Understanding the Variance of Earnings Growth: The Case of Shipping

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Abstract

This paper studies what explains the volatility of earnings growth in shipping over time. The elegant econometrics methods of Chaves (2009) and Campbell (1991) are employed and Panamax and Capesize markets are analyzed empirically. The main finding is that a large part of unexpected earnings growth is related to news about future returns. This implies that when operating profits are higher than expected, vessel price volatility is expected to increase sequentially meaning vessel prices move toward operating profits. There are two main contributions of this research: the application of financial economics theory to shipping freight markets and the change of focal points from forecasting to understanding of freight markets.

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1. Introduction

Shipping is notorious for its extreme freight rate risk that refers to uncertainty caused by freight fluctuations over the magnitude of cash flows (or operating earnings). Capesize market volatility measured by the standard deviation of weekly growth for the last 20 years is 5 times bunker fuel (Rotterdam IFO 380CST) price volatility and 17 times the volatility of the currency market (USD-KRW). Therefore, the measurement, assessment, management, and forecast of freight volatility are important for the sustainability of the shipping business. Nevertheless, *little* research in shipping finance literature explores why earnings growth changes over time, and what this change tells us about future market movements.

To handle the above problems, this paper intends to break unexpected earnings growth (or a surprise in earnings growth) today into three news components: unexpected return (or news about current return), news about future earnings growth, and news about future returns. To make this idea precise, we select Panamax and Capesize markets and then use Chaves' (2009) and Campbell's (1991) approaches to explore which of the three news is closely related to unexpected earnings growth today. Our key finding is that a large part of unexpected earnings growth is attributed to news about future returns, implying that a current change in earnings growth corresponds to a subsequent change in vessel prices (or returns) somewhere in the future. This finding accords well with the conclusion of Lee and Yun (2021), who show that the mean reversion of the price–charter ratios in the bulk sector comes largely from price changes in favor of return predictability.

Our implications can help enhance a deep understanding of freight market movements on the academic side and also establish investment and risk management strategies on the practical side.

Our contributions are two-fold. First, our work is worthwhile for inter-disciplinary research on financial economics and shipping finance. To name a few, there are several inter-disciplinary works regarding shipping derivatives (Kyriakou et al., 2018; Gómez-Valle et al., 2021), investor sentiment (Papapostolou et al., 2014), and theoretical asset pricing (Moutzouris and Nomikos, 2020). To the best of our knowledge, we are the first to apply the variance decomposition to shipping to better understand the variance of earnings growth. Notably, shipping market participants are interested in variation in earnings, because it is a more important income source than vessel price appreciation in the shipping industry. Considering that the finance literature has an interest in decomposing unexpected stock returns (Campbell, 1991; Campbell and Ammer, 1993; and Chaves, 2009), it would be also interesting to compare the different characteristics of the two markets.

Second, our focal point is on interpreting the market, *not* forecasting. As emphasized in Campbell (1991),[1] forecasting the market means predicting price changes in the future, whereas interpreting the market means explaining why prices change over time. A lot of the shipping literature is devoted to forecasting the market by using ARCH or GARCH series to study time-varying volatility or volatility spillover effects (Alizadeh and Nomikos, 2011; Alizadeh, 2013; Dai et al., 2015; Tsouknidis, 2016; Gavriilidis et al., 2018 to name a few). Besides, considering that *correlation* does not necessarily mean *causation*, forecasting the market might be in line with *causation*, whereas interpreting the market is closer to *correlation*. We focus on 'when you observe a surprise in earnings today, how are the three news components expected to change?' in terms of correlation, *not* 'whether the earnings surprise forecasts the three components in terms of causation'. One merit of having the variance decomposition framework is that it also helps interpret the signal *reversely*: 'when you observe one of the three components, for example, what do you learn about this observation that caused a surprise in earnings in the beginning?'.

This paper is organized as follows. Section 2 outlines a present-value identity of

[1] For the details, see Campbell (1991).

unexpected earnings growth, and Section 3 gives descriptive statistics about the data we use. Sections 4 and 5 perform our empirical analysis and a Monte Carlo experiment for robustness tests. Section 6 concludes the paper.

2. Theoretical Framework

This section outlines a basic concept of a variance decomposition of unexpected earnings growth by present-value logic. Following Campbell (1991) and Campbell and Ammer (1993), *unexpected* earnings growth, defined as $\Delta\pi_{t+1} - E_t[\Delta\pi_{t+1}]$, has a form:

$$\Delta\pi_{t+1} - E_t[\Delta\pi_{t+1}] = (E_{t+1} - E_t)\left[\sum_{j=0}^{\infty}\rho^j r_{t+1+j} - \sum_{j=1}^{\infty}\rho^j \Delta\pi_{t+1+j}\right], \quad (1)$$

where $\Delta\pi_{t+1}$ is log earnings growth at the end of time t; r_{t+1} is log return; $\rho(< 1)$ is a constant discount factor; and $(E_{t+1} - E_t)(x)$ denotes $E_{t+1}x - E_t x$ that means a *surprise* in x. Note that Eq. (1) is derived from a present-value identity of price–charter ratios:

$$\delta_t = p_t - \pi_t = E_t\left[\sum_{j=0}^{\infty}\rho^j\{\Delta\pi_{t+1+j} - r_{t+1+j}\}\right],$$

where δ_t is log price–charter ratio; $p_t(= \log P_t)$ is log price; and $\pi_t(= \log \Pi_t)$ is log earnings. Eq. (1) can also be decomposed as

$$\Delta\pi_{t+1} - E_t[\Delta\pi_{t+1}]$$
$$= (r_{t+1} - E_t r_{t+1}) + (E_{t+1} - E_t)\left[\sum_{j=1}^{\infty}\rho^j r_{t+1+j}\right] - (E_{t+1} - E_t)\left[\sum_{j=1}^{\infty}\rho^j \Delta\pi_{t+1+j}\right]. \quad (2)$$

Here, $(r_{t+1} - E_t r_{t+1})$ is unexpected return (or news about current return); $(E_{t+1} - E_t)\left[\sum_{j=1}^{\infty}\rho^j r_{t+1+j}\right]$ is news about future returns; and $(E_{t+1} - E_t)\left[\sum_{j=1}^{\infty}\rho^j \Delta\pi_{t+1+j}\right]$ is news about future earnings growth.

A question might be raised that earnings growth is an observed economic variable that is not typically put on the left-hand side (LHS), when it comes to the convention that the traditional variance decomposition is usually applied to the price–charter ratios δ (Lee and Yun, 2021) or unexpected returns r (Campbell, 1991; Campbell and Ammer, 1993; Chaves, 2009). Two arguments justify our framework (1). First, the three information sources $(\delta, r, \Delta\pi)$ are interconnected to each other. When you know the two, for example, the remaining information can be naturally inferred from the accounting identity (Cochrane, 2008).[2] When holding the identity, nothing is wrong technically to locate any information of the three on the LHS. More importantly, as already mentioned in Section 1, shipping market participants are more attentive to variation in earnings growth for financial sustainability.

In summary, Eq. (2) gives a great deal of interpretation on how unexpected earnings growth today on the LHS interacts with three news information on the right-hand side (RHS). For example, today's earnings rise expects news about current and future returns (i.e., $(r_{t+1} - E_t r_{t+1}) + (E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j r_{t+1+j}\right]$) to increase but news about future earnings growth (i.e., $(E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j \Delta\pi_{t+1+j}\right]$) to decrease. Using this present-value identity, we intend to explore which of the three news is the *lion's share* of today's earnings change in shipping markets.

3. Data

Panamax and Capesize data is collected from the Clarksons Research database. The Panamax data consist of Panamax 76K 5-year-old secondhand prices and 1-year time charter rates (Long-run Historical Series) from January 1989 to December 2020. The Capesize data have Capesize 180K 5-year-old secondhand prices and 1-year time charter rates (Long-run

[2] For the details, see Subsection 4.1.

Historical Series) from January 1992 to December 2020. Note that all available data above are deflated by the U.S. Consumer Price Index (CPI) to offset an inflation effect.

We find that the Capesize market seems to be more volatile than the Panamax market because the standard deviation (0.339) of price–charter ratio δ_t in the Capesize market is larger than that (0.233) in the Panamax market (Table 1).

[INSERT TABLE 1 HERE]

Both markets are highly correlated with each other (Figure 1). As for the Panamax market in the recent period of the COVID-19 outbreak, the price–charter ratios tend to be lower than the long-term mean, meaning that ship prices at that time appear to be undervalued relative to earnings.

[INSERT FIGURE 1 HERE]

By definition, the constant discount factor ρ can be estimated by

$$\rho = \frac{1}{1 + \exp\left(-\overline{pd}\right)},$$

where $\bar{x}$ means a sample average. By calculation, the Panamax market has $\rho = 0.9994$ on a monthly basis, while the Capesize market has $\rho = 0.9995$.

4. Empirical Analysis

This section aims to relate the present-value identity of unexpected earnings growth (Section 2) to our empirical approach. Subsection 4.1 introduces the approach, and Subsection 4.2 presents the estimation results. Subsections 4.3 and 4.4 apply Chaves' (2009) and Campbell's (1991) variance decomposition to the present-value identity, respectively.

4.1. Empirical Approach

The starting point of our approach is to acknowledge that earnings growth is closely related to returns and price–charter ratios:

$$r_{t+1} = k + \rho \cdot \delta_{t+1} + \Delta\pi_{t+1} - \delta_t, \tag{3}$$

where k is a log-linear constant. Note that Eq. (3) is derived by applying the first-order Taylor expansion to log return $r_{t+1}(= \log(1 + R_{t+1}) = \log(P_{t+1} + \Pi_{t+1}) - \log(P_t))$.[3]

Next, we present three simple regressions:

$$\Delta\pi_{t+1} = a_\pi + b_\pi \cdot \delta_t + \varepsilon^{\pi}_{t+1}, \tag{4}$$

$$r_{t+1} = a_r + b_r \cdot \delta_t + \varepsilon^{r}_{t+1},$$

$$\delta_{t+1} = a_\phi + \phi \cdot \delta_t + \varepsilon^{\phi}_{t+1},$$

where ε^{π}_{t+1} is an earnings shock (equivalently, unexpected earnings growth); ε^{r}_{t+1} is a return shock (equivalently, unexpected return); and ε^{ϕ}_{t+1} is a price–charter shock. Plugging Eq. (4) into Eq. (3) delivers the following linking identities:

$$b_r = \rho\phi + b_\pi - 1. \tag{5}$$

$$\varepsilon^{r}_{t+1} = \rho \cdot \varepsilon^{\phi}_{t+1} + \varepsilon^{\pi}_{t+1}. \tag{6}$$

Clearly, earnings growth cannot move independently because it is tied to return r and price–charter ratio δ. By present-value logic, therefore, one of the three information is essentially redundant. When you know the two, for example, the remaining information can be easily inferred by using the two linking identities (Cochrane, 2008).

[3] We assume that loglinear approximation errors are not serious enough to affect out results.

Notably, error identity (6) has the same form as a present-value identity of unexpected earnings growth:

$$\Delta\pi_{t+1} - E_t[\Delta\pi_{t+1}]$$

$$= (r_{t+1} - E_t[r_{t+1}]) + (E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j r_{t+1+j}\right] - (E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j \Delta\pi_{t+1+j}\right],$$

where

$$\varepsilon_{t+1}^{\pi} = \Delta\pi_{t+1} - E_t[\Delta\pi_{t+1}], \tag{7}$$

$$\varepsilon_{t+1}^{r} = r_{t+1} - E_t[r_{t+1}],$$

$$\rho\varepsilon_{t+1}^{\phi} = (E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j \Delta\pi_{t+1+j}\right] - (E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j r_{t+1+j}\right].$$

We find that discounted price–charter shock $\rho\varepsilon_{t+1}^{\phi}$ can break into news about future earnings growth $(E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j \Delta\pi_{t+1+j}\right]$ and returns $(E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j r_{t+1+j}\right]$. To better understand how it works, we further scrutinize each component of $\rho\varepsilon_{t+1}^{\phi}$:

$$(E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j \Delta\pi_{t+1+j}\right] = \underbrace{(E_{t+1} - E_t)[\rho \cdot \Delta\pi_{t+2}]}_{=\rho \cdot b_\pi \cdot \varepsilon_{t+1}^{\phi}} + \underbrace{(E_{t+1} - E_t)[\rho^2 \cdot \Delta\pi_{t+3}]}_{=(\rho \cdot b_\pi)\cdot(\rho\phi)\cdot\varepsilon_{t+1}^{\phi}} \cdots$$

$$= \lim_{j\to\infty} \frac{\rho b_\pi \{1 - (\rho\phi)^j\}}{1 - \rho\phi} \times \varepsilon_{t+1}^{\phi} = \frac{\rho b_\pi}{1 - \rho\phi} \cdot \varepsilon_{t+1}^{\phi} \equiv N_{t+1}^{\pi},$$

$$(E_{t+1} - E_t)\left[\sum_{j=1}^{\infty} \rho^j r_{t+1+j}\right] = \frac{\rho b_r}{1 - \rho\phi} \cdot \varepsilon_{t+1}^{\phi} \equiv N_{t+1}^{r},$$

where N_{t+1}^{π} is news about future earnings growth, and N_{t+1}^{r} is news about future returns. Combining these components leads to

$$\rho\varepsilon_{t+1}^{\phi} = \frac{\rho b_\pi}{1-\rho\phi} \cdot \varepsilon_{t+1}^{\phi} - \frac{\rho b_r}{1-\rho\phi} \cdot \varepsilon_{t+1}^{\phi} = \rho \cdot \varepsilon_{t+1}^{\phi} \left(\frac{b_\pi - b_r}{1-\rho\phi}\right).$$

Here, the last equality comes from linking identity (5):

$$b_\pi - b_r = 1 - \rho\phi.$$

To summarize, we conclude that unexpected earnings growth $\varepsilon_{t+1}^{\pi}(= \Delta\pi_{t+1} - E_t[\Delta\pi_{t+1}])$ today is associated with three news:

$$\varepsilon_{t+1}^{\pi} = \varepsilon_{t+1}^{r} - (N_{t+1}^{\pi} - N_{t+1}^{r}). \tag{8}$$

From now on, we will proceed with the new error identity (8) to study what of three news is associated with unexpected earnings growth today in terms of correlation, *not* causation.

4.2. Estimation Results

This subsection estimates a set of coefficients (b_π, b_r, ϕ) and three shocks ($\varepsilon^{\phi}, \varepsilon^{\pi}, \varepsilon^{r}$) for the Panamax (Panel A, Table 2) and Capesize markets (Panel B). Four main findings are presented below.

[INSERT TABLE 2 HERE]

First, the two shipping markets appear to be highly persistent. Evidence is that the first-order autocorrelation ϕ is close to one: the Panamax market has $\phi = 0.948$ (Panel A), and the Capesize market has $\phi = 0.947$ (Panel B). This persistent behavior is also observed in the U.S. stock market: the autocorrelation is 0.941 (Cochrane, 2008).

Second, price–charter ratio δ_t strongly forecasts returns but weakly forecasts earnings growth as evidenced by the *t*-values.[4] This evidence implies that the mean-reversion

[4] The rule of thumb is that when the absolute value of the *t*-values for a specific regressor is over two, the regressor is significant at the 5% level in a statistical sense.

phenomenon inherent in the price–charter ratios (Figure 1) comes primarily from return variation (or price change) in the way that ship prices tend to move toward earnings. When earnings lags behind ship prices, as a counter example, it would be espected that earnings change might drive the mean reversion in favor of cashflow forecastability.

Third, linking identities (5) and (6) almost hold. The actual coefficient of the return regression (-0.052) in the Panamax market (Panel A) is the same as the implied return coefficient (-0.052) computed by $b_r = \rho\phi + b_\pi - 1$; both coefficients are the same in rounding up to the fourth decimal point. For this reason, we will proceed with the implied return coefficient and shock throughout the paper to reflect such interconnection between the three elements $(\delta, r, \Delta\pi)$.

Fourth, price–charter shock ε^{ϕ} appears to be highly and contemporaneously correlated with earnings shock ε^{π}: $corr(\varepsilon^{\phi}, \varepsilon^{\pi}) = -0.782$ (Panel A), and $corr(\varepsilon^{\phi}, \varepsilon^{\pi}) = -0.902$ (Panel B). The high correlation means that a rise in earnings π today decreases price–charter ratio $\delta = p - \pi$ but increases earnings growth $\Delta\pi$.

[INSERT FIGURE 2 HERE]

Figures 2 and 3 plot 12-month trailing moving averages of three shocks $(\varepsilon^{\phi}, \varepsilon^{\pi}, \varepsilon^{r})$ for the Panamax and Capesize markets, respectively. One interesting finding is that the 2008 global financial crisis had a serious effect on the shipping markets. This finding can be justified by a big negative return shock ε^{r} and earnings-growth shock ε^{π} at that time. In the meantime, COVID-19 might have a *less* serious effect than the global financial crisis because the two shocks seem to have no big fall.

[INSERT FIGURE 3 HERE]

4.3. Contemporaneous error relationship

This subsection investigates the contemporaneous relationship between three shocks ($\varepsilon^{\Phi}, \varepsilon^{\pi}, \varepsilon^{r}$) to better understand shipping market behavior. To do that, we begin by restating error identity (6):

$$\varepsilon^{\pi} = \varepsilon^{r} - \rho \cdot \varepsilon^{\Phi}. \quad (9)$$

First, multiplying both sides of Eq. (9) by ε^{Φ} and then taking unconditional expectations deliver

$$cov(\varepsilon^{\pi}, \varepsilon^{\Phi}) = cov(\varepsilon^{r}, \varepsilon^{\Phi}) - \rho \cdot var(\varepsilon^{\Phi}), \quad (10)$$

where

$$cov(\varepsilon^{\pi}, \varepsilon^{\Phi}) = E[\varepsilon^{\pi} \cdot \varepsilon^{\Phi}] - E[\varepsilon^{\pi}] \cdot E[\varepsilon^{\Phi}] = E[\varepsilon^{\pi} \cdot \varepsilon^{\Phi}]$$

such that $E[\varepsilon^{\pi}] = E[\varepsilon^{\Phi}] = 0$ by definition. As a result, the Panamax market produces $cov(\varepsilon^{\pi}, \varepsilon^{\Phi}) = -0.595\%$, $cov(\varepsilon^{r}, \varepsilon^{\Phi}) = -0.048\%$, and $var(\varepsilon^{\Phi}) = 0.550\%$ while the Capesize market produces $cov(\varepsilon^{\pi}, \varepsilon^{\Phi}) = -1.362\%$, $cov(\varepsilon^{r}, \varepsilon^{\Phi}) = -0.184\%$, and $var(\varepsilon^{\Phi}) = 1.179\%$. All numbers above shows that the price–charter movements are usually associated with earnings change today:

$$cov(\varepsilon^{\pi}, \varepsilon^{\Phi}) \approx -\rho \cdot var(\varepsilon^{\Phi}).$$

This reasoning is also supported by $corr(\varepsilon^{\Phi}, \varepsilon^{\pi}) = -0.782$ (Panel A, Table 2), and $corr(\varepsilon^{\Phi}, \varepsilon^{\pi}) = -0.902$ (Panel B). For example, the observation that the price–charter ratios (Figure 1) are lower than the long-term mean can give two possible interpretations: (a) earnings are higher than prices, or (b) prices are lower than earnings. Our results above can support (a).

Second, multiplying both sides of Eq. (9) by ε^{r} and then taking unconditional expectations lead to

$$cov(\varepsilon^{\pi}, \varepsilon^{r}) = var(\varepsilon^{r}) - \rho \cdot cov(\varepsilon^{r}, \varepsilon^{\phi}). \tag{11}$$

As a result, the Panamax market has $cov(\varepsilon^{\pi}, \varepsilon^{r}) = 0.462$, $var(\varepsilon^{r}) = 0.414$, and $cov(\varepsilon^{r}, \varepsilon^{\phi}) = -0.048$, while the Capesize market has $cov(\varepsilon^{\pi}, \varepsilon^{r}) = 0.574$, $var(\varepsilon^{r}) = 0.390$, and $cov(\varepsilon^{r}, \varepsilon^{\phi}) = -0.184$. These numbers give a clue that earnings change today is closely related to return change:

$$cov(\varepsilon^{\pi}, \varepsilon^{r}) \approx var(\varepsilon^{r}).$$

Another piece of evidence is $corr(\varepsilon^{\phi}, \varepsilon^{r}) = 0.698$ (Panel A, Table 2), and $corr(\varepsilon^{\phi}, \varepsilon^{r}) = 0.661$ (Panel B).

To summarize, earning shock ε^{π} tends to move together with both return shock ε^{r} and price–charter shock ε^{ϕ}. However, it would be interesting that ε^{r} does not covary with ε^{ϕ}: $corr(\varepsilon^{\phi}, \varepsilon^{r}) = -0.101$ (Panel A; Table 2), and $corr(\varepsilon^{\phi}, \varepsilon^{r}) = -0.272$ (Panel B). We infer from these findings that earnings change is key to driving the shipping markets. In contrast, the stock market behaves differently: price change triggers both price–dividend and return changes (Cochrane, 2008). The probable reason why the two markets exhibit different behavior is that the nature of cash flows is different. For example, managers in the stock market are reluctant to cut dividends because cutting dividends might signal bad news to market participants. Indeed, paying dividends is perceived as a financial commitment (Larrain and Yogo, 2008), and therefore dividend paths are smooth over time. In contrast, managers in the shipping market cannot usually control earnings, which is far from the commitment of a single player. Rather, earnings in shipping are determined by demand and supply over time. When demand outweighs supply, for example, it leads to a rise in earnings. With this different characteristic in mind, we move on to the variance decomposition in the shipping markets.

4.3. Chaves' (2009) Variance Decomposition

This subsection seeks to relate the present-value identity of unexpected earnings growth (2) to Chaves' (2009) variance decomposition:

$$var(\varepsilon_{t+1}^{\pi}) = cov(\varepsilon_{t+1}^{r}, \varepsilon_{t+1}^{\pi}) + cov(N_{t+1}^{r}, \varepsilon_{t+1}^{\pi}) - cov(N_{t+1}^{\pi}, \varepsilon_{t+1}^{\pi}), \qquad (12)$$

where

$$N_{t+1}^{\pi} \equiv \frac{\rho b_{\pi}}{1-\rho\phi} \cdot \varepsilon_{t+1}^{\phi},$$

$$N_{t+1}^{r} \equiv \frac{\rho b_{r}}{1-\rho\phi} \cdot \varepsilon_{t+1}^{\phi},$$

$var(\cdot)$ is an unconditional variance operator, and $cov(\cdot)$ is a covariance operator.[5] In Eq. (12), the three covariance terms on the RHS explain the variance of unexpected earnings growth on the LHS.

Panels A and B of Table 3 calculate Chaves' (2009) variance decomposition of unexpected earnings growth in the Panamax and Capesize markets, respectively. Note that all covariance terms on the RHS of Eq. (12) are divided by $var(\varepsilon_{t+1}^{\pi})$ so that the proportions (or shares) add

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[5] To obtain this, one multiplies ε_{t+1}^{π} on both sides of Eq. (8):

$$(\varepsilon_{t+1}^{\pi})^2 = \varepsilon_{t+1}^{r} \cdot \varepsilon_{t+1}^{\pi} + N_{t+1}^{r} \cdot \varepsilon_{t+1}^{\pi} - N_{t+1}^{\pi} \cdot \varepsilon_{t+1}^{\pi}.$$

Then, take an unconditional expectation on both sides above:

$$E[(\varepsilon_{t+1}^{\pi})^2] = E[\varepsilon_{t+1}^{r} \cdot \varepsilon_{t+1}^{\pi}] + E[N_{t+1}^{r} \cdot \varepsilon_{t+1}^{\pi}] - E[N_{t+1}^{\pi} \cdot \varepsilon_{t+1}^{\pi}].$$

A simple covariance rule such that $cov(A,B) = E[A \cdot B] - E[A] \cdot E[B]$ leads to Eq. (12) by definition: $E[\varepsilon_{t+1}^{\phi}] = E[\varepsilon_{t+1}^{\pi}] = E[\varepsilon_{t+1}^{r}] = 0$. Rearranging N_{t+1}^{r} and N_{t+1}^{π} also corresponds to

$$var(\varepsilon_{t+1}^{\pi}) = cov(\varepsilon_{t+1}^{r}, \varepsilon_{t+1}^{\pi}) - \rho \cdot cov(\varepsilon_{t+1}^{\phi}, \varepsilon_{t+1}^{\pi})$$

by using a linear property of $cov(N^{\pi}, \varepsilon^{\pi}) = cov\left(\frac{\rho b_{\pi}}{1-\rho\phi} \cdot \varepsilon^{\phi}, \varepsilon^{\pi}\right) = \frac{\rho b_{\pi}}{1-\rho\phi} cov(\varepsilon^{\phi}, \varepsilon^{\pi})$.

up to 100%.

[INSERT TABLE 3 HERE]

One common finding is that news about future returns N^r_{t+1} accounts for about half of earnings-growth volatility $var(\varepsilon^\pi_{t+1})$ in the two shipping markets: $cov(N^r_{t+1}, \varepsilon^\pi_{t+1}) = 54.8\%$ (Panel A), and $cov(N^r_{t+1}, \varepsilon^\pi_{t+1}) = 49.7\%$ (Panel B). Considering news about current return ε^r further, *total* news about returns defined as $\varepsilon^r + N^r$ can explain a large part of the earnings-growth volatility: $cov(\varepsilon^r_{t+1} + N^r_{t+1}, \varepsilon^\pi_{t+1}) = 98.5\%$ (Panel A), and $cov(\varepsilon^r_{t+1} + N^r_{t+1}, \varepsilon^\pi_{t+1}) = 79.4\%$ (Panel B). When it comes to the fact that return variation is largely driven by price changes in the unit of million dollars, all results above demonstrate that earnings surprise today corresponds to a subsequent surprise in ship prices.

These proportions can also tell the difference between the two markets. In the Panamax market (Panel A), the fact that the covariance between N^π_{t+1} and ε^π_{t+1} is close to nearly zero (i.e., $cov(N^\pi_{t+1}, \varepsilon^\pi_{t+1}) = -0.015$) indicates that unexpected earnings growth today ε^π_{t+1} has almost nothing to do with future changes in earnings N^π_{t+1}. This finding implies that the current earnings surprise has *little* to say about future earnings changes. In contrast, the fact that the Capesize market (Panel B) has $cov(N^\pi_{t+1}, \varepsilon^\pi_{t+1}) = -0.206$ gives a hint that Capesize earnings growth is somewhat forecastable, suggesting that Capesize earnings surprise today should carry useful information about future earnings changes.

To help better understand this, Figure 4 plots news about future earnings growth N^π and news about future returns N^r in the two markets. Clearly, the fact that N^π of the Panamax market (Graph A) is less volatile than that of the Capesize market (Panel B) can give less forecastability in the Panamax market.

[INSERT FIGURE 4 HERE]

We want to present two industry norms to discuss the above forecastability. First, many Capesize bulk carriers are subject to long-term contracts such as Contract of Affreightments (COAs) or Consecutive Voyage Charters (CVCs) with major players (e.g., steel mills, power plants, or resources traders). Second, the number of the Capesize voyage routes is usually less than that of the Panamax routes. These two norms can restrict the availability of Capesize vessels in the spot market, indicating that fewer options in the Capesize market might induce more predictive evidence. We elaborate on this discussion in more detail in the next section.

4.4. Campbell's (1991) Variance Decomposition

This subsection implements the present-value identity of unexpected earnings growth empirically by using Campbell's (1991) variance decomposition:

$$var(\varepsilon_{t+1}^{\pi}) = var(\varepsilon_{t+1}^{r}) + var(N_{t+1}^{r}) + var(N_{t+1}^{\pi})$$
$$+2cov(\varepsilon_{t+1}^{r}, N_{t+1}^{r}) - 2cov(\varepsilon_{t+1}^{r}, N_{t+1}^{\pi}) - 2cov(N_{t+1}^{r}, N_{t+1}^{\pi}). \quad (13)$$

In Eq. (13), unexpected earnings growth today can be accounted for by three variance terms and three covariance terms.[6]

Panels A and B of Table 4 produce Campbell's (1991) variance decomposition of earnings growth in the Panamax and Capesize markets, respectively. Likewise, the sum of all variance-covariance terms on the RHS of Eq. (13) is normalized so that all proportions amount to 100%.

[INSERT TABLE 4 HERE]

[6] The derivation begins by taking squares on both sides of (8) as

$$(\varepsilon_{t+1}^{\pi})^2 = (\varepsilon_{t+1}^{r})^2 + (N_{t+1}^{r})^2 + (N_{t+1}^{\pi})^2 + 2\varepsilon_{t+1}^{r} \cdot N_{t+1}^{r} - 2\varepsilon_{t+1}^{r} \cdot N_{t+1}^{\pi} - 2N_{t+1}^{r} \cdot N_{t+1}^{\pi}$$

using $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$. Then, taking an unconditional expectation on both sides leads to the Campbell's (1991) variance decomposition in Eq. (13).

We find that a large part of unexpected earnings growth ε_{t+1}^{π} is associated with total news about returns $\varepsilon_{t+1}^{r} + N_{t+1}^{r}$. Specifically, the Panamax market (Panel A) shows that total news about returns can account for 97.1% $(= var(\varepsilon^{r} + N^{r}) = var(\varepsilon^{r}) + var(N^{r}) + 2cov(\varepsilon^{r}, N^{r}))$ of earnings-growth volatility $var(\varepsilon^{\pi})$, while the Capesize market (Panel B) has 64.2% $(= var(\varepsilon^{r} + N^{r}))$.

These two proportions can also support our conclusion that earnings surprise today should correspond to a subsequent surprise in ship prices, consistent with the results of Chaves' (2009) variance decomposition (Subsection 4.3). The proportions can also distinguish the Panamax and Capesize markets. The fact that 97.1%$(= var(\varepsilon^{r} + N^{r}))$ in the Panamax market is greater than 64.2%$(= var(\varepsilon^{r} + N^{r}))$ suggests that subsequent price variation in the Panamax market is much more volatile than that in the Capesize market.

Here comes the recent story. We would anticipate that COVID-19 might devastate the entire shipping market in the beginning. This negative view could expect future earnings to fall sharply, indicating that $E_t \Delta\pi_{t+1}$ might be very low. However, it is surprising that the supply chain problem has come to arise so that today's earnings increase such that $\Delta\pi_{t+1} - E_t \Delta\pi_{t+1} > 0$. This positive news can tell us that ship prices start to rise along the way of uprising earnings paths, which might trigger the increased demand for new shipbuilding contracts pro-cyclically.

Another key finding is that the share of news about future earnings $var(N_{t+1}^{\pi})$ is lowest in the two markets, implying that earnings growth is *hardly* predictable: $var(N_{t+1}^{\pi}) = 0\%$ (Panel A), and $var(N_{t+1}^{\pi}) = 5.2\%$ (Panel B). The number close to zero suggests that earnings in shipping nearly should follow a random walk such that earnings growth is close to white noise (or i.i.d.) to justify weak predictive evidence for earnings growth. In contrast, some literature argues that the price–charter ratios can strongly forecast future earnings growth (e.g., Greenwood and Hanson, 2015; Moutzouris and Nomikos, 2019). If this argument were true, then $var(N_{t+1}^{\pi})$ would be volatile enough to be far away from 0%.

More to the point, the fact that $var(N_{t+1}^{\pi}) = 5.2\%$ in the Capesize market (Panel B) is larger than $var(N_{t+1}^{\pi}) = 0\%$ in the Panamax market (Panel A) points out that Capesize earnings growth is more forecastable than Panamax one. To understand this, it is worth noting that Panamax vessels with lots of shipping routes carry a wider range of cargoes than do Capesize vessels. When natural disasters happen so that one of the routes shuts down unexpectedly, for example, the Panamax market is easier to find an alternative to cope with the shutdown by replacing another route than the Capesize market. In other words, the limited alternatives can render momentum that a small shutdown can deteriorate the entire supply in the Capesize market. As such, we contend that the Capesize market might be less competitively efficient than the Panamax market when it comes to the theory that an efficient market has no arbitrage opportunity with little forecastable evidence.

5. Robustness

This section aims at performing a Monte Carlo experiment for the variance decomposition by imposing two restrictions on the VAR system. The Monte Carlo experiment is motivated by the ongoing debate: (a) strong earnings-growth forecastability but week return predictability, or (b) weak earnings-growth forecastability but strong return predictability. Our standpoint is that the price–charter ratios give strong evidence for returns (Lee and Yun, 2021), implying that the mean reversion comes largely from price change, not earnings change. This implication accords well with our conclusion that earnings surprise today corresponds to subsequent price changes in favor of (b). Otherwise, we would expect subsequent earnings changes to be volatile enough to support (a). Subsection 5.1 outlines the two restrictions for the Monte Carlo study, and Subsections 5.2 and 5.3 report the Monte Carlo results for Chaves' (2009) and Campbell's (1991) variance decomposition, respectively.

5.1. Two Restrictions for Monte Carlo Study

The first restriction is characterized by $b_r = 0$ in supportive of (a), meaning that the price–charter ratios cannot forecast returns by the null hypothesis:

$$\begin{bmatrix} \delta_{t+1} \\ \Delta\pi_{t+1} \\ r_{t+1} \end{bmatrix} = \begin{bmatrix} \phi \\ 1-\rho\phi \\ 0 \end{bmatrix} \cdot \delta_t + \begin{bmatrix} \varepsilon_{t+1}^{\phi} \\ \varepsilon_{t+1}^{\pi} \\ \rho \cdot \varepsilon_{t+1}^{\phi} + \varepsilon_{t+1}^{\pi} \end{bmatrix}, \tag{14}$$

where VAR (14) underlies linking identities (5) and (6):

$$b_\pi = 1 - \rho\phi,$$

$$\varepsilon_{t+1}^{r} = \rho \cdot \varepsilon_{t+1}^{\phi} + \varepsilon_{t+1}^{\pi}.$$

Here, we use the sample covariance between price–charter shock ε^{ϕ} and earnings shock ε^{π} (Table 2) by drawing 50,000 random normals from the initial point of the unconditional density $\delta_0 \sim \mathcal{N}(0, \sigma^2(\varepsilon^{\phi})/(1-\phi^2))$. Next, we feed such artificial data through the VAR system and then see how they generate the hypothetical scenario for the variance decomposition against the real scenario (Subsections 4.3 and 4.4).

The second restriction is characterized by $b_\pi = 0$ in supportive of (b), meaning that earnings growth is unpredictable by the null hypothesis:

$$\begin{bmatrix} \delta_{t+1} \\ \Delta\pi_{t+1} \\ r_{t+1} \end{bmatrix} = \begin{bmatrix} \phi \\ 0 \\ \rho\phi - 1 \end{bmatrix} \cdot \delta_t + \begin{bmatrix} \varepsilon_{t+1}^{\phi} \\ \varepsilon_{t+1}^{r} - \rho \cdot \varepsilon_{t+1}^{\phi} \\ \varepsilon_{t+1}^{r} \end{bmatrix}, \tag{15}$$

where VAR (15) also underlies linking identities (5) and (6). Likewise above, we generate the sample covariance between price–charter shock ε^{ϕ} and return shock ε^{r} and then simulate them forward through the VAR system.

5.2. Monte Carlo study for Chaves' (2009) Variance Decomposition

Panels A and B of Table 5 report Chaves' (2009) variance decomposition conducted by the Monte Carlo study in the Panamax and Capesize markets, respectively.

[INSERT TABLE 5 HERE]

Our conclusion is that return predictability is by far evident, indicating that subsequent price changes in the future might be closely related to earnings surprise today. Evidence is that the hypothetical covariance shares restricted by $b_\pi = 0$ (i.e., no cashflow forecastability) are almost analogous to the real shares (Table 3), especially for the Panamax market. Concretely, the restriction of $b_\pi = 0$ delivers that almost all earnings-growth volatility $var(\varepsilon_{t+1}^{\pi})$ is associated with total news about returns: $cov(\varepsilon_{t+1}^{r} + N_{t+1}^{r}, \varepsilon_{t+1}^{\pi}) = 94.7\%$ (Panel A), and $cov(\varepsilon_{t+1}^{r} + N_{t+1}^{r}, \varepsilon_{t+1}^{\pi}) = 92.2\%$ (Panel B). These two numbers manifest that the mean reversion of the price–charter ratios is largely attributed to price (or return) change, although the hypothetical share of $cov(N_{t+1}^{r}, \varepsilon_{t+1}^{\pi}) = 62.5\%$ in the Capesize market appears to differ from the real share of $cov(N_{t+1}^{r}, \varepsilon_{t+1}^{\pi}) = 49.7\%$ (Panel B, Table 3).

Our results supporting the restriction of $b_\pi = 0$ are indeed robust. Evidence is that the 95% confidence intervals for $cov(\varepsilon_{t+1}^{r}, \varepsilon_{t+1}^{\pi})$ and $cov(N_{t+1}^{r}, \varepsilon_{t+1}^{\pi})$ do not include zero. This finding demonstrates that the current observation of earnings surprise is associated with current and future changes in prices even in the hypothetical world, consistent with our empirical results (Section 4). Meanwhile, we emphasize that the confidence interval for $cov(N_{t+1}^{\pi}, \varepsilon_{t+1}^{\pi})$ includes zero: $[-0.414, 0.460]$ (Panel A), and $[-0.488, 0.549]$ (Panel B). This finding suggests that current earnings surprise should have almost nothing to do with future earnings changes.

Next, the restriction of $b_r = 0$ (i.e., no return predictability) tells the opposite story. Doing so narrates that more than half of $var(\varepsilon_{t+1}^{\pi})$ is associated with news about future earnings growth: $cov(N_{t+1}^{\pi}, \varepsilon_{t+1}^{\pi}) = -56.7\%$ (Panel A), and $cov(N_{t+1}^{\pi}, \varepsilon_{t+1}^{\pi}) = -71.4\%$ (Panel B). This hypothetical scenario occurs because the restriction of $b_r = 0$ forces news about future earnings growth N^{π} to be far more volatile than news about future returns N^r in favor of cashflow forecastability: $|cov(N^{\pi}, \varepsilon^{\pi})| = 56.7\% > |cov(N^r, \varepsilon^{\pi})| = 0.4\%$ (Panel A), and $|cov(N^{\pi}, \varepsilon^{\pi})| = 71.4\% > |cov(N^r, \varepsilon^{\pi})| = 1.0\%$ (Panel B). But, this hypothetical story is not true because the real scenario (Figure 4) illustrates that N^r is more variable than N^{π}.

5.3. Monte Carlo study for Campbell's (1991) Variance Decomposition

Panels A and B of Table 6 report Campbell's (1991) variance decomposition conducted by the Monte Carlo study in the Panamax and Capesize markets, respectively.

[INSERT TABLE 6 HERE]

Clearly, return predictability is so compelling that subsequent changes in vessel prices should be volatile. This result arises because the real shares (Table 4) are closer to hypothetical ones restricted by $b_{\pi} = 0$ (i.e., no cashflow forecastability) than ones restricted by $b_r = 0$. Specifically, the restriction of $b_{\pi} = 0$ generates that a large part of earnings-growth volatility $var(\varepsilon_{t+1}^{\pi})$ is associated with total news about returns: $var(\varepsilon^r + N^r) = 98.1\%$ (Panel A), and $var(\varepsilon^r + N^r) = 93.9\%$ (Panel B).

To summarize, our key finding is that earnings surprise today corresponds to a subsequent change in vessel prices. One might question that the hypothetical shares restricted by $b_{\pi} = 0$ in the Capesize market might differ from the real shares (Panel B, Table 3). Rather, this finding can crystallize that Capesize earnings growth is somewhat forecastable.

6. Concluding remarks

This paper breaks unexpected earnings growth, which is of central interest for shipping companies, into three components: unexpected return (or news about current return), news about future earnings growth, and discount rates. By using the elegant econometrics methods of Chaves (2009) and Campbell (1991), we explore which of the three news is highly correlated with the current earnings-growth volatility.

The key finding is that a large part of unexpected earnings growth corresponds to news about current and future returns. This finding gives a great deal of implication that earnings change today gives rise to a subsequent change in ship prices somewhere in the future. Our results accord with the fact that the price–charter ratios strongly forecast returns but weakly predict earnings growth (Lee and Yun, 2021). In other words, the mean reversion of the price–charter ratios comes mainly from price changes, while vessel prices are usually lagging behind operating earnings in favor of return predictability. Another impressive finding is that the Panamax market behaves differently from the Capesize market. We present potential reasons above, but it deserves future work to deepen the understanding of how shipping markets behave over time.

Our contribution might also be appealing to practitioners. Shipping markets tend to be susceptible to exogenous shocks such as the US-China conflict, COVID-19, and the Russia-Ukraine war. Nobody forecasts such shocks and the consequences going on precisely, so managing the shipping business is a very difficult task by nature. Notwithstanding, we provide one clear lesson to be predicted that a surprise in earnings today can correspond to subsequent changes in vessel prices at the least in the dry bulk markets. When observing any surprising news about earnings growth against market consensus, our lessen could help shipping companies respond to this signal by reconsidering their business plans.

Of course, other asset markets are not free from exogenous shocks. But, shipping markets have their own distinct characteristics. First, earnings in shipping tend to sway a lot by the shocks because they could hit seaborne trade directly as evidenced by the recent supply bottleneck problem and energy crisis. Second, vessels are very illiquid assets unlike liquid financial securities. Third, vessels have time-decay against non-time-perishable securities. It would be interesting to take these characteristics into account for future work in an effort to better understand shipping markets.

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Tables

Table 1. Descriptive statistics

This table reports the descriptive statistics about the two main bulk carrier markets. Panels A and B show means and standard deviations of price–charter ratio δ_t, log earnings growth $\Delta\pi_t$, and log return r_t in the Panamax and Capesize markets, respectively.

Panel A: Panamax from Jan. 1989 to Dec. 2020

	δ_t	$\Delta\pi_t$	r_t
Mean	7.477	−0.002	−0.002
Standard Deviation	0.233	0.103	0.065

Panel B: Capesize from Jan. 1992 to Dec. 2020

	δ_t	$\Delta\pi_t$	r_t
Mean	7.575	−0.003	−0.003
Standard Deviation	0.339	0.139	0.064

Table 2. Estimation results

This table reports the regression coefficients, the *t*-values estimated based on Eq. (4), and the standard deviations of the error terms on the diagonal and correlations on the off-diagonal. Panels A and B present those above in the Panamax and Capesize markets, respectively.

Panel A: Panamax from Jan. 1989 to Dec. 2020

	Estimate		Error standard deviation (diagonal) and correlation		
	b (or ϕ)	$t(b$ or $\phi)$	ε^{ϕ}	ε^{π}	ε^{r}
δ	0.948	50.083	0.074	−0.782	−0.101
$\Delta\pi$	0.001	0.051	−0.782	0.103	0.698
r	−0.052	−3.741	−0.101	0.698	0.064

Panel B: Capesize from Jan. 1992 to Dec. 2020

	Estimate		Error standard deviation (diagonal) and correlation		
	b (or ϕ)	$t(b$ or $\phi)$	ε^{ϕ}	ε^{π}	ε^{r}
δ	0.947	50.460	0.109	−0.902	−0.272
$\Delta\pi$	0.016	0.621	−0.902	0.139	0.661
r	−0.038	−2.939	−0.272	0.661	0.062

Table 3. Results of Chaves' (2009) variance decomposition

Panel A presents the shares of Chaves' (2009) variance decomposition in the Panamax market, and Panel B presents those in the Capesize market. The standard errors (s.e.) in parentheses are calculated based on the standard delta method (see Chapter 10 of Cochrane (2009)).

Panel A: Panamax

	$cov(\varepsilon_{t+1}^{r}, \varepsilon_{t+1}^{\pi})$	$cov(N_{t+1}^{r}, \varepsilon_{t+1}^{\pi})$	$cov(N_{t+1}^{\pi}, \varepsilon_{t+1}^{\pi})$
Proportion	0.437	0.548	−0.015
(s.e)	(0.000)	(0.055)	(0.055)

Panel B: Capesize

	$cov(\varepsilon_{t+1}^{r}, \varepsilon_{t+1}^{\pi})$	$cov(N_{t+1}^{r}, \varepsilon_{t+1}^{\pi})$	$cov(N_{t+1}^{\pi}, \varepsilon_{t+1}^{\pi})$
Proportion	0.297	0.497	−0.206
(s.e.)	(0.000)	(0.106)	(0.106)

Table 4. Results of Campbell's (1991) variance decomposition

Panels A and B present the proportions of Campbell's (1991) variance decomposition in the Panamax and Capesize markets, respectively. The standard errors in parentheses are calculated based on the standard delta method.

Panel A: Panamax

	$var(\varepsilon^r_{t+1})$	$var(N^r_{t+1})$	$var(N^\pi_{t+1})$	$2cov(\varepsilon^r_{t+1}, N^r_{t+1})$	$2cov(\varepsilon^r_{t+1}, N^\pi_{t+1})$	$2cov(N^r_{t+1}, N^\pi_{t+1})$
Proportion	0.392	0.491	0.000	0.088	−0.002	−0.026
(s.e.)	(0.000)	(0.099)	(0.003)	(0.004)	(0.004)	(0.048)

Panel B: Capesize

	$var(\varepsilon^r_{t+1})$	$var(N^r_{t+1})$	$var(N^\pi_{t+1})$	$2cov(\varepsilon^r_{t+1}, N^r_{t+1})$	$2cov(\varepsilon^r_{t+1}, N^\pi_{t+1})$	$2cov(N^r_{t+1}, N^\pi_{t+1})$
Proportion	0.202	0.305	0.052	0.135	−0.056	−0.252
(s.e.)	(0.000)	(0.130)	(0.054)	(0.014)	(0.014)	(0.038)

Table 5. Monte Carlo Experiment on Chaves' (2009) Variance Decomposition

This table reports the Monte Carlo results with two restrictions: (a) $b_r = 0$, and (b) $b_\pi = 0$. By generating 50.000 artificial data for each restriction, we simulate them forward through the VAR system and then calculate Chaves' (2009) variance decomposition. Panels A and B present the shares on average, the Monte Carlo standard errors (s.e.), and the lower and upper bounds of 95% confidence interval (C.I.) in the Panamax and Capesize markets, respectively.

Panel A: Panamax

Restriction	Decomposition	Avg. share	s.e.	95% C.I. Lower bound	95% C.I. Upper bound
$b_r = 0$	$cov(\varepsilon^r_{t+1}, \varepsilon^\pi_{t+1})$	0.437	0.023	0.392	0.482
	$cov(N^r_{t+1}, \varepsilon^\pi_{t+1})$	−0.004	0.146	−0.286	0.287
	$cov(N^\pi_{t+1}, \varepsilon^\pi_{t+1})$	−0.567	0.147	−0.854	−0.272
$b_\pi = 0$	$cov(\varepsilon^r_{t+1}, \varepsilon^\pi_{t+1})$	0.437	0.023	0.392	0.482
	$cov(N^r_{t+1}, \varepsilon^\pi_{t+1})$	0.510	0.226	0.146	1.026
	$cov(N^\pi_{t+1}, \varepsilon^\pi_{t+1})$	−0.053	0.224	−0.414	0.460

Panel B: Capesize

Restriction	Decomposition	Avg. share	s.e.	95% C.I. Lower bound	95% C.I. Upper bound
$b_r = 0$	$cov(\varepsilon^r_{t+1}, \varepsilon^\pi_{t+1})$	0.297	0.018	0.261	0.332
	$cov(N^r_{t+1}, \varepsilon^\pi_{t+1})$	−0.010	0.125	−0.243	0.250
	$cov(N^\pi_{t+1}, \varepsilon^\pi_{t+1})$	−0.714	0.126	−0.948	−0.451
$b_\pi = 0$	$cov(\varepsilon^r_{t+1}, \varepsilon^\pi_{t+1})$	0.297	0.018	0.261	0.332
	$cov(N^r_{t+1}, \varepsilon^\pi_{t+1})$	0.625	0.268	0.214	1.253
	$cov(N^\pi_{t+1}, \varepsilon^\pi_{t+1})$	−0.078	0.267	−0.488	0.549

Table 6. Monte Carlo Experiment on Campbell's (1991) Variance Decomposition
This table reports the Monte Carlo results with two restrictions: (a) $b_r = 0$, and (b) $b_\pi = 0$. By generating 50.000 artificial data for each restriction, we simulate them forward through the VAR system and then calculate Campbell's (1991) variance decomposition. Panels A and B present the variance shares on average, the Monte Carlo standard errors (s.e.), and the lower and upper bounds of 95% confidence interval (C.I.) in the Panamax and Capesize markets, respectively.

Panel A: Panamax

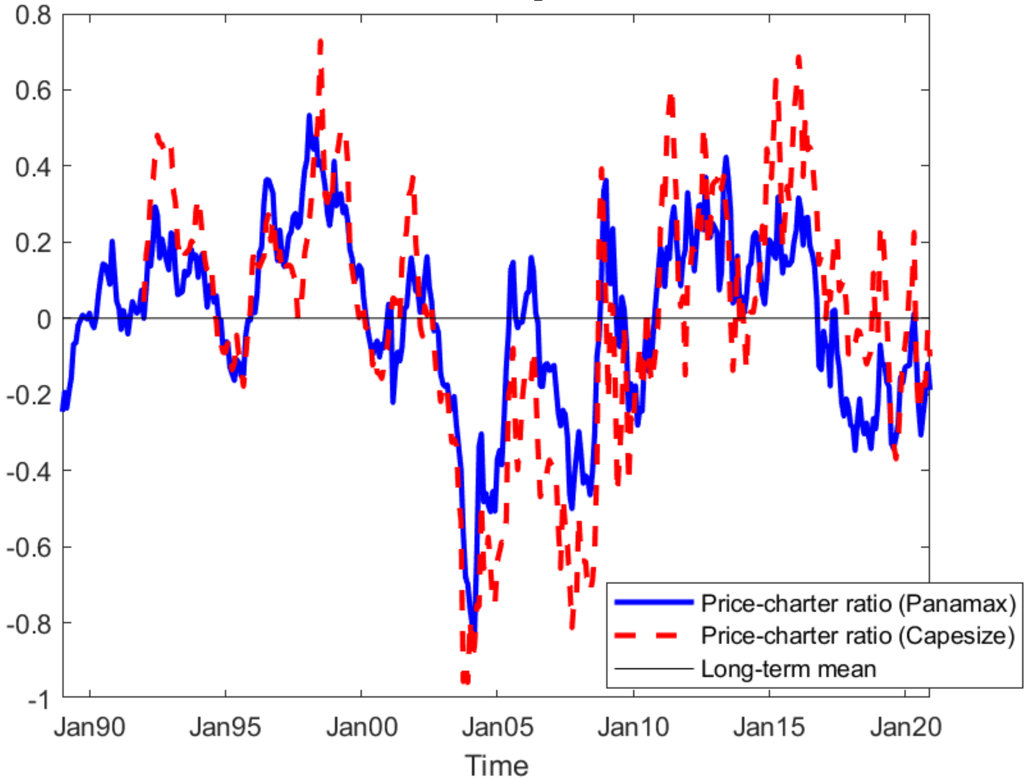
Restriction	Decomposition	Avg. share	s.e.	95% C.I. Lower bound	95% C.I. Upper bound
$b_r = 0$	$var(\varepsilon^r_{t+1})$	0.393	0.029	0.339	0.452
	$var(N^r_{t+1})$	0.035	0.053	0.000	0.180
	$var(N^\pi_{t+1})$	0.561	0.275	0.122	1.189
	$2cov(\varepsilon^r_{t+1}, N^r_{t+1})$	−0.001	0.025	−0.053	0.054
	$2cov(\varepsilon^r_{t+1}, N^\pi_{t+1})$	−0.089	0.049	−0.192	−0.001
	$2cov(N^r_{t+1}, N^\pi_{t+1})$	0.077	0.287	−0.258	0.797
$b_\pi = 0$	$var(\varepsilon^r_{t+1})$	0.393	0.029	0.339	0.452
	$var(N^r_{t+1})$	0.508	0.459	0.035	1.717
	$var(N^\pi_{t+1})$	0.087	0.135	0.000	0.407
	$2cov(\varepsilon^r_{t+1}, N^r_{t+1})$	0.080	0.055	0.000	0.211
	$2cov(\varepsilon^r_{t+1}, N^\pi_{t+1})$	−0.008	0.039	−0.082	0.081
	$2cov(N^r_{t+1}, N^\pi_{t+1})$	0.077	0.533	−0.273	1.535

Panel B: Capesize

Restriction	Decomposition	Avg. share	s.e.	95% C.I. Lower bound	95% C.I. Upper bound
$b_r = 0$	$var(\varepsilon^r_{t+1})$	0.202	0.016	0.172	0.236
	$var(N^r_{t+1})$	0.019	0.030	0.000	0.099
	$var(N^\pi_{t+1})$	0.646	0.218	0.250	1.107
	$2cov(\varepsilon^r_{t+1}, N^r_{t+1})$	−0.003	0.034	−0.067	0.069
	$2cov(\varepsilon^r_{t+1}, N^\pi_{t+1})$	−0.191	0.045	−0.281	−0.107
	$2cov(N^r_{t+1}, N^\pi_{t+1})$	0.056	0.221	−0.278	0.567
$b_\pi = 0$	$var(\varepsilon^r_{t+1})$	0.202	0.016	0.172	0.236
	$var(N^r_{t+1})$	0.569	0.522	0.057	1.933
	$var(N^\pi_{t+1})$	0.095	0.158	0.000	0.419
	$2cov(\varepsilon^r_{t+1}, N^r_{t+1})$	0.168	0.077	0.054	0.352
	$2cov(\varepsilon^r_{t+1}, N^\pi_{t+1})$	−0.021	0.072	−0.137	0.149
	$2cov(N^r_{t+1}, N^\pi_{t+1})$	0.055	0.615	−0.316	1.689

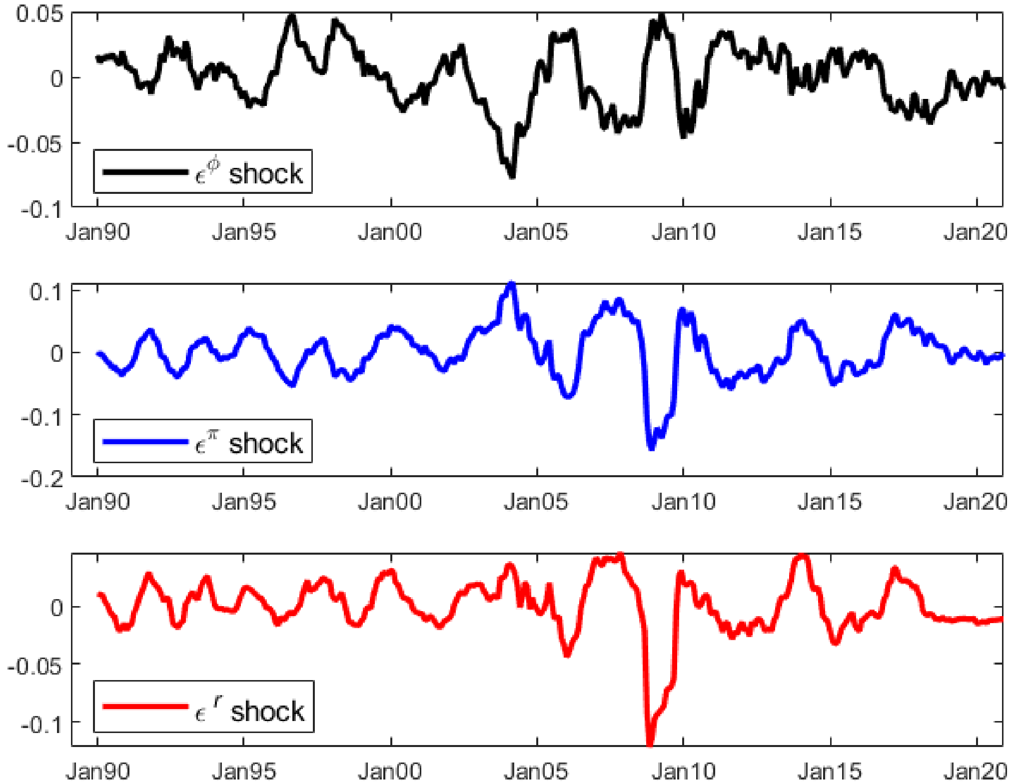
Figures

Figure 1. Price–charter ratios in Panamax and Capesize markets



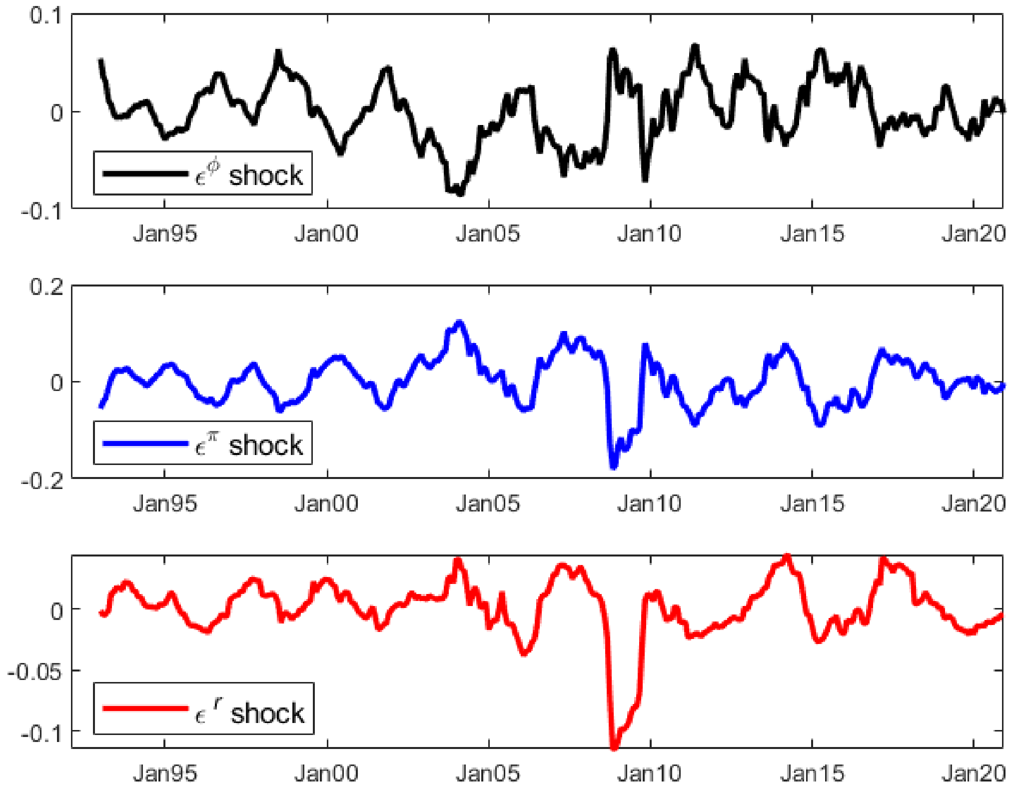
Note: Price–charter ratios are redefined as deviations from the long-term mean so that the mean is set to be zero.

Figure 2. 12-month trailing moving average of three shocks in the Panamax market



Note: The Panamax 76K 5-year secondhand prices and 1-year time charter rates are used to represent the Panamax market. The original sample period starts from Jan. 1989, but the adjusted sample period starts Jan. 1990 because of using a 12-month trailing moving average.

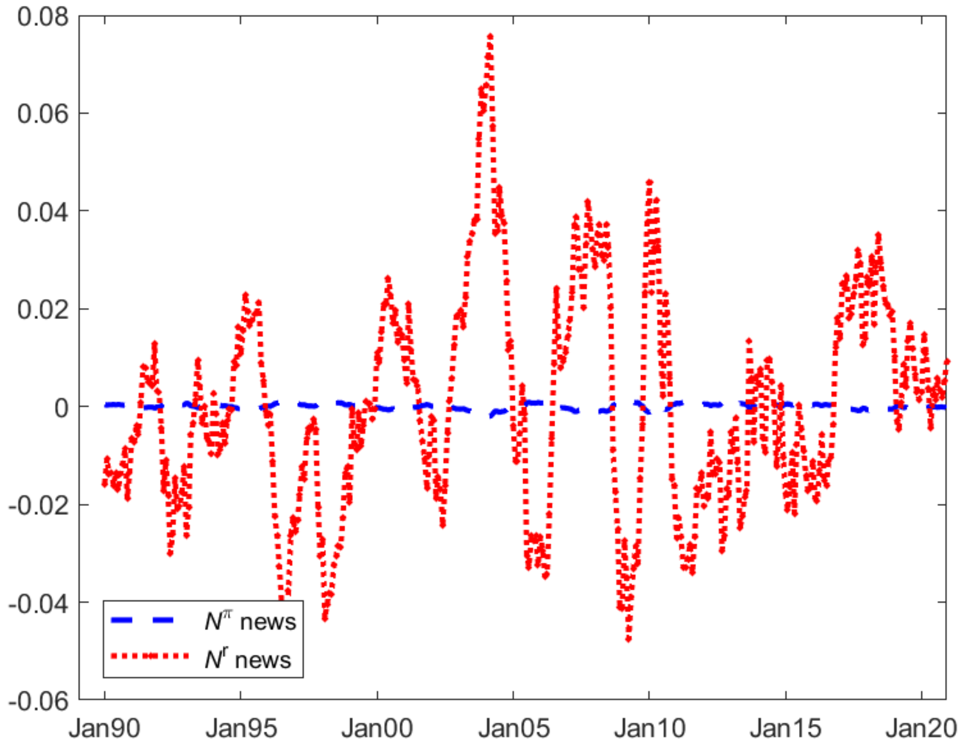
Figure 3. 12-month trailing moving average of three shocks in the Capesize market



Note: The Capesize 180K 5-year secondhand prices and 1-year time charter rates are used to represent the Capesize market. The original sample period starts from Jan. 1992, but the adjusted sample period starts Jan. 1993 by using a 12-month trailing moving average.

Figure 4. 12-month trailing moving averages of news about future earnings growth and returns

Graph A: Panamax



Graph B: Capesize