of zero and a standard deviation of 2.37. Firm B’s price stays at $15 for periods t₁, t₂, t₃, and t₄ and drops to $10 in period t₅, when the liquidating dividend is announced. The paths of the share prices of A and B are depicted in Figures 1 and 2 below.
As shown in Table I below, firm A's price changes display a greater variance than firm B's (5.5 versus 5.0) even though firm A's share price is on average closer to its actual value of $10 (i.e., more accurate) than firm B's share price. This greater accuracy can be observed simply from looking at Figures 1 and 2. A more precise measure of average share price accuracy would be the average of the squared deviations of share price from actual value in periods $t_1$, $t_2$, $t_3$, $t_4$, and $t_5$ (the smaller the figure, the more accurate the price). As shown in Table I below, the average of these squared deviations for firm A is 5.55 and for firm B is 20.
## Measuring Share Price Accuracy

### Table I

**Firm A**

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate -Piece-of-the-Puzzle Element</td>
<td>Random Noise Element</td>
<td>Total Effect</td>
<td>Price</td>
<td>Square of Price Change</td>
<td>Square of Deviation of Price from Actual Value of $10</td>
</tr>
<tr>
<td>( t_0 )</td>
<td>( t_1 )</td>
<td>( -1 )</td>
<td>( -1.5 )</td>
<td>( -2.5 )</td>
<td>( 15.00 )</td>
</tr>
<tr>
<td>( t_1 )</td>
<td>( 0 )</td>
<td>( -1 )</td>
<td>( -3.0 )</td>
<td>( -4.0 )</td>
<td>( 10.50 )</td>
</tr>
<tr>
<td>( t_2 )</td>
<td>( -1 )</td>
<td>( +1.5 )</td>
<td>( +5.0 )</td>
<td>( 11.00 )</td>
<td>( 0.25 )</td>
</tr>
<tr>
<td>( t_3 )</td>
<td>( -1 )</td>
<td>( 0 )</td>
<td>( -1.0 )</td>
<td>( 10.00 )</td>
<td>( 1.00 )</td>
</tr>
<tr>
<td>Total</td>
<td>( -5 )</td>
<td>0</td>
<td>-5.0</td>
<td>27.5</td>
<td>27.75</td>
</tr>
<tr>
<td>Variance or Average Square of Deviation</td>
<td>5.50</td>
<td>5.550</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Firm B**

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate -Piece-of-the-Puzzle Element</td>
<td>Random Noise Element</td>
<td>Total Effect</td>
<td>Price</td>
<td>Square of Price Change</td>
<td>Square of Deviation of Price from Actual Value of $10</td>
</tr>
<tr>
<td>( t_0 )</td>
<td>( t_1 )</td>
<td>0</td>
<td>0</td>
<td>15.00</td>
<td>0</td>
</tr>
<tr>
<td>( t_1 )</td>
<td>( 0 )</td>
<td>0</td>
<td>15.00</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>( t_2 )</td>
<td>( 0 )</td>
<td>0</td>
<td>15.00</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>( t_3 )</td>
<td>( 0 )</td>
<td>0</td>
<td>15.00</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>( t_4 )</td>
<td>( 0 )</td>
<td>0</td>
<td>15.00</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>( t_5 )</td>
<td>( -5 )</td>
<td>0</td>
<td>-5.0</td>
<td>10.00</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>( -5 )</td>
<td>0</td>
<td>-5.0</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Variance or Average Square of Deviation</td>
<td>5.0</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This example is generalizable to ongoing firms not facing immediate liquidation. Specifically, the result that firm A will have on average a more accurate share price and will display a higher price variance is replicable under the following changed assumptions. Imagine a five-period cycle in which, once every fifth time period, the prices of firm A and B are equally accurate. Firm A is updated every period. Firm B is updated only every fifth period, but with a bigger piece of information so that, after the updating, its price is for the moment as accurate as firm A’s. The example above now illustrates one such cycle with each firm starting at an equally accurate $15 at $t_0$ and each ending up at an equally more accurate $10$ in $t_5$, but with firm A making adjustments along the way. The same calculations as in the example above show that in this case also firm A has on average greater share price accuracy and greater price variance.

I am not claiming that more frequent updating inevitably results in the combination of greater share price variance and greater share price accuracy. Whether or not it does depends on the amount of noise in the updating bits of information. The example only illustrates that greater share price accuracy can plausibly be accompanied by greater share price variance. There are other possibilities as well. If the random noise element is sufficiently small, firm A, compared to firm B, could have a combination of smaller price variance and greater share price accuracy. If the random noise element is sufficiently large, firm A, compared to firm B, could have a combination of larger price variance and less share price accuracy. Where the amount of random noise element to new information is between these two extremes, however taking account of just this second consideration—more frequent updating—, the more accurate the share price is at a given time, the more share price movement one would expect to see.

In the real world, both countervailing considerations are at work. The first consideration, relating to time to liquidation, is working so that greater price movement suggests less share price accuracy and the second is working so that, at least if information bits contain an amount of noise in the middle range, greater price movement suggests greater share price accuracy. One can say as a theoretical matter that the second consideration would be more important relative to the first in the case of relatively short term (e.g., day-to-day or week-to-week) price changes compared to longer term (quarter-to-quarter, year-to-year, or decade-to-decade) price changes, because with the longer term price changes the noise elements of the day to day updates tend to cancel each other out. For any given term’s price changes, however, this observation does not tell us which consideration predominates. Whether greater price movement indicates greater or lesser price accuracy is ultimately an empirical question. I will discuss immediately below strong empirical support for the conclusion that, in the case of relatively short term price changes, more movement
Measuring Share Price Accuracy

indicates greater share price accuracy.

This discussion of price informedness suggests that price variance over time may not be a good inverse proxy for share price accuracy. As a theoretical matter, greater variance may be associated with more share price accuracy rather than less, especially if the time intervals are short between the points at which the price changes are measured.

III. THE R² METHODOLOGY

A new measure for the informedness of share prices and hence their accuracy involves a measure, R², which is related to the extent to which share prices of an economy’s issuers move together. For the reasons discussed below, R² appears to be a better inverse proxy than share price variance for how much fundamental information concerning future shareholder distributions is impounded in share prices: the lower is R², the more accurate are prices.

A. Preliminary Theoretical Considerations

There are good preliminary theoretical reasons for believing that higher co-movement of stocks in an economy indicates less informed prices of the shares of individual firms. These reasons follow from an explanation offered by Laura Veldkamp concerning why share prices appear as a general matter to co-vary more than would be called for by measures of their fundamental value. Veldcamp suggests this pattern results from the facts that information is costly and that information about the future distributions of one issuer has some predictive value concerning the future distributions of other issuers as well. As a result, investors may economize in their expenditures for acquisition of information. They may collect information about one issuer and also use it to predict the future distributions of other issuers even where they could make better predictions about the future distributions of the others if the collected information specifically about each of these other issues as well. The price of the shares of the other issuers would therefore co-vary with that of the issuer about which the information is collected more than would be called for by their respective fundamentals. In a richer information environment where collecting information about each individual issuer is less expensive, less of this reliance

---

16. The R² measure for an individual country is computed as follows. For each individual issuer j in the country, run a regression using time-series data on the issuer’s share rate of return whereby \( r_j,t = \beta_j + \beta_{j,m} r_{m,t} + \beta_{j,i} r_{i,t} + e_{j,t} \), with \( r_m \) = market return and \( r_i \) = industry return. Then decompose the total variance of the issuer’s return as follows: \( \sigma^2_j = \sigma^2_m + \sigma^2_i \). R² for firm j is then defined as \( R^2 = \sigma^2_i / (\sigma^2_i + \sigma^2_j) \). R² for the country is an average of the R²’s for its individual issuers, weighted by the total variation of each stock’s return. From this formula, one can see that there is more firm-specific variation when R² is low. R² is low.

on information about one issuer to predict the future returns of another would occur and the amount of co-variance would be lower. In such a world, individual share prices would be more accurate. Thus lower co-variance would be an indicator of greater share price accuracy.

B. Indirect Evidence That $R^2$ Is a Good Inverse Proxy for Share Price Accuracy

The idea that $R^2$ is a good inverse proxy for share price accuracy initially arose from the observation by Morck, Yeung, and Yu ("MYY") that countries vary a great deal in the extent to which share prices of their firms tend to move together, the phenomenon measured by $R^2$.18 This difference among countries is shown dramatically in Figure 3, on the next page. For example, for most weeks during the first half of 1995, in each of China, Malaysia, and Poland, over 80 percent of stocks moved in the same direction; for the same period in each of Denmark, Ireland, and the United States, there was not a single week in which as many as 58 percent of firms moved in the same direction (despite, in the case of the United States, the then-ongoing bull market).19 These startling differences cry out for explanation.

1. The Link between $R^2$, Poor Quality Government, and Risk Arbitrage

MYY try to explain these national differences by exploring the factors that seem to be associated with low and high $R^2$ scores. They observe, as illustrated in Figure 3, that developed countries, ones with high per-capita GDP, tend to have low $R^2$s and emerging countries, ones with low per-capita GDP, tend to have high $R^2$s. There is no obvious reason why low per-capita GDP would lead directly to a greater tendency for share prices to move together. More likely, MYY reason, low per-capita GDP is associated with other national characteristics that lead to this result.20 MYY try to identify what these other characteristics might be and in the process find evidence that $R^2$ is a good inverse proxy of how much fundamental information is impounded in share prices.

MYY first consider a number of obvious structural characteristics of a country that a priori would appear likely to affect its $R^2$.21 One factor is country size. Firms in a small country might be more uniformly subject to environmental influences such as bad weather or nearby geopolitical instability. Small countries also tend to have more uniform factor endowments, making

19. Id. Data from other periods in the 1990s behave similarly. Id.
20. Id. at 227-28.
21. Id. at 230-41.
Measuring Share Price Accuracy

their overall economies more sensitive to changes in relative factor prices such as the price of oil. A second structural characteristic is the extent of diversity of a country’s firms across industries: the less the diverse the industries, the more likely the fortunes of all firms will move together. A third structural characteristic, which serves as a kind of catchall, is the extent to which the earnings of a country’s firms tend to move together.

Figure 3
MYY run a regression with a log transformation of country $R^2$s as the dependent variable (the variable to be explained) and with per-capita GDP and measures of each of these three structural characteristics as the independent variables (the variables that potentially explain the dependent variable). The coefficient for per-capita GDP remains statistically significant. Continuing with the proposition that there is no reason why low per-capita GDP would lead directly to share prices moving together, the continued significance of the per-capita GDP coefficient suggests it is a proxy for yet additional country characteristics, *institutional* rather than structural, that help explain the variation in $R^2$ across countries.\(^{22}\) MYY add to the regression one additional independent variable, a measure for "good government." This measure consists of the sum of the scores for each country on indexes created by La Porta *et al*\(^{23}\) relating to government corruption, risk of government expropriation, and risk of governmental contract repudiation. With the addition of this factor, the coefficient for per-capita GDP becomes insignificant. In sum, countries vary in their $R^2$s not just because of differences in their structural characteristics, such as country size and diversity of industry. An institutional factor—the quality of government—appears to play an important role as well.

MYY's discovery that governmental quality plays an important role in explaining differences among countries in their $R^2$s leads them to hypothesize that $R^2$ might be a good inverse proxy for price informedness.\(^{24}\) I believe this is a plausible hypothesis. My reasoning, building upon MYY, begins with the observation that the predictability of future cash distributions to a firm's outside shareholders depends on two factors. One is the predictability of the level of the firm's underlying cash flows. The second is the predictability of the division of these underlying cash flows between the outside shareholders, on one hand, and inside shareholders and other firm stakeholders, on the other.

In countries with low good government scores, extra-legal governmental influence will play a larger role in determining both the level of firm cash flows and the division of these cash flows. In low good-government-score countries, a firm's profitability can be dramatically affected by whether or not it has close relationships with governmental officials, the persons who grant government contracts, issue licenses, and determine when to enforce regulations. Also in such countries, the division of a firm's cash flows will deviate from the standard corporate law model of pro-rata distribution among all shareholders. Instead, inside shareholders receive, in one form or another, more than a pro-rata share of the wealth generated by a firm's activities, and other stakeholders receive more than a market return for their contributions to the firm.\(^{25}\)

\(^{22}\) *Id.* at 241-51.


\(^{24}\) Morck *et al.*, *Information Content*, supra note 18, at 242-43.

\(^{25}\) Russia provides an excellent case study of this problem. *See* Bernard Black *et al.*, *Russian
deviations come at the expense of outside shareholders. The closer a firm's inside shareholders and other stakeholders are to governmental officials, the greater are the governmental tolerance of such deviations.

This larger extra-legal governmental influence on the amount of distributions ultimately reaching outside shareholders makes these distributions harder to predict. To start, in low score countries, the cash flow levels of firms themselves are harder to predict. This is because the impact of this extra-legal governmental influence on cash flows from one firm to the next is harder to predict than the purely market factors that would determine firm cash flows in the absence of such influence. The problem of predicting the impact of such influence on the cash flows of any one particular firm is aggravated by the opaque, erratic nature of political regimes prevalent in many emerging countries. In addition, the proportion of this cash flow that will ultimately be paid out to outside shareholders of a firm in a low score country is itself less predictable. In such a country, outside shareholders are, as noted, relatively unprotected legally. The total amount of distributions that they receive over the life of the firm is arbitrary. Outsiders receive what is left over, if anything, after the inside shareholders and other stakeholders have taken what their positions of political power allow them to get, plus, perhaps, the occasional distribution to outsiders made for some strategic reason.

The last step in our reasoning concerns the effect of these less predictable distributions to outside shareholders on the process of share pricing. When future distributions to outside shareholders are harder to predict, naive speculators—the "noise traders"—are more likely to become confused, which adds to the riskiness undertaken by rational smart money speculators—the risk arbitrageurs—who bet against them. This added riskiness makes it less attractive to be a risk arbitrageur, which means less such activity occurs in the economy. Less information about fundamentals (both firm specific and market wide) is incorporated in price because fewer risk arbitraguers find it worthwhile to gather, analyze, and act on such information. As a result, there is more effect on price from the trading of the naive speculators ("noise trading") and share prices will less accurately reflect what the distributions to outside shareholders ultimately turn out to be. This problem of a low level of risk arbitrage in countries with low good government measures may be accentuated by the fact


26. Morck et al., Information Content, supra note 18, at 242-44. The idea that there will be more noise trading when future distributions to outside shareholders are less predictable is consistent with the idea that when less information is publicly available, less trading based on privately acquired and analyzed information will occur. See supra notes 9-12 and accompanying text.

27. J. Bradford De Long et al., Noise Trader Risk in Financial Markets, 98 J. POL. ECON. 703, 733. See also supra Part I.C.

28. Morck et al., Information Content, supra note 18, at 244-47.
that in such countries, risk arbitragers may be less confident that they will be able to keep free from confiscation of the profits that they do manage to make.\textsuperscript{29} This lower level of risk arbitrage, with its resulting lower level of price informedness and hence price accuracy and higher level of noise trading, can be expected to be accompanied by the higher $R^2$s that one observes with the low good government score countries. This is because the fads and fashions that motivate naive speculative traders tend to have an impact across the market.

In sum, the link between high $R^2$s and low price informedness is established as follows. High $R^2$s are observed to be associated with low good government scores. Low good government scores suggest that extra-legal governmental influence will play a larger role in determining future distributions to outside shareholders. The impact of this kind of influence is harder to predict than the market forces that would otherwise determine the level of such distributions, thereby making the distributions themselves less predictable. This unpredictability confuses naïve speculative traders, which causes them to act in ways that add to the risk of smart money speculation. This added risk depresses the level of risk arbitrage activity, which has two consequences. One is that less information is impounded in prices. The other is that the naïve speculative traders have a larger role in setting prices. The fads and fashions that motivate the naïve speculative traders tend to have impact across the market, and hence their larger role in the market results in prices of different firms tending to move together more. As a consequence, country $R^2$ will be higher. Thus, everything else being equal, a high $R^2$ is indicative of a low level of risk arbitrage, which will result in a low level of price informedness.

2. \textit{Further Implications of the Link between $R^2$ and Poor Quality Government}

The implications for share price informedness of our analysis go even deeper than this, however. While the mechanisms of real economic efficiency promoted by share price accuracy still work to some extent even when prices are relatively less accurate, the greater extra-legal governmental influence that drives up $R^2$ not only leads to a lower level of share price accuracy, it makes this lower level of price accuracy even less effective than it would otherwise be in promoting the functioning of these mechanisms of real economic efficiency. To see why, recall that a share price is less accurate when it is less likely to be close to the share's actual value, which is the discounted present value of what the future distributions to outside shareholders ultimately turn out to be. In low good government score countries, a significant factor in this lower level of share price accuracy is the underlying unpredictability concerning the

\textsuperscript{29} \textit{Id.} at 243.

132
Measuring Share Price Accuracy

proportion of a firm's underlying overall cash flow that will ultimately reach outside shareholders. Thus, share price is doubly less informed in terms of being an estimate of the firm's underlying overall cash flows. This result is critical because the theory suggesting that accurate share prices enhance real economic efficiency assumes that accurate share prices are good estimates of future underlying overall firm cash flow. A firm's residuals are, under in this theory, assumed reliably to go largely to its shareholders and every shareholder, whether inside or outside, is assumed to receive a pro-rata distribution of these residuals. In short, share prices in a country with a low quality government are doubly disabled in their capacity to promote efficiency in the real economy. First, because there is less risk arbitrage, share prices are poorer predictors of future distributions to outside shareholders. Second, future distributions to outside shareholders are themselves less reliable indicators of a firm's underlying cash flow. It is the accuracy of prices as predictors of firm cash flows that promotes the effectiveness of the mechanisms of efficiency in the real economy.

3. Other Indirect Evidence That $R^2$ Is a Good Inverse Proxy for Price Informedness

Two other pieces of indirect evidence help support the hypothesis that $R^2$ is an inverse proxy for price informedness. First, the average $R^2$ for U.S. firms has decreased significantly over the twentieth century, particularly since World War II. This corresponds to a period in which, for both technological and institutional reasons, more information has become available for risk arbitraguers to use, even putting aside mandatory disclosure, which was originally adopted in the 1930s and has since been significantly enhanced.

Second, MYY examined a subsample consisting of $R^2$s of all the developed countries in their study. In the regressions they ran to try to explain the differences in $R^2$s among these countries, they included, as an additional independent variable, another La Porta et al. index, one purporting to measure the protection of outside shareholders through rights that help them control directors. They find that the coefficient for this index was negative and statistically significant, thus suggesting an inverse relationship between the level of such protections and country $R^2$.

MYY's explanation for this result starts with the assumption that in a country with weak protection for outside shareholders, managers will find it easier to divert a larger portion of the firm's cash flow to themselves. These

30. See supra Part II.B.
31. Morck et al., Information Content, supra note 18, at 220-22.
32. La Porta et al., supra note 23.
33. Morck et al., Information Content, supra note 18, at 255.
managers are more likely to divert extra cash flow generated by favorable firm specific developments than extra cash flow generated by favorable developments in the economy as a whole. This is because a diversion of the firm-specific, development-generated income is less likely to be detected, since outsiders know more about changes in economy-wide factors than about changes in firm-specific factors. Thus, changes in firm cash flow due to changes in economy-wide factors are more likely to be passed on to outside shareholders. As a consequence, these changes in economy-wide factors are likely to affect distributions to outside shareholders more than they affect the underlying cash flow of the firm. The result will be the higher $R^2$s that are observed in the data for countries with a lower level of protection for outside shareholders. This effect will be accentuated by the fact that, relative to countries with more protection, risk arbitrageurs in low protection countries will rationally devote more of their attention to predicting economy-wide factors and less to predicting firm specific factors, because these economy-wide factors play a larger role in determining distributions to outside shareholders.\textsuperscript{34}

In conclusion, while the higher $R^2$s in such countries do not necessarily indicate that share prices are less accurate predictors of future distributions to outside shareholders, they will be less accurate predictors of underlying firm cash flows and thus again will not perform as well their real-economy, efficiency-enhancing functions.\textsuperscript{35}

C. Direct Test of $R^2$ as a Proxy for Share Price Accuracy

Durnev, Morck, Yeung, and Zarowin ("DMYZ") examine more directly the usefulness of $R^2$ as an inverse proxy for share price accuracy by examining the relationship between a firm's $R^2$ and the extent to which its share price reflects future versus current earnings.\textsuperscript{36} For a set of U.S. publicly traded firms, DMYZ go back in time and regress each firm's then current stock price on its then current and future earnings. They find that future earnings explain more of the share prices of low $R^2$ firms than with high $R^2$ firms. In other words, share prices of lower $R^2$ firms are better predictors of their future earnings than share prices of high $R^2$ firms.

This finding is much more direct evidence that low $R^2$ firms have more accurate share prices. Remember that a more accurate share price is one that better predicts future shareholder distributions. Future distributions can only come from presently known existing assets or future cash flows, and future earnings are on average a reasonably good proxy for future cash flows.

\textsuperscript{34} Id. at 254.
\textsuperscript{35} See supra Part I.B.
Measuring Share Price Accuracy

CONCLUSION

Theory suggests that regulatory policies relating to a wide range of activities—issuer disclosure, insider trading and tipping, selective disclosure to institutions and analysts, and analyst recommendations—may possibly affect share price accuracy. With respect to each of these activities, however, there is heated debate concerning whether in fact the activity has such an effect and if so in which direction. The widespread belief that the level of share price accuracy affects the efficiency of the real economy suggests the importance of resolving these debates. Assuming this belief is correct, it is obvious that regulatory policy could be improved if there were more empirical evidence addressing these questions.

This Article has addressed the problem of developing a practical empirical measure of share price accuracy. It has argued that share price variance, the traditional measure, is ambiguous in its actual implications. Under at least some circumstances, greater share price movement indicates greater, not less, share price accuracy. A new measure, $R^2$, which reflects the extent to which a firm's share price moves with the prices of all the other firms in the economy, appears to be a more reliable proxy. While further testing is required, there are good theoretical and empirical reasons for believing that a lower $R^2$ (i.e., less co-movement) means a more accurate price.