The Complete Range of ERCs and the Implied Persistence of Unexpected Earnings

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Abstract

In this paper, we consider ERCs ranging from negative to positive infinity and, by assuming an AR(1) pattern for the persistence of unexpected earnings, we capture the market's expectation of the magnitude of persistence of unexpected earnings from the ERC. We develop a framework for interpreting ERCs outside the previously explored classes of transitory (ERC=1), permanent (ERC=$1+\frac{1}{r}$), and decaying ($1<$ERC$<1+\frac{1}{r}$) by introducing several new classes: growing (ERC$>1+\frac{1}{r}$), partially offsetting (0<ERC<1), offsetting (ERC=0), and subsuming (ERC<0). Our framework allows for a broader interpretation of observed ERCs and a richer empirical context. Additionally, by directly linking the ERC and implied persistence, we provide another way to interpret the market's understanding of the information conveyed by the earnings announcement.

1. Introduction

The term 'earnings response coefficient' is widely used in the accounting and finance literature to describe the relation between unexpected accounting earnings and the unexpected stock returns generated immediately around the earnings announcement. Despite acknowledgement that there are infinite possible values for the earnings response coefficient (e.g. Easton and Zmijewski [1989], Beaver, Clarke, and Wright [1979]), prior literature has generally not explored earnings response coefficients (ERCs) outside the boundaries of transitory (ERC = 1) and permanent (ERC = $1+\frac{1}{r}$). We develop a multi-class framework for interpreting ERCs ranging from negative to positive infinity. In particular, in addition to the previously explored classes of transitory, permanent, and decaying we introduce growing (ERC > $1+\frac{1}{r}$), partially offsetting (0 < ERC <1), offsetting (ERC = 0), and subsuming (ERC < 0). We also further explore the connection, established by Kormendi and Lipe [1987] ("KL"), between the ERC and the market's belief regarding magnitude of the persistence of unexpected earnings. KL test whether the *actual* persistence of earnings is positively related to the return-earnings relation, assuming a moving average of earnings changes. In contrast, we use the ERC to infer the *expected* magnitude of persistence, assuming an AR(1) pattern for unexpected earnings. This allows us to identify, from the price impact of an earnings announcement, changes in the series of expected future earnings without the need to specify the process for previously expected earnings (i.e. without requiring any assumption about *total* earnings).[1]

A dual-class ERC framework of transitory and permanent is inadequate for explaining the observed distribution of ERCs. In their analysis of the persistence of unexpected earnings, KL

[1] While we assume an AR(1) persistence for unexpected earnings, it is not necessary to do so. We explain this point further in a subsequent section.

find returns-earnings multiples ranging from -2.28 to 17.98 for their sample firms, and casual examination of the market's reaction to more recent earnings announcements corroborates the KL findings. When Radio Shack announced their earnings for the quarter ended March 2004, the price response was such that the ERC on the earnings surprise was 10, implying a very reasonable discount rate (r) of approximately 11% assuming permanent earnings. However, the implied required returns for other firms announcing earnings on the same day were not necessarily as 'reasonable.' For example, the ERCs for Safeco and Sprint for the same quarter were -1.40 (r = -42%) and 3.86 (r = 35%), respectively, if unexpected earnings were permanent. Indeed, Figure 1 illustrates a wide range of observed ERCs on a single earnings announcement day.

Under the dual-class framework, researchers typically expect ERCs to exceed 7.0 assuming permanent earnings and plausible required rates of return (Kothari and Zimmerman [1995]). Kothari [2001] claims that the most plausible ERC is 11, with a viable range between 8 and 20. Several prior papers have endeavored to explain the typically 'low' cross-sectional average ERC estimate using various rationales, including model misspecification.[2] As a measure of the market's interpretation of a particular earnings announcement, however, ERCs are more properly considered as an event-specific measure. Consequently, it is the *distribution* of ERCs that should be of primary interest to researchers. There is no theoretical reason why the market's reaction to a given earnings surprise must be limited to two main 'types' or to a particular range. Under the discounted cash flow model, the market's reaction to any information is simply the aggregate present value of the changes in expected future cash flows which results from the

[2] See, for example, Hayn [1995] and Ramakrishnan and Thomas [1998], among others. The interested reader is referred to Kothari [2001] for a more detailed discussion of this issue.

information.[3] By incorporating the notion of unexpected earnings as a signal (Beaver, Clarke, and Wright [1979]), our expanded framework allows for a more comprehensive interpretation of the possible distribution of ERCs and a richer empirical context in which to evaluate the market's response to the realization of a particular firm's unexpected earnings. Furthermore, by directly linking the ERC and implied persistence, we provide a way to interpret the market's understanding of the information conveyed by the earnings announcement. Future researchers can then compare the implied and actual persistence to gain insight as to whether or not the market appropriately understands the information content of earnings.[4]

In the next section, we briefly review the theoretical foundations for the existing dual-class taxonomy for earnings response coefficients. We then propose a more general ERC format consistent with the Ohlson [1991, 1995] models and illustrate the link between this ERC and persistence. In sections 3 and 4, we elaborate upon the taxonomy and, within each classification, we derive the magnitude of the persistence of unexpected earnings, assuming the persistence is expected to follow an AR(1) pattern. Our discussion in section 3 centers on the existing dual-class framework while in Section 4 we present our additional ERC types. Section 5 concludes.

2. Model development

2.1 Background

Beginning with the seminal works of Beaver [1968] and Ball and Brown [1968], researchers have endeavored to understand the relation between accounting earnings and market

[3] As noted by Liu [2004], the discounted cash flow, residual income, and discounted dividend models are mathematically equivalent.

[4] While several papers, including Sloan [1996] and Collins, Gong, and Hribar [2003], compare the actual and implied persistence of cash flows and accruals, their framework is somewhat different from that proposed in this paper. In particular, these papers focus on a comparison of earnings association coefficients (timeliness) with actual time series parameters. In contrast, we use an unexpected earnings-ERC (information content) framework.

prices. From among this broad interest, two of the types of studies that have emerged are those questioning the timeliness of earnings and those questioning the information content of earnings. Timeliness studies, such as Liu and Thomas [2000] and Easton, Harris and Ohlson [1992], document the association between earnings and contemporaneous prices and returns through an earnings association coefficient (EAC). In these studies, returns are measured over the same period for which earnings are calculated. The EAC is thus a reflection of the extent to which accounting earnings captures news within the same long-window that the stock price embeds the news. In contrast, Easton and Zmijewski [1989] were the first to coin the term "earnings response coefficient" to describe the relation between earnings news and the change in prices over a *short* horizon surrounding the release of the news. It and subsequent studies, such as Elliott and Hanna [1996], document the information content of earnings--its use in setting prices.

Though their empirical applications differ, both types of studies focus on the nature of the relation between earnings and prices and both speak to the implied persistence of earnings.[5] Because we are interested in the information content of an earnings announcement, in particular the market's assessment of the expected persistence of unexpected earnings, we utilize the ERC framework.

A significant step in understanding the impact of accounting earnings upon market prices involved focusing on the persistence of earnings, very generally defined as to what extent earnings today relate to future earnings. Kormendi and Lipe [1987] examined how the magnitude of the return-earnings relation relates to the time-series of earnings. They found that the persistence of earnings is positively related to the magnitude of the return-earnings relation. Though their empirical tests use a long-window association (timeliness) context, their model is

[5] A complete review of the EAC and ERC literature is beyond the scope of this paper. While we highlight a handful of papers, the reader is referred to Kothari [2001] for a more comprehensive discussion of the literature.

general enough to be used within an ERC or an EAC framework.[6] KL define persistence as the present value of revisions in expectations of future earnings related to the unexpected earnings and assume a very general structure for the time-series of earnings. In their model development, they establish the special cases of permanent and transitory earnings. Transitory earnings innovations are not expected to repeat in the future and thus persistence is zero. With only a current period innovation there is no need for discounting, and stock price increases by the amount of the earnings innovation resulting in a relation between the earnings innovation and returns equal to 1. In contrast, permanent earnings innovations are expected to repeat in every future period, and persistence is equal to 1. A return-earnings relation of $1+\frac{1}{r}$ results from combining the current period innovation with a discounted perpetuity of the same magnitude. While KL state other levels of persistence are possible, they are not directly examined.[7] Subsequent papers have focused on the range encompassed by these two special cases. However, as pointed out in Beaver, Clarke, and Wright [1979], earnings and prices could be related in many ways, because the output of an accounting system is a set of signals about the state of the firm.

Several empirical papers have used the ERC framework to investigate various aspects of the accounting model. ERCs have been used to infer earnings quality (e.g. Bandyopadhyay [1994]) and to measure market understanding of elements of earnings, e.g. the implications of special items for future earnings (Burgstahler, Jiambalvo, and Shevlin [2002]). To our knowledge, however, no paper uses the ERC to infer the market's assessment of the persistence of unexpected earnings.

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[6] Though the model in Kormendi and Lipe [1987] can be used in either framework, the authors were not the formal originators of the EAC and ERC terminology.
[7] Kormendi and Lipe [1987] were not the first to note that the relation could extend beyond these two special cases. Miller and Rock [1985] make the same comment.

2.2 Assumptions

Consistent with prior literature (Lipe [1990]; Ohlson [1995]), we assume that the stock price equals the present value of expected future dividends. As in KL, we further assume full payout of unexpected earnings and any persistence thereof; that is, the present value of revisions in expectations of future dividends equals the present value of revisions in expectations of future earnings. Thus, any revision in the expectation of future earnings has pricing implications. As in KL, we use the term 'persistence' to describe this revision in expectations.

We also assume that unexpected earnings is the only information received by the market at the earnings announcement. ERCs, by design, seek to capture the market's reaction only to unexpected earnings, thus we do not consider information sources other than accounting earnings.[8] As in Beaver [1968] and Easton and Zmijewski [1989], we focus on the market reaction to the news contained in the announcement of earnings, an endogenous event. This differs from examining the relation between the stock market's pricing and accounting system's recording of an exogenous economic event as in Easton, Shroff and Taylor [2000]. The price reaction when the earnings announcement reveals a non-zero error in the market's expectation of earnings reflects the market's interpretation of the new information.[9] The relation between unexpected earnings and the resulting price reaction has previously been considered within an ERC framework. We utilize this framework in our development of an expanded range of possible ERCs and to structure the link to implied persistence.

Finally, consistent with Ohlson [1995], we assume a flat term structure and that the clean surplus relation holds.

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[8] We note, however, that incorporating the 'other information' described in Ohlson [1995] and others does not alter the basic intuition of the framework we develop.

[9] Within this ERC framework, we do not consider a role for the notion of 'uncertainty resolution,' as in Beaver [1968]. That is, if there is zero unexpected earnings there is zero news and, hence, zero price reaction in our model to the announcement of earnings.

2.3 The Earnings Response Coefficient

It is well-accepted that price changes as a result of the receipt of new information by the market. In particular, at the earnings announcement the change in price is a function of the unexpected earnings realization. Recall that we assume unexpected earnings to be the only value-relevant information released at the earnings announcement. By convention, this function is generally presented using a multiple of the following form:

$$\Delta P_{t-\delta,t}^{cum-div} = \lambda \cdot \varepsilon_t \tag{1}$$

where $\Delta P_{t-\delta,t}^{cum-div}$ is change in cum-dividend price from time t-δ to time t

ε_t is the unexpected earnings reported at time t

Throughout the remainder of the paper, the term 'ERC' will be used to refer to λ, the multiple relating unexpected earnings to the price change, as shown in equation 1.[10]

To provide an initial framework for interpreting the coefficient on unexpected earnings, we first consider an earnings-based valuation model at a point immediately prior to the earnings announcement. The market knows reported accounting earnings measures permanent earnings with error and has expectations of each. Ohlson [1991] shows that assumptions of no-arbitrage and permanent (Hicksian) earnings allow for valuation based on expected permanent earnings in the following form:

$$P_{t-\tau}^{cum-div} = \left(1 + \frac{1}{r}\right) \cdot E_{t-\tau}\left[x_t\right] \tag{2}$$

where $P_{t-\tau}^{cum-div}$ is cum-dividend price at time t-τ

r is the discount rate

[10] An ERC, as defined in Easton and Zmijewski [1989], is the relation between unexpected returns and unexpected earnings deflated by beginning price. While we do not show the deflation, the relation in equation 3 between change in price and unexpected earnings yields the same coefficient.

x_t is permanent earnings for time t and thereafter

$E_{t-\tau}[.]$ is the expectations operator at time $t-\tau$

At any point in time, cum-dividend price is a function of the expectation *at that point* of future permanent earnings. At the earnings announcement, the market learns the magnitude of the unexpected (accounting) earnings and, as a result, updates its expectation of future earnings. Thus we can consider the form of the earnings multiple in Ohlson [1991], $(1+\frac{1}{r})$, as a starting point for understanding the market reaction to earnings announcement information. The unexpected earnings realization is capitalized into price according to the market's interpretation of its persistence. It is important to note that the unexpected earnings can be a current cash flow and/or an accrual that will result in cash flows in the future. The form of the unexpected earnings, cash or accrual, does not affect our framework as we use the market's pricing of the unexpected earnings to understand the persistence of the *reported* unexpected earnings.

Note that the Ohlson [1991] coefficient has two components. The current portion, equal to 1, reflects that an incremental dollar of income earned today provides another dollar of value; it is the portion of the price impact due to current period unexpected earnings. The future portion, equal to $\frac{1}{r}$, captures the related future income expected to arise; it is the portion of the price impact due to (permanent) changes in the expected future earnings series.

2.4 Framework for Examining the Relation between the ERC and Persistence

Though the Ohlson [1991] coefficient serves as a starting point, to more completely capture the relation between the ERC and persistence requires flexibility within the future portion of the coefficient on unexpected earnings. We therefore introduce the following generalized structure for the ERC, the pricing of unexpected earnings:

$$\Delta P_{t-\delta,t}^{cum-div} = \left(1 + \frac{\pi}{r}\right) \cdot \varepsilon_t \qquad (3)$$

where π is the capitalization of the future persistence of unexpected earnings.

The two elements of the general ERC reflect the current effect (1) plus a term ($\frac{\pi}{r}$) that captures the future impact. We will refer to these two items as the current and future portion of the ERC throughout the remainder of the paper. KL also separate the current effect of unexpected earnings from the present value of the revisions in expected future earnings. While KL focus on how unexpected earnings are priced within the permanent and transitory range, we use the pricing of the unexpected earnings to reveal the market's assessment of persistence and do not impose limits on the reaction.

Readily apparent in equation 4 are the commonly considered cases of transitory (π=0) and permanent (π=1) unexpected earnings. If the incremental dollar of income is transitory and not expected to repeat in the future, the current portion remains equal to one and the future portion equals zero. Alternatively, we can write the future portion of the transitory income as $\frac{0}{r}$; the total ERC on transitory earnings is 1 as in previous models. If the incremental dollar of income is permanent and expected to repeat in every future period, the capitalization of the infinite stream equals $\frac{1}{r}$, as in Ohlson [1991]. Note that the future portion is the term that captures the expected level of persistence of the incremental dollar of income, because it summarizes the revision in expectations of the entire future earnings series. Again, we remind the reader that we are focusing on the persistence of the *reported* unexpected earnings which may result from either current cash flow or accruals.

In general, the magnitude of $\frac{\pi}{r}$ indicates the future impact of the unexpected earnings. That is, it summarizes the net effect of the changes in the future expected earnings series which result from the current period's unexpected earnings realization. In the next section, we use equation 4 as the basis for mapping from the ERC to the persistence parameter of an AR(1) series.

We pause here to note that Easton [1998] derives the form of the ERC implied by Ohlson [1995] and finds it to be $1+\frac{k}{r}$, which is consistent with the form we utilize in equation 3. At first, this suggests we could use Ohlson's [1995] linear information dynamics for the pattern of earnings and solve for the persistence of the unexpected earnings. Solving for the partial derivatives of future expected earnings related to the earnings surprise using the linear information dynamics yields the following general equation for the *n*th partial derivative in Ohlson's [1995] notation:

$$\frac{\partial \tilde{x}_{t+n}}{\partial \varepsilon_{1t}} = \begin{cases} 1 & n = 0 \\ \omega^n + \sum_{i=0}^{n-1} r \cdot \frac{\partial \tilde{x}_{t+i}}{\partial \varepsilon_{1t}} & n > 0 \end{cases} \qquad (4)$$

Given the constraint in Ohlson [1995] that $\omega \in [0,1]$, the partial derivative series converges to a growth rate of 1+*r*; yielding an infinite price reaction. Therefore, despite being able to solve for the partial derivatives related to persistence from the linear information dynamics, they are not useful in our setting. More importantly, Ohlson's [1995] persistence variable is known and fixed and is the same as that for all other elements of earnings. This is in contrast to our setting where we explicitly limit the persistence parameter's applicability to only the current unexpected earnings. Therefore, while our framework starts with an ERC that has a form similar to that seen in Easton [1998] (based on Ohlson [1995]), no assertion about the time series of any other part of the earnings stream is required or made in the current study.

2.5 Pattern for Expected Persistence of Unexpected Earnings

Easton and Zmijewski [1989, p. 120-121] state "the form of the ERC depends on the assumed time-series process of earnings." However, to map from ERC to persistence, via π, requires only an assumption of the time-series pattern of the reported *unexpected* earnings. All changes in the expectation of future earnings are captured in the ERC on unexpected earnings in equation 3. That is, the time-series process of *expected* earnings remains unchanged.

We assume the future persistence of unexpected earnings will take the form of an AR(1) process. Prior literature includes many examples using autoregressive time-series as a framework when modeling the earnings process.[11] The AR(1) is the simplest of these processes and provides a clear and intuitive picture of persistence. Using this assumption, we can alternatively write the future portion of equation 3 as an AR(1) series with a persistence factor, ϕ, for unexpected earnings.[12]

$$\Delta P_{t-\delta,t} = \left(1 + \sum_{i=1}^{\infty}\left(\frac{\phi}{1+r}\right)^{i}\right)\cdot \varepsilon_t \tag{5}$$

Thus, because equation 5 is an alternate version of equation 3, we can directly relate the future portion of the ERC and the AR(1) parameter as follows:

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[11] Examples include Foster [1977] and Brown and Rozeff [1979]. We note, however, that the intuition of the model does not depend on the AR(1) assumption. The same process could be used to link the ERC and any assumed pattern of persistence.

[12] While the AR(1) process appears somewhat restrictive, we must remember we can restate any pattern of changes in expectations of future earnings resulting from the unexpected earnings as an AR(1) pattern. For example, if the unexpected earnings will perfectly repeat for the next three periods and then cease having any effect this can be restated as an AR(1) as follows:

$$\frac{\varepsilon_t}{1+r} + \frac{\varepsilon_t}{(1+r)^2} + \frac{\varepsilon_t}{(1+r)^3} = \frac{\phi\cdot\varepsilon_t}{1+r} + \frac{\phi^2\cdot\varepsilon_t}{(1+r)^2} + \frac{\phi^3\cdot\varepsilon_t}{(1+r)^3} + \frac{\phi^4\cdot\varepsilon_t}{(1+r)^4} + \ldots = \sum_{i=1}^{\infty}\frac{\phi^i\cdot\varepsilon_t}{(1+r)^i}$$

In the above equation, if the cost of capital is 10% then the AR(1) persistence factor that equates the left and right hand sides is ϕ=0.7845.

$$\lambda = 1 + \frac{\pi}{r} = 1 + \sum_{i=1}^{\infty} \left(\frac{\phi}{1+r} \right)^i \tag{6}$$

Equation 6 illustrates the relation between the ERC and the persistence factor, ϕ. In the next section we provide classifications of possible ERCs and the resulting values of ϕ.

In order to simplify equation 6, we first note that the sum of a power series can take the form:

$$S_\infty = \sum_{k=1}^{\infty} g^k = \frac{g}{1-g} \quad \text{where } -1 < g < 1. \tag{7}$$

Requiring that $|\phi| < 1+r$, we then set[13]

$$g = \frac{\phi}{1+r} \tag{8}$$

Substituting into equation 6 yields:

$$\lambda = 1 + \sum_{i=1}^{\infty} \left(\frac{\phi}{1+r} \right)^i = 1 + \frac{g}{1-g} = 1 + \frac{\frac{\phi}{1+r}}{1 - \frac{\phi}{1+r}} \tag{9}$$

which can be simplified to either:

$$\lambda = 1 + \frac{\phi}{1+r-\phi} \qquad \text{or} \qquad \phi = \frac{(\lambda - 1)\cdot(1+r)}{\lambda} \tag{10}$$

2.6 Unexpected Earnings as a Signal

Beaver, Clarke, and Wright [1979, p. 317] introduce the idea of unexpected earnings serving as a signal by pointing out that earnings are the output (signals) "from an information system which is a mapping from states into signals." Note that an expense (or revenue) today

[13] This requirement says any future growth of unexpected earnings, the excess of ϕ over 1, cannot exceed the discount rate. Without this restriction, future earnings would grow to infinity. We will expand upon this notion in section 4.1.

can inform about either future revenues or future expenses. For example, consider an unexpected expenditure of $100 on research and development that is expected to result in an increase in future revenues (creating a positive net present value project). Here the current and future portions are of opposite sign. We define an unexpected earnings signal as the case in which the surprise will persist with the opposite sign; that is, $-\varepsilon_t$ will persist.[14] To our knowledge, prior research has not considered the concept that $-\varepsilon_t$ can persist. In the above example, a current outflow is related to future inflows. In our notation this is persistence of $-\varepsilon_t$, which serves as a signal about future earnings.

In the case of the unexpected earnings signal, the current portion of the ERC continues to have a coefficient of 1 but the future portion has a negative sign. While the future portion of the ERC becomes negative, ϕ should not do the same; a negative persistence factor results in the impact of unexpected earnings on future earnings alternating signs each period. Therefore, we modify equation 6 to allow for subtraction of the future portion (equivalent to a negative π), but continue to require ϕ to be positive as follows:

$$\lambda = 1 - \frac{\pi}{r} = 1 - \frac{\left(\frac{\phi}{1+r}\right)}{1 - \left(\frac{\phi}{1+r}\right)} \tag{11}$$

This can be simplified to either:

$$\lambda = 1 - \frac{\phi}{1 + r - \phi} \quad \text{or} \quad \phi = \frac{(\lambda - 1)\cdot(1+r)}{\lambda - 2} \tag{12}$$

Summarizing the relation between the ERC and the persistence factor from equations 10 and 12, we have:

[14] Our definition of an unexpected earnings signal is restrictive in that it does not allow for an affirmative signal. Rather we are attempting to capture the additional element of a change going forward that is implied by persistence of $-\varepsilon_t$.

$$\lambda = \begin{cases} 1 + \dfrac{\phi}{1 + r - \phi} & \lambda \geq 1 \\ 1 - \dfrac{\phi}{1 + r - \phi} & \lambda < 1 \end{cases} \quad \text{or} \quad \phi = \begin{cases} \dfrac{(\lambda - 1)\cdot(1 + r)}{\lambda} & \lambda \geq 1 \\ \dfrac{(\lambda - 1)\cdot(1 + r)}{\lambda - 2} & \lambda < 1 \end{cases} \tag{13}$$

Note that ϕ remains positive, regardless of whether the ERC is greater than or less than 1, i.e. the sign of π. The persistence is of either ε_t or $-\varepsilon_t$; it does not have oscillating signs as would be implied by a negative ϕ.

Figure 2 captures the relation shown in equation 13 by graphing the persistence factor on the ERC (shown with an assumed discount rate of 10%). Here we see that the persistence factor is symmetric around an ERC of 1. Recall that an ERC of 1 is equivalent to a future impact equal to 0. While prior research has focused on ERCs between 1 and $1+\frac{1}{r}$ (between 1 and 11 in Figure 2), in the next sections we develop a taxonomy for the entire potential distribution of ERCs.

3. Previously Established Classes of Persistence of Unexpected Earnings

We begin our taxonomy by first briefly summarizing the ERCs and AR(1) persistence parameters, ϕ, for the persistence classes currently in use in the literature. In section 4, we expand the classification set to include all possible ERCs and derive their related persistence parameters.

We note again that accounting recognition lag, as in Easton, Shroff and Taylor [2000], is the case where there is income reported but no change in price since the price change occurred at a previous point in time. In considering ERCs, it is by definition the unexpected earnings that have caused the market to change price. Consequently, accounting recognition lag is not an issue in this study. However, the possibility of an ERC equal to zero, the case in which the realization of unexpected earnings results in no price reaction, will be discussed in section 4.4.

3.1. Permanent

Extant literature uses the term "permanent" when an amount realized in the current period is expected to recur in all future periods (e.g. Ramakrishnan and Thomas [1998]). As illustrated in equation 2, economic income is a determinant of firm value. When the market receives new information in the form of an earnings announcement, they may revise their estimate of all future economic earnings upward by an amount equal to the current realization of unexpected earnings. In this case, unexpected earnings are permanent. As in equation 2, permanent unexpected earnings are capitalized with the following characteristics:

$$\begin{aligned} &ERC = 1 + \frac{1}{r} \\ &\Rightarrow \pi = 1 \Rightarrow \phi = 1 \end{aligned} \qquad (14)$$

Unexpected earnings are perfectly persistent when the market's adjustment to its expectation of each future earnings number is the same as the amount of the current unexpected earnings. The resulting ERC, illustrated in equation 14, capitalizes this infinite stream. The adjustment to expected future earnings is represented by the persistence factor, the AR(1) parameter ϕ. For the permanent class, ϕ equals one. [15]

3.2 Transitory

The other predominant pattern generally considered in prior literature is that reported earnings can be transitory, i.e. "one-time only." In this case, the market neither expects current unexpected earnings to repeat nor revises its expectation of future earnings. Therefore, we see a current price impact of 1, as reflected in the current portion of the ERC, but no additional price

[15] While the value of π is also equal to one, it is easily seen from equation 6 that equality of ϕ and π is not generally the case.

impact related to changes in the expected future earnings stream. This yields the following relation:

$$ERC = 1 + \frac{0}{r} \qquad (15)$$
$$\Rightarrow \pi = 0 \Rightarrow \phi = 0$$

When the market considers current unexpected earnings to be transitory, unexpected earnings are recognized by the market and priced immediately. However, because the market does not anticipate current unexpected earnings to impact the future earnings series, the persistence factor is zero. This is illustrated in equation 15 where the ERC of 1 is purely a current effect.

3.3 Decaying

At the earnings announcement, the market may conclude that the unexpected earnings will repeat beyond the current period but that the effect will not persist forever, especially if the unexpected earnings is from the extreme end of the distribution of expectations (Freeman and Tse [1992]). This implies a level of persistence lying between the permanent and transitory classes. That is, the persistence of unexpected earnings lies on the continuum between zero and one. While Ramakrishnan and Thomas [1998] attempt to separate the price effect of earnings into distinct pieces that are either permanent or transitory, the assumption that unexpected earnings must be either permanent or transitory does not capture the notion that unexpected earnings may persist for a finite period or at a level lower than the amount of current unexpected earnings.[16] We classify this type of persistence of unexpected earnings as decaying with the following properties:

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[16] Recall from footnote 11 that any series can be re-written as an AR(1), whether the series is truly "decaying," i.e. the AR(1) persistence is between zero and 1, or is a finite-horizon realization of the current amount of unexpected earnings.

$$
\begin{aligned}
&1+\frac{0}{r} < ERC < 1+\frac{1}{r} \\
&\Rightarrow 0 < \pi < 1 \Rightarrow 0 < \phi < 1
\end{aligned} \tag{16}
$$

With a persistence factor between 0 and 1, these can be written as if the unexpected earnings exhibit a pattern of decay over time. While viewing the future earnings as an AR(1) stream yields an endless stream, increasing decay combined with discounting results usually results in the far future having little impact, as illustrated in Figure 3. For example, after five periods a persistence factor as high as 0.7 results in $1 of unexpected earnings today having less than a $0.17 effect. Discounted using *r*=10%, the price impact of the $0.17 five years out is only $0.10. Thus a decaying pattern can serve as a good proxy for patterns such as a multi-year contract covering the next few years.

ERCs in the decaying class, in the range of 1 to $1+\frac{1}{r}$, have been found in most empirical work that has calculated either cross-sectional or time-series ERCs, beginning with Easton and Zmijewski [1989]. In their study, the mean ERC was 1.649 using a two-day window. They also calculated a persistence factor by regressing subsequent forecast revisions on the forecast error, the unexpected earnings. Their mean persistence factor was 0.344 for the next quarter and 0.126 two quarters out. Assuming an average *r* of 18%, the 1.659 ERC implies an annual persistence factor of 0.464 from equation 13.[17] The 0.464 obtained from our framework is similar to the combined total of 0.470 from EZ, suggesting that our assumption of an AR(1) pattern for the persistence of unexpected earnings is reasonable. Notice that while EZ separately computed ERCs and a persistence parameter, by adding an assumed time-series pattern for the unexpected

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[17] The assumed average *r* of 18% is chosen to reflect the 1975-80 time-period of the data used by EZ. During those years, the CRSP average annual equally weighted return was 19.8% and the value weighted return was 36.6%. Assuming a lower average *r* of 10% would reduce the estimated persistence factor to 0.433.

earnings we are able to use the ERC to provide a direct estimate of the implied persistence parameter.

4. Additional Classes of Persistence of Unexpected Earnings

Although the permanent and transitory boundaries are commonly used in ERC studies, either explicitly or implicitly, there is not an economic justification for their existence as boundaries. The market is free to react to the news contained in the unexpected earnings as it sees fit. In this section we develop additional classes of ERCs outside the traditional range of transitory to permanent as well as their implied levels of persistence. We begin with ERCs higher than permanent then discuss those lower than transitory.

4.1 Growing

Consider a company that has just introduced a new product. The market's reaction to unexpected earnings resulting from the sale of the new product may reflect a change in the product's expected future growth. An ERC in excess of $1+\frac{1}{r}$ implies that the changes in expected future earnings are for amounts greater than the amount of the current unexpected earnings realization. In other words, we expect growth in economic earnings; the persistence factor, ϕ, is greater than 1. Note that, strictly speaking, this is not a true AR(1) series in that the persistence term exceeds 1 in absolute value. However, because the future amounts are discounted to obtain the current valuation, we can still operate within an AR(1) framework provided that, as in equation 8, the upper limit for ϕ is $1+r$. Without this limit, the discounted present value of future earnings would be infinity. This is similar to the restriction on growth seen in valuation models. Here, growth in the impact of the current unexpected earnings in future periods (the excess of the persistence factor over 1) must not exceed r.

Growing earnings shocks thus have the following properties:

$$\begin{aligned} &1+\frac{1}{r} < ERC < 1+\frac{\infty}{r} \\ &\Rightarrow \pi > 1 \Rightarrow 1 < \phi < 1+r \end{aligned} \tag{17}$$

4.2 The Role of Unexpected Earnings as a Signal

As previously defined, unexpected earnings serves as a signal when its current magnitude and future impact are of opposite sign. This occurs when an action increases (decreases) current earnings and decreases (increases) anticipated future earnings. For example, a restructuring charge has a negative impact on current earnings, but the market may expect future earnings to be higher, a positive future impact. Of course, the directions of the signs need not be a current negative and future positive. A firm may have less current expenditures for research and development than anticipated, an action which increases current period income but may negatively affect future periods. In each case, current unexpected earnings signals that future earnings will be affected in a manner opposite to the currently observed surprise. As discussed earlier and referring back to equation 11, this is captured as persistence of $-\varepsilon_t$, rather than the usual $+\varepsilon_t$. Based on the relative magnitudes of the current and future impacts of the unexpected earnings, we split ERCs below transitory (i.e. less than one) into three groups.

4.2.1 Partially Offsetting Signal

The market may infer from the earnings announcement is that the current period's unexpected earnings will be partially, but not completely, offset by changes in the discounted present value of anticipated future earnings. While the revisions in expected future earnings are of opposite sign to the current unexpected earnings, the magnitude of current unexpected earnings outweighs the aggregated discounted present values of the changes in expected future earnings. That is, the future impact ($\frac{\pi}{r}$) partially offsets the current impact (1), and the total ERC is positive but small. The following properties result:

$$\begin{aligned} &1+\frac{-r}{r}<ERC<1+\frac{0}{r} \\ &\Rightarrow -r<\pi<0 \Rightarrow 0<\phi<\frac{1+r}{2} \end{aligned} \qquad (18)$$

As seen in equation 18, partially offsetting ERCs range from 0 to 1 (exclusive). We calculate ϕ using equation 13 and assuming the market anticipates persistence of $-\varepsilon_t$, ensuring an AR(1) series with a positive parameter. Similar to the permanent ERC, which is a function of *r*, we see that the upper bound on the persistence factor is a function of *r*. In EZ, the 10th percentile of the distribution of their firm-specific ERCs was 0.043, falling within this partially offsetting signal group. Assuming an average discount rate of 18%, this would imply an AR(1) series based on the persistence of $-\varepsilon_t$ with a parameter of 0.088.

4.2.2 Offsetting Signal

Within an ERC framework, it is possible for unexpected earnings to generate no price reaction.[18] This can arise from two situations. The first is if the current unexpected earnings relate to a zero net present value item or economic event. In this case, the current effect is exactly offset by the discounted present value of the changes in expected future earnings. Consequently, the second term in equation 6 must exactly offset the first term to yield no price change. Note that this differs from the returns-earnings association framework in studies such as EST. In such studies, price may remain unchanged when reported earnings relate to information

[18] The possibility of a price reaction when there are no unexpected earnings is outside the realm of this paper, as ERCs focus on measuring the market's response to the information contained in the revelation of the unexpected earnings.

that was previously embedded in price. In other words, the accounting recognition lag originated when the price change occurred at the time the market learned of the economic event.

In the second situation, the unexpected earnings are part of purely price irrelevant earnings (RT). By definition no economic event has occurred; as no information is conveyed via the unexpected earnings, there is no price reaction. Consider a company known to have flexibility in reporting that creates an accrual unrelated to an economic event and that the market is able to see through. The market also knows that this accrual must be reversed in a subsequent period because the sum of accounting earnings over the firm's life is not affected by accounting choices (Sunder’s [1997] “Conservation of Income” principle). The price-irrelevant unexpected earnings will be offset by a future amount of (also price-irrelevant) earnings of the opposite sign.

Continuing within the framework of equation 6, we view unexpected earnings that elicit no price reaction as having both a current and future impact. The coefficient on current unexpected earnings remains 1 while the future impact must have an offsetting coefficient of –1; the magnitudes of the current and future impacts are equal. The properties of offsetting signals are:

$$\begin{aligned} ERC &= 1 + \frac{-r}{r} \\ \pi = -r &\Rightarrow \phi = \frac{1+r}{2} \end{aligned} \tag{19}$$

The coefficient on the future impact is represented by $\frac{-r}{r}$, a complete offset to current unexpected earnings. The zero net present value example provides an intuitive context for computing a persistence parameter for unexpected earnings when the ERC is zero. While the price-irrelevant earnings scenario is not as intuitive, we are still able to compute an implied persistence related to the changes in expected future earnings. The level of persistence necessary to achieve offsetting of the current impact is a function of the discount rate, as with the other classes of ERCs.

4.2.3 Subsuming Signal

The sign of the market's response may be opposite that of unexpected earnings (Holthausen and Verrecchia [1988]), resulting in a negative ERC. Recall the earlier example of an expenditure currently recorded as an expense that is related to a positive net present value project. While the current earnings impact is clearly negative, we expect the market to respond positively upon learning of the project because of the related future revenues. In this case, the discounted present value of the changes in expected future earnings outweighs the impact on current unexpected earnings. In other words, the relative magnitudes are such that the future subsumes the present, resulting in the following properties:[19]

$$\begin{aligned} &1+\frac{-\infty}{r} < ERC < 1+\frac{-r}{r} \\ &\pi < -r \Rightarrow \frac{1+r}{2} < \phi < 1+r \end{aligned} \qquad (20)$$

As with ERCs greater than zero, the greater the absolute value of the subsuming ERC, the larger the perceived impact on future earnings. If the ERC is between 0 and -1, the aggregated present value of the change in expected future earnings does not outstrip the current unexpected earnings. For negative (positive) unexpected earnings, such an ERC implies a positive (negative) NPV project that does not persist forever. If the ERC is less than -1, total price change is relatively large, indicating that the future impact outweighs the current unexpected earnings impact. For negative unexpected earnings, for example, an ERC less than -1 implies a relatively large positive price change, suggesting that the market expects future earnings to be higher and growing, consistent with an opinion of "money well-spent." On the other hand, if

[19] Note that the magnitude of persistence of $-\varepsilon_t$ is limited by $1+r$, similar to the limitations in the growing ERC class.

unexpected earnings was positive, an ERC less than -1 implies a relatively large *negative* price change, consistent with the "hole" getting deeper over time.

5. Conclusion

Our work provides empiricists with an expanded framework in which to interpret their event study results rather than remain silent on estimated ERCs outside the permanent to transitory range. Although prior literature has not explored ERCs outside the transitory to permanent bounds, there is no theoretical reason for these event-specific measures to be so constrained. We develop a more complete taxonomy for possible ERCs, allowing them to range from negative to positive infinity. We develop decaying, growing, partially offsetting, offsetting, and subsuming classes in addition to the traditional permanent and transitory classes, as summarized in Figure 4. We also contribute to the literature by using the ERC to capture the market's expectation of the magnitude of the persistence of unexpected earnings. While we assume the latter takes the form of an AR(1) process, providing a simple and clear picture of persistence, our framework can be used with any assumed form of persistence.

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Figure 1: Price Changes for April 20, 2004 Quarterly Earnings Announcements, with Non-Zero Unexpected Earnings

Unexpected earnings are as reported in the *Wall Street Journal*. Price change is the closing minus opening price per share on April 20, 2004. If earnings were reported after the market closed, the April 21, 2004 change in price is reported. The lines labeled permanent (assuming 10% discount rate) and transitory represent the price-earnings relation that would have occurred for that level of persistence of unexpected earnings. The shaded area represents ERCs bounded by transitory and permanent as commonly considered in prior accounting research.

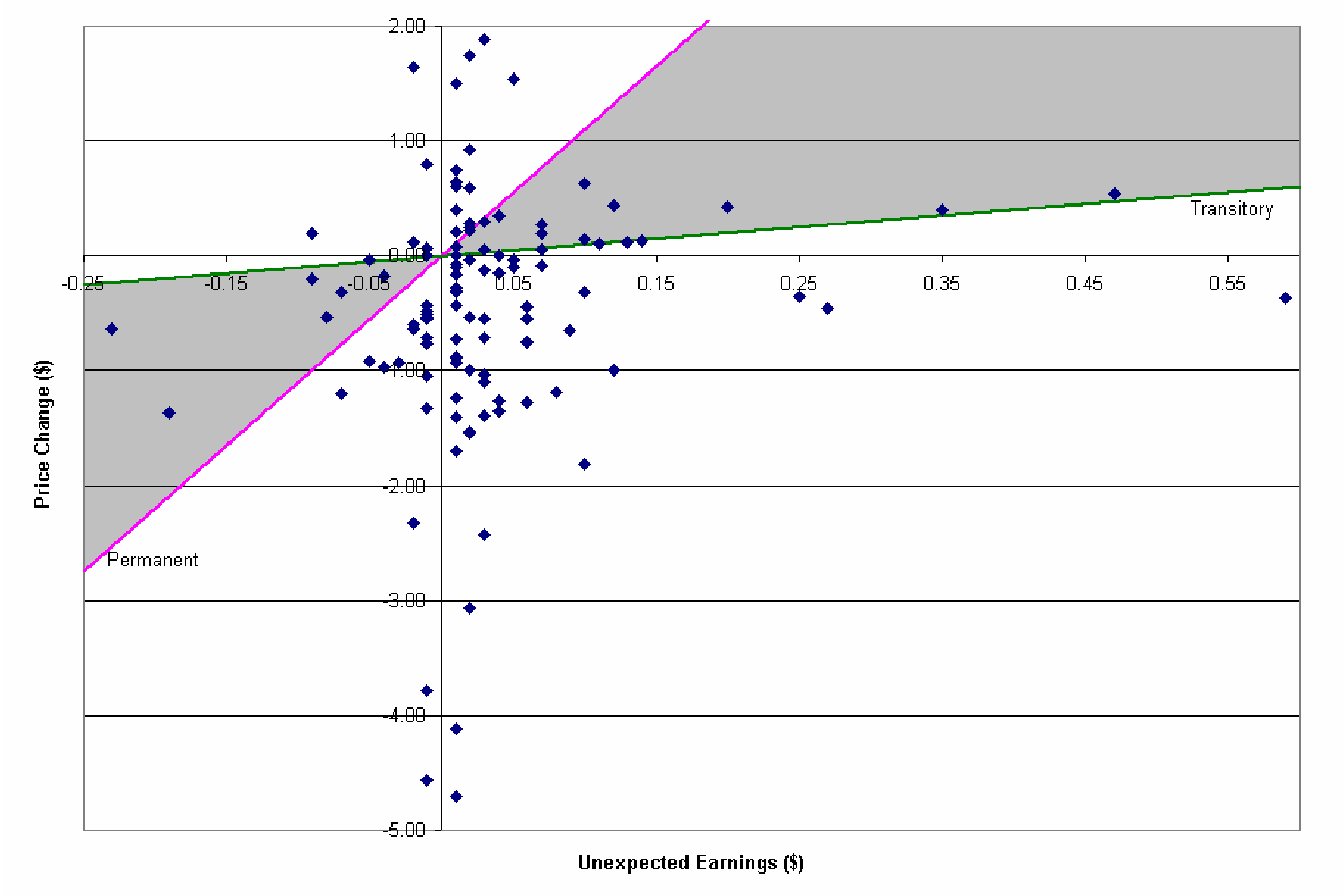

Figure 2: Relation Between Earnings Response Coefficients (λ) and Implied Persistence Parameters (ϕ)

Equation 13 shows the relation between the earnings response coefficient and the persistence parameter assuming an AR(1) pattern for the persistence of unexpected earnings. In the graph, we assume a discount rate of 10%.

$$\lambda = \begin{cases} 1+\dfrac{\phi}{1+r-\phi} & \lambda \geq 1 \\ 1-\dfrac{\phi}{1+r-\phi} & \lambda < 1 \end{cases} \quad \text{or} \quad \phi = \begin{cases} \dfrac{(\lambda-1)\cdot(1+r)}{\lambda} & \lambda \geq 1 \\ \dfrac{(\lambda-1)\cdot(1+r)}{\lambda-2} & \lambda < 1 \end{cases} \tag{13}$$

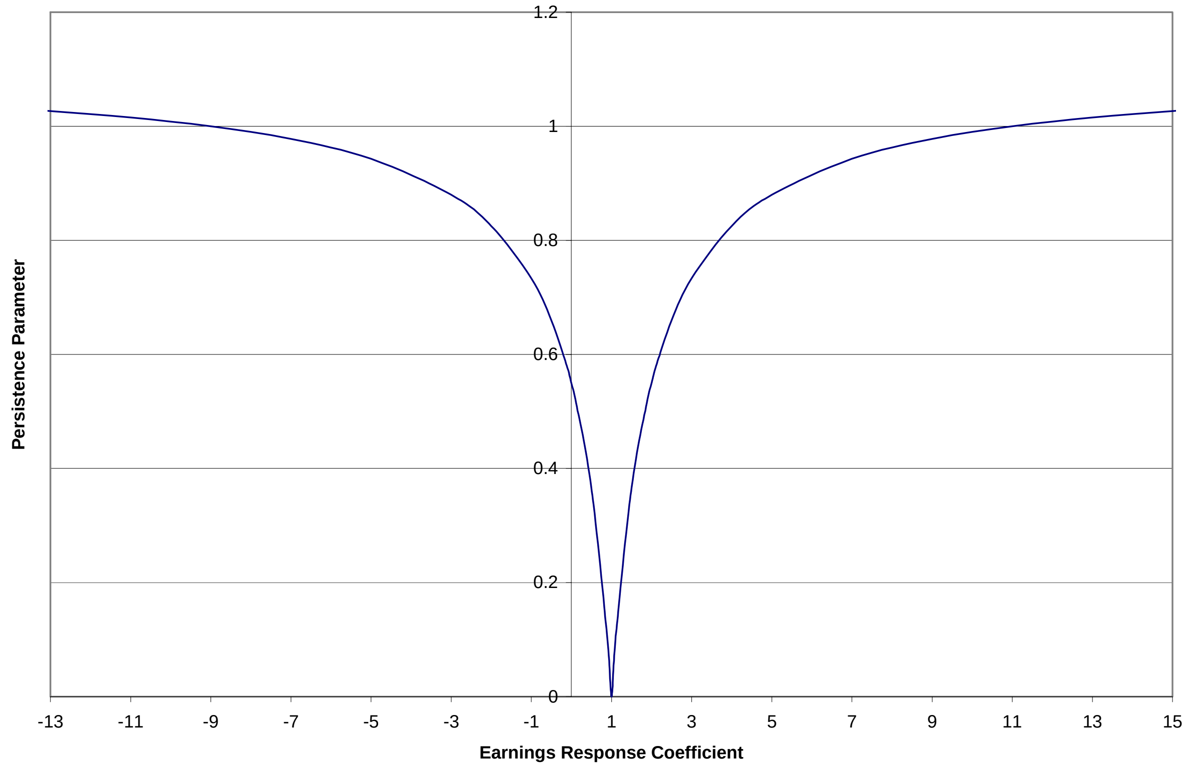

Figure 3: Discounted Value of Future Earnings Assuming Differing Levels of Persistence Parameter

Each line represents the rate of decay of a $1 earnings innovation, given various levels of persistence and a 10% discount rate. The level of persistence is indicated by the number to the left of the line.

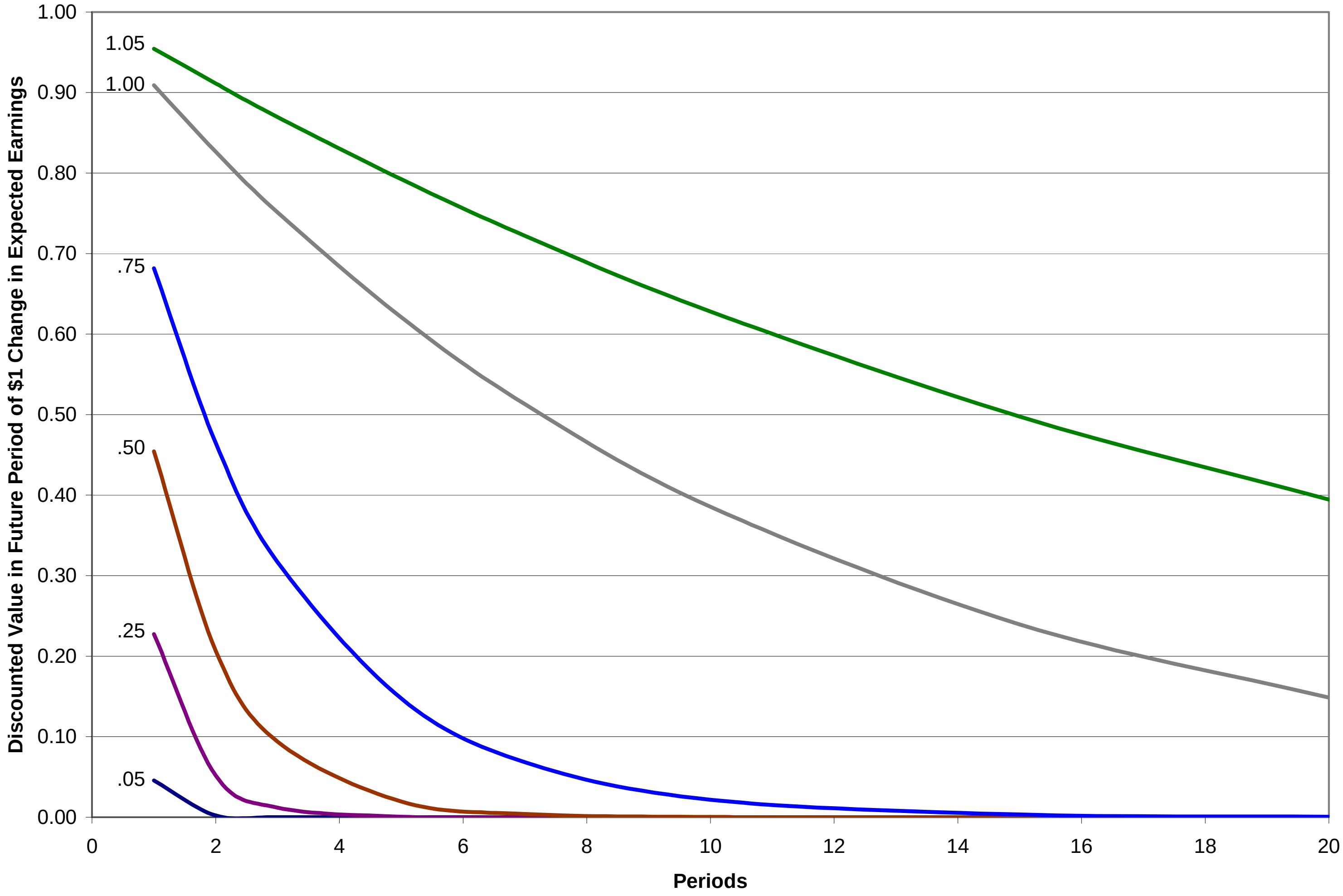

Figure 4: Summary of Earnings Response Coefficient Classes and Implied Levels of Persistence

The classes of ERCs developed within this paper are based on the relation shown below:

$$\lambda = 1 + \frac{\pi}{r} = 1 + \sum_{i=1}^{\infty} \left(\frac{\phi}{1+r} \right)^i \quad (6)$$

where

- λ is the ERC relating unexpected earnings to the change in cum-dividend price at the announcement of earnings
- π captures the impact of the change in future earnings expectations resulting from unexpected earnings
- ϕ is an AR(1) parameter capturing the persistence of unexpected earnings
- r is the discount rate

Class	Earnings Response Coefficient	Future Impact (π)	Persistence Parameter (ϕ)
Subsuming	$1 + \frac{-\infty}{r} < ERC < 1 + \frac{-r}{r}$	$\pi < -r$	$\frac{1+r}{2} < \phi < 1+r$
Offsetting	$ERC = 1 + \frac{-r}{r}$	$\pi = -r$	$\phi = \frac{1+r}{2}$
Partially Offsetting	$1 + \frac{-r}{r} < ERC < 1 + \frac{0}{r}$	$-r < \pi < 0$	$0 < \phi < \frac{1+r}{2}$
Transitory	$ERC = 1 + \frac{0}{r}$	$\pi = 0$	$\phi = 0$
Decaying	$1 + \frac{0}{r} < ERC < 1 + \frac{1}{r}$	$0 < \pi < 1$	$0 < \phi < 1$
Permanent	$ERC = 1 + \frac{1}{r}$	$\pi = 1$	$\phi = 1$
Growing	$1 + \frac{1}{r} < ERC < 1 + \frac{\infty}{r}$	$\pi > 1$	$1 < \phi < 1+r$