An Investigation of the Relative Performance Evaluation Hypothesis

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Abstract

In spite of strong theoretical motivation, empirical studies of executive compensation have provided only limited evidence of relative performance evaluation (RPE). Some research findings support a weak-form RPE hypothesis that executive pay is positively related to firm performance and negatively related to peer-group performance, but there is little support for the strong-form RPE hypothesis that performance shocks common to a firm and its peers are removed when executive performance is evaluated for compensation purposes. Whether this lack of empirical evidence is due to limited use of RPE by companies or misspecification of empirical models is an unresolved research issue. Previous studies of RPE have not recognized two-way relations between pay and performance that are fundamental to the agency models – performance affects pay and pay affects performance. In this study, we estimate models of RPE that recognize this simultaneity between pay and performance. In contrast to previous findings, our results support strong and weak form RPE with respect to both accounting and stock returns for a large cross-section of firms.

Keywords: relative performance evaluation, executive compensation, stock options, pay for performance

1. Introduction

Relative performance evaluation is predicted by agency theory and implied by arguments that executives operate in competitive labor markets, but documentation of relative performance evaluation (RPE), especially strong-form RPE, has been elusive in large-sample studies of executive compensation (Janakiraman, Lambert, and Larcker 1992, Murphy 1999). Strong-form RPE is more meaningful than weak-form RPE because the strong-form hypothesis considers whether shocks that jointly affect firm and peer performance are removed when evaluating executive performance, whereas the weak-form hypothesis considers only whether firm performance is evaluated relative to peer performance. The absence of empirical support for strong-form RPE and the limited support for weak-form RPE is puzzling because peer performance measures are readily available at low cost for publicly traded companies. Some research has considered reasons why RPE might not be used, suggesting that factors not considered by the agency models mitigate its usefulness (Dye 1992, Aggarwal and Samwick 1999, Garvey and Milbourn 2001). An alternative explanation for the lack of empirical support for RPE is that models used to evaluate the RPE hypothesis are misspecified.

In this study, we consider the possibility that models used to test the RPE hypothesis are misspecified because they do not accommodate endogeneity of pay and performance. Boschen and Smith (1995) and Anderson, Banker, and Ravindran (2000) observed that two-way relations between pay and performance are fundamental to the agency models underlying empirical models of executive compensation. Both studies document simultaneous relations between pay and stock returns. Failure to incorporate this endogeneity of pay and performance in empirical specifications of RPE models may lead to biased results.

Janakiraman, Lambert, and Larcker (1992), JLL hereafter, distinguished between strong and weak form RPE and devised a test of the strong-form hypothesis. Their test involves estimation of the reduced form of a recursive model where firm performance affects pay but pay does not affect performance. We modify the JLL model to accommodate endogeneity of pay and performance and estimate the model using ExecuComp data for 2,226 firms. Results of our estimations support strong-form RPE when performance is evaluated using either accounting return on assets (ROA) or stock return (RET).

Our specification differs in other ways from the JLL specification. We use total compensation, including the Black-Scholes (1973) value of options granted, instead of cash compensation as our pay measure. This difference reflects changes in compensation practices and data availability between the time of the JLL study and our study. During the time period that JLL studied, cash pay made up a much larger proportion of total pay than it has in recent years, proxy statements did not provide as much detail about executive compensation, and a large comprehensive database of executive pay such as ExecuComp was not available.

Our specification also considers the influence of stock and option holdings on both the amount of total pay and performance. Consistent with the agency models, total pay decreases with stock and option holdings because the need for fresh incentive pay is reduced by equity holdings by managers, and firm performance is positively related to stock and option holdings because managers' incentives to improve performance increase with stock and option holdings.

In the next section, we review previous literature on RPE. In section 3, we describe our empirical model and tests of weak and strong form RPE. In section 4, we describe the data and present the results of estimating the model. In section 5, we discuss the implications of this research.

2. Tests of the RPE hypothesis

Relative performance evaluation is a fundamental prediction of agency theory (Holmstrom 1979, 1982, Baiman and Demski 1980, Lazear and Rosen 1981, Diamond and Verrecchia 1982). When firm performance includes idiosyncratic (firm-specific) components and systematic (industry or market wide) components, RPE may be used to remove systematic risk from agents' pay. Removing common shocks from performance measures provides a cleaner evaluation of the agent's actions and reduces the risk transferred to risk-averse managers by performance-based contracts. RPE contracts are cheap to administer when objective measures of firm and peer performance are available.

Empirical Evidence of RPE

Antle and Smith (1986) analyzed average pay of top executives at 36 firms in the chemical, aerospace, and electronics industries from 1947 to 1977. They used a very broad compensation measure that included cash compensation, stock and option grants and changes in value of executives' holdings of stock and options. They constructed peer-group performance indices, weighted by the correlation between firm and peer ROA, for 2-digit SIC industry groups. In time series estimations of firm performance on the peer-group indices, they separated ROA and RET into systematic and unsystematic components. Their RPE hypothesis (strong form) was that compensation would be positively related to the unsystematic performance metrics and not positively related to the systematic performance metrics.

Antle and Smith compared time series estimations of compensation on ROA and RET with time series estimations of compensation on UROA (unsystematic), SROA (systematic), URET, and SRET. They found that the specification that included the unsystematic and systematic components was preferred for 16 of 39 firms. For this subset of 16 firms, they tested for RPE by examining whether the coefficient on unsystematic performance was greater than zero and the coefficient on systematic performance was not greater than zero.

Antle and Smith found 9 firms where the coefficient on UROA was greater than zero and only 2 firms where the coefficient on SROA was greater than zero. Of 9 firms where the coefficient on UROA minus the coefficient on SROA was different from zero, 8 were positive. With respect to RET, they found 16 firms where the coefficient on URET was greater than zero but they also found 12 firms where the coefficient on SRET was greater than zero. For 12 firms where the coefficient on URET minus the coefficient on SRET was greater than zero, all were positive. Antle and Smith repeated their analysis using different measures of compensation. When returns on holdings were excluded from their measure of pay, they found support for RPE with respect to ROA but not with respect to RET. When only cash compensation was considered, they did not find support for RPE.

Gibbons and Murphy (1990) performed a large-sample analysis of RPE based on 7,757 observations of changes in cash compensation (salary and bonus) for CEOs at 1,049 firms from 1974 to 1986. Their data was obtained from *Forbes* annual surveys of CEO compensation. Their empirical model related the log value of the change in cash compensation to the change in the log value of shareholder wealth (equivalent to RET) for the firm and peer groups. They constructed peer groups using value-weighted portfolios based on 1, 2, 3, and 4-digit SIC codes. Their RPE hypothesis (weak form) was that the coefficient on firm performance would be positive and that the coefficient on peer performance would be negative. Their results support weak-form RPE for stock returns. They found that the RPE effect was greater for broader peer indices and greatest for the market portfolio, implying that cash compensation of executives is partially insulated from market shocks. They also performed some analyses with accounting returns but did not find support for RPE.

They repeated their large-sample analysis using a broader measure of compensation that included grants of restricted stock (but not options) and found similar results. For a small sample of 73 firms, they used a measure of total compensation that included option grants but they did not find RPE for this group. They also used a time-series specification for 690 firms that had six or more usable observations and found that the coefficient on peer stock returns was negative (consistent with weak-form RPE) for two-thirds of these firms.

Janakiraman, Lambert, and Larcker (1992) analyzed changes in cash compensation (salary and bonus) of CEOs at 609 firms based on *Forbes* compensation surveys from 1970 to 1988. They used changes in return on equity (ROE) and levels of

RET as their performance measures and determined peer performance using value-weighted portfolios for 2-digit SIC codes. Their model may be represented as follows:

$$C_{it} - C_{i,t-1} = \alpha_i + \beta_{ix}(x_{it} - E[x_{it}]) + \beta_{ip}x_{pt} + \varepsilon_{it} \quad (1)$$

$$x_{it} = a_i + b_i x_{pt} + u_{it}$$

where C_{it} represents cash compensation of the CEO at firm i in period t, x_{it} represents firm performance in period t, $E[x_{it}]$ represents expected firm performance in period t, and x_{pt} represents peer performance in period t.

JLL distinguished between weak-form RPE, where $\beta_x > 0$ and $\beta_p < 0$, and strong-form RPE where the peer group performance measure is completely removed. The strong-form hypothesis may be expressed as $\beta_p = -b\beta_x$ under the assumption that the agent's effort has no effect on the expected performance of the peer group. JLL estimated time-series regressions for each firm and aggregated the results. They did not find RPE with respect to changes in ROE and they found evidence of weak but not strong form RPE for RET.

Aggarwal and Samwick (1999) argued that principal-agent models fail to recognize that interactions between shareholders and managers take place in environments where firms compete strategically in imperfectly competitive markets. They developed an analytical model that yields the prediction that there would be less RPE in more competitive industries. Using Execucomp data for CEOs, they related total pay (including short-term pay, the value of restricted stock and option grants, long-term incentive plan pay-outs and all other compensation) and short-term pay (salary, bonus and other annual compensation) in separate estimations to changes in shareholder wealth (Jensen and Murphy 1990), interacted with measures of industry concentration.

Aggarwal and Samwick estimated a variety of specifications with compensation variables defined in first-difference or levels forms and peer firm performance determined using 3-digit and 4-digit SIC codes (value-weighted). In their estimations using total pay, the results did not support weak or strong form RPE. The coefficients on both the firm and industry performance were positive. In their estimations using short-term pay, their results supported weak-form RPE when the compensation variable was in first-difference form but not when the compensation variable was in levels form. They found that the negative peer-performance effect was smaller in more competitive industries, consistent with their hypothesis.

Garvey and Milbourn (2001) argued that firms may not gain much by removing market risk from executive compensation because the market provides compensation for bearing market risk via the market risk premium and executives can adjust personal portfolios to offset market risk in their compensation. They suggested that these arguments were stronger for older executives than for younger executives because younger executives have more exposure to idiosyncratic risk through their human capital. Using a model similar to Aggarwal and Samwick's model and ExecuComp data, they found that market risk has no significant effect on executive compensation for their full sample. When they split the sample into old and young CEOs, they found evidence that a small amount of market risk is backed out of executive pay for young CEOs.

Collectively, these studies provide mixed support for the weak-form RPE hypothesis and, with the exception of Antle and Smith's results, no support for the strong-form RPE hypothesis. While recent research has focused on explaining the absence of RPE, an alternative explanation for failure to observe RPE is that the models used to detect it are misspecified.

3. RPE and simultaneity of pay and performance

Two-way relations between the level of pay and performance are central to the agency models. In the ex-post settling up model (Fama 1980, Gibbons and Murphy 1992) and the multi-period agency model (Lambert 1983, Rogerson 1985, Murphy 1986), the ability and pay of the manager is inferred from sequential observations of performance. In the moral hazard (Holmström 1979) and self-selection (Freeman 1977, Harris and Holmström 1982) models, the reservation wage reflects the manager's ability. In all of the models, performance affects pay, and, because more able managers are paid more, pay affects performance. Furthermore, the expected cost of a compensation system increases as it becomes more performance-based because the agents must be compensated for accepting additional risk (Abowd 1990).

A few empirical studies have considered reciprocal relations between pay and performance. Abowd (1990) specified a simultaneous equations model that included measures of performance-sensitivity in year t and performance in year $t+1$ as endogenous variables. For ROA, he found that $t+1$ performance increased with the sensitivity of compensation to performance in t. His results were not as strong for RET. Boschen and Smith (1995) specified a simultaneous equations model that included contemporaneous measures of compensation and market performance (RET) as endogenous variables. For cash compensation and total compensation, they found that compensation is significantly and positively related to RET and that RET is significantly and positively related to compensation. Anderson, Banker, and Ravindran (2000) estimated a model of compensation that included total pay and stock returns as endogenous variables and found significantly positive relations between incentive pay and stock returns and between stock returns and total pay.

The JLL model described in (1) above includes an equation that relates compensation to firm and peer performance and a second equation that relates firm performance to peer performance. This specification may be modified to accommodate simultaneity between pay and performance by including the compensation variables in the second equation.

$$C_{it} - C_{i,t-1} = \alpha_i + \beta_{ix}(x_{it} - E[x_{it}]) + \beta_{ip}x_{pt} + \varepsilon_{it} \quad (2)$$

$$x_{it} = a_i + b_{ic}(C_{it} - C_{i,t-1}) + b_{ip}x_{pt} + u_{it}$$

Instead of using the first-difference specification of the compensation variable, we include the lagged value of compensation as a pre-determined variable in both equations. This relaxes a restriction imposed by the first-difference specification. Boschen and Smith (1995) observed that the first-difference specification of the compensation variable implicitly assumes that performance has a permanent effect on pay. In the ex-post settling up model (Fama 1980, Gibbons and Murphy 1992), the compensation change associated with a performance shock is not permanent except in the special case where the manager's true productivity evolves as a random walk. When they estimated their model, Boschen and Smith found that the coefficient on the lagged compensation was significantly less than one, indicating decay over time in the compensation response. Including lagged compensation as a pre-determined variable leads to the following specification.

$$C_{it} = \alpha + \beta_1 C_{i,t-1} + \beta_2(x_{it} - E[x_{it}]) + \beta_3 x_{pt} + \varepsilon_{it} \quad (3)$$

$$x_{it} = a + b_1 C_{it} + b_2 C_{i,t-1} + b_3 x_{pt} + u_{it}$$

We use the log of total pay (including salary, bonus, other annual, restricted stock grants, the Black-Scholes value of option grants, long-term incentive plan pay-outs, and all other compensation) as the compensation measure instead of the log of cash compensation used by JLL. We also include measures of managers' stock and option holdings as independent variables in both the compensation and performance equations. While the agency models do not explicitly consider the influence of agents' existing holdings in the firm on their compensation agreements, predictions about the effects of existing holdings on total pay and performance are natural extensions of agency theory.

Because stock and option holdings tie executive wealth to firm performance, the steepness of the incentive contract may be reduced when stock and option holdings are higher, reducing the incentive components of current compensation and the total cost of the compensation agreement. Similarly, because stock and option holdings provide incentives similar to incentive pay, firm performance may be positively affected by executive holdings of stock and options. Anderson, Banker, and Ravindran (2000) found evidence consistent with these predictions. They deflated stock and option holdings by total pay as a proxy for managers' wealth. We measure stock holdings at the end of the fiscal period using the disclosed number of shares multiplied by the closing stock price. We measure option holdings using the intrinsic value of managers' exercisable and unexercisable option holdings reported in the proxy statements.

Following JLL, we estimate two versions of the model, one includes ROA as the performance variable and the other includes RET as the performance variable.[1] We include the log of sales as a measure of size in the compensation equations of both models. Rosen (1982) argued that the observed systematic relationship between executive compensation and firm size can be attributed to larger, more complex firms hiring better managers.

The performance term in the JLL specification includes the difference between firm performance, x_{it}, and expected performance, $E[x_{it}]$. In their ROE model, they use previous ROE as their measure of expected firm performance because there is autocorrelation in the accounting return series. This first-difference specification is restrictive because it assumes that the accounting return series follows a random walk. It also constrains the formation of performance expectations to information included in the firm's previous accounting return. Expectations of current performance developed for the purpose of evaluating executive performance may also depend on the performance of peer firms in the previous period. Therefore, instead of using a first-difference specification of ROA, we include the current value of ROA as an endogenous variable and the lagged values of ROA and peer-group ROA as pre-determined variables in our ROA model. The expected signs on the lagged values of ROA and peer-group ROA are negative because they determine expected performance.

We also include measures of growth (sales growth and asset growth between periods t - 1 and t) and financial leverage (debt to assets) in the ROA equation. We include both sales growth and asset growth because increases in sales and assets may

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[1] JLL used the accounting return on equity (ROE) as the performance variable. Antle and Smith (1986) used ROA.

have different effects on ROA. To the extent that increases in sales reflect realizations of greater demand for firm products, ROA will increase. Because asset growth may precede realizations of anticipated greater demand, ROA may decrease with asset growth. ROA is likely to decrease with financial leverage because financial leverage is higher for firms with more assets-in-place and less operating risk (Smith and Watts 1992).

<u>ROA model</u>

$$ln(Total\ pay_t) = \alpha + \beta_1{*}ln(Total\ pay_{t-1}) + \beta_2{*}\ ROA_t + \beta_3{*}\ PeerROA_t + \beta_4{*}\ ROA_{t-1} + \beta_5{*}\ PeerROA_{t-1} + \gamma_1{*}\ Stock\ holdings/total\ pay_t + \gamma_2{*}\ Option\ holdings/total\ pay_t + \gamma_3{*}\ ln(Sales_t) + \varepsilon$$

$$ROA_t = a + b_1{*}ln(Total\ pay_t) + b_2{*}ln(Total\ pay_{t-1}) + b_3{*}\ PeerROA_t + b_4{*}\ ROA_{t-1} + b_5{*}\ PeerROA_t.1 + c_1{*}\ Stock\ holdings/total\ pay_t + c_2{*}\ Option\ holdings/total\ pay_t + c_3{*}\ Sales\ growth_t + c_4{*}\ Asset\ growth_t + c_5{*}\ Debt\ to\ assets_t + e$$

In the RET model, we do not include the lagged values of RET and peerRET because, as JLL observed, RET is generally considered to be uncorrelated over time. Therefore, expectations of current RET do not depend on previous RET. Otherwise, the RET model is similar to the ROA model except that we include measures of volatility (annualized standard deviation of daily stock returns over a 5 year period) and financial leverage (debt to assets) as exogenous variables in the RET equation. We expect that RET will increase with volatility because expected returns increase with risk and decrease with financial leverage because firms with greater leverage typically have lower operating risk.

<u>RET model</u>

$$ln(Total\ pay_t) = \alpha + \beta_1{*}ln(Total\ pay_{t-1}) + \beta_2{*}\ RET_t + \beta_3{*}\ PeerRET_t + \gamma_1{*}\ Stock\ holdings/total\ pay_t + \gamma_2{*}\ Option\ holdings/total\ pay_t + \gamma_3{*}\ ln(Sales_t) + \varepsilon$$

$$RET_t = a + b_1*ln(Total\ pay_t) + b_2*ln(Total\ pay_{t-1}) + b_3* PeerRET_t + c_1* Stock\ holdings/total\ pay_t + c_2* Option\ holdings/total\ pay_t + c_3* Volatility_t + c_4* Debt\ to\ assets_t + e$$

Tests of weak-form and strong-form RPE hypotheses

In both of the above models, the test for weak-form RPE is $\beta_2 > 0$ and $\beta_3 < 0$. If these conditions are satisfied, then the test for strong-form RPE (that the common shock is completely removed) is $\beta_3 = -\beta_2 b_3$. JLL observed that it is difficult to obtain reliable statistical tests for this type of non-linear constraint but that a simple test for this particular constraint could be devised by substituting the performance equation into the compensation equation in their recursive model and estimating the reduced form. This can be achieved in a similar manner by estimating the reduced form of our simultaneous equations models.

Reduced form of ROA model

$$ln(Total\ pay_t) = \alpha + (\beta_1 + \beta_2 b_2)/(1- \beta_2 b_1)*ln(Total\ pay_{t-1}) + (\beta_2 b_3 + \beta_3)/(1- \beta_2 b_1)* PeerROA_t + (\beta_2 b_4 + \beta_4)/(1- \beta_2 b_1)* ROA_{t-1} + (\beta_2 b_5 + \beta_5)/(1- \beta_2 b_1)* PeerROA_{t-1} + (\beta_2 c_1 + \gamma_1)/(1- \beta_2 b_1)* Stock\ holdings/total\ pay_t + (\beta_2 c_2 + \gamma_2)/(1- \beta_2 b_1)* Option\ holdings/total\ pay_t + \gamma_3/(1- \beta_2 b_1)* ln(Sales_t) + \beta_2 c_3/(1- \beta_2 b_1)* Sales\ growth_t + \beta_2 c_4/(1- \beta_2 b_1)* Asset\ growth_t + \beta_2 c_5/(1- \beta_2 b_1)* Debt\ to\ Assets_t + \mu$$

Reduced form of RET model

$$ln(Total\ pay_t) = \alpha + (\beta_1 + \beta_2 b_2)/(1- \beta_2 b_1)*ln(Total\ pay_{t-1}) + (\beta_2 b_3 + \beta_3)/(1- \beta_2 b_1)* PeerRET_t + (\beta_2 c_1 + \gamma_1)/(1- \beta_2 b_1)* Stock\ holdings/total\ pay_t + (\beta_2 c_2 + \gamma_2)/(1- \beta_2 b_1)* Option\ holdings/total\ pay_t + \gamma_3/(1- \beta_2 b_1)* ln(Sales_t) + \beta_2 c_3/(1- \beta_2 b_1)* Volatility_t + \beta_2 c_4/(1- \beta_2 b_1)* Debt\ to\ assets_t + \mu$$

The reduced-form models were obtained by substituting the performance equations into the compensation equations. Notice that the coefficients on $PeerROA_t$ in the ROA model and $PeerRET_t$ in the RET model are equal to $(\beta_2 b_3 + \beta_3)/(1 - \beta_2 b_1)$. The test of the strong form hypothesis is $\beta_3 = -\beta_2 b_3$. This occurs if the coefficients on these peer performance variables are equal to zero. Thus, the strong-from tests of the RPE hypothesis are that the coefficients on $PeerROA_t$ and $PeerRET_t$ in the reduced form estimations are not significantly different from zero, conditional on the weak-form tests being satisfied.

4. Results of estimating the RPE models

We obtained the compensation data used to estimate the models from ExecuComp and the financial data from Compustat. The ExecuComp data typically includes information about the compensation of the top five executives at each firm as disclosed in the proxy statements. To address potential dependence between employees from the same firm, we averaged the compensation and holdings variables for the named executives for each firm (Antle and Smith 1986, Anderson, Banker and Ravindran 2000). Thus, each observation represents one firm-year. After eliminating observations with missing values for any variable, we obtained a sample of 5,383 firm-year observations during the period from 1993-1999. Descriptions of the variables and descriptive statistics are provided in table 1. As in Antle and Smith (1986) and Janakiraman, Lambert, and Larcker (1992), we measured peer-group performance using two-digit SIC groups.

We estimated the ROA and RET models using two-stage least squares (Judge et al. 1998). We checked for multicollinearity using Belsley, Kuh and Welsch's (1980) diagnostic and found that the data do not exhibit high multicollinearity. We identified influential observations using recommended cutoffs for leverage points, Studentized residuals, the DFFITS measure, and standard influences of observations on the covariance of estimates (Belsley, Kuh and Welsch 1980, Krasker, Kuh and Welsch 1983). We excluded 48 observations from the ROA model and 10 observations from the RET model under the stringent condition that an observation is considered influential if any one cutoff is exceeded. We used Hausman tests to compare the simultaneous equations models for ROA and RET with models that did not consider the endogeneity of pay and performance and found that these tests support endogeneity and the simultaneous equations model.

Results of estimating the ROA model are presented in table 2. The significantly positive coefficient on ROA_t of 0.03572 (p-value = 0.0001) in the compensation equation and the significantly positive coefficient of 8.03439 (p-value = 0.0001) on $ln(Total\ pay_t)$ in the performance equation indicate the validity of the simultaneous equations specification. The coefficient on the lagged value of total pay, $ln(Total\ pay_{t-1})$, of 0.65272 is significantly less than one (p-value = 0.0001), supporting the separate level and lag specification of the compensation variable over the more restrictive first-difference specification.

The weak-form RPE hypothesis is supported by the significantly positive coefficient on ROA_t and the significantly negative coefficient on $PeerROA_t$ of -0.00792 (p-value = 0.0138) in the compensation equation. The significantly negative coefficients on ROA_{t-1} and $PeerROA_{t-1}$ indicate that expected performance is determined with reference to both firm and peer-group performance in the preceding period.

In the compensation equation of the ROA model, the significantly negative coefficients of -0.00026 (p-value = 0.0004) on the stockholdings and -0.00004 (p-value =

0.0030) on option holdings variables are consistent with the argument that employees with large holdings require less incentive pay and therefore less total pay. In the performance equation, the significantly positive coefficients of 0.00280 (p-value = 0.0047) on stock holdings and 0.00053 (p-value = 0.0004) on option holdings support the argument that incentives provided by equity holdings improve firm performance.

Similar results are found for the RET equation in table 3. The significantly positive coefficient on RET_t of 0.00739 (p-value = 0.0013) in the compensation equation and the significantly positive coefficient of 11.63690 (p-value = 0.0001) on $ln(Total\ pay_t)$ in the performance equation support the simultaneous equations specification. The weak-form RPE hypothesis is supported by the significantly positive coefficient on RET_t and the significantly negative coefficient on $PeerRET_t$ of -0.00015 (p-value = 0.0450) in the compensation equation. In the compensation equation, the significantly negative coefficients of -0.00030 (p-value = 0.0002) on the stockholdings and -0.00003 (p-value = 0.0067) on option holdings variables are consistent with the argument that employees with large holdings require less incentive and total pay. In the performance equation, the significantly positive coefficients of 0.01120 (p-value = 0.0446) on stock holdings and 0.00161 (p-value = 0.0496) on option holdings support the incentive argument.

Tests of the strong-form RPE hypothesis

The algebraic form of the strong-from hypothesis for both the ROA and RET models is $\beta_3 = -\beta_2 b_3$. Based on the table 2 results for ROA, $\beta_3 = -0.00792$ and $-\beta_2 b_3 =$ -0.00849. While these amounts are numerically very close, the strong-form test requires that they are not significantly different from each other. As described above, this test may be performed by estimating the reduced form of the ROA model. Results of this estimation are presented in table 4. The coefficient of interest is the coefficient on the $PeerROA_t$ variable, $(\beta_2 b_3 + \beta_3)/(1- \beta_2 b_1)$. The estimation results indicate that this coefficient has a value of 0.00086 and is not significantly different from zero (p-value = 0.7630), consistent with strong-form RPE.

Based on the table 3 results for RET, β_3 = -0.00015 and $-\beta_2 b_3$ = -0.00016. Again, while the values are numerically very close, the statistical test requires estimation of the reduced form of the RET model. This estimation is presented in table 5. In the RET model, the coefficient on $PeerRET_t$ of 0.00001 (p-value = 0.7692) is not significantly different from zero. Thus, our findings support both weak-form and strong-form RPE hypotheses for both accounting and stock returns.

Alternative specifications

We estimated the simultaneous equations model using cash compensation instead of total compensation. The results of this estimation did not support weak or strong form RPE. In addition, we estimated the total pay equation without considering the simultaneity between total pay and performance. Weak-form RPE could not be detected from this estimation. Thus, both the definition of compensation and the endogeneity of pay and performance are critical to the specification of the empirical model.

5. Conclusion

The lack of empirical support to date for the RPE hypothesis has caused concern among researchers because the theory and assumptions for RPE are fundamental to agency theories of executive compensation. Under the agency umbrella, there are a number of possible explanations for the failure to detect RPE. First, RPE may not be used because it is too costly to obtain relative performance measures for peer firms. This explanation has little merit because relations between executive pay and accounting or stock returns have been extensively documented, and companies can obtain accounting and market price information for publicly traded peer companies at almost no cost.

Second, there may be other business reasons why companies do not engage in RPE. Dye (1992) suggests that companies may prefer not to use RPE because it may encourage executives to invest in industries where they can outperform competitors rather than in industries where they can earn the highest absolute returns. JLL and Aggarwal and Samwick (1999) suggest that the agency models ignore strategic interaction among firms. Using the ExecuComp data, Aggarwal and Samwick find weak-form RPE for short-term compensation only. This weak-form RPE is smaller in magnitude in more competitive industries. Gibbons and Murphy (1990) find greater evidence of RPE for broader market indices but Garvey and Milbourn (2001) argue against using RPE to remove market risk since executives can be compensated for bearing market risk or can remove it themselves. Using the ExecuComp data, they find small magnitude weak-form RPE for young executives only.

Third, the models used to detect RPE may be misspecified. Abowd (1990) and Rosen (199) observed that the endogeneity of pay and performance is fundamental to the agency models. Abowd (1990), Boschen and Smith (1995) and Anderson, Banker and Ravindran (2000) provided evidence of two-way relations between pay and performance. Using the ExecuComp data, we document both weak-form and strong-form RPE for accounting and stock returns when the JLL model of RPE is modified to accommodate reciprocal relations between pay and performance. This eliminates a serious discrepancy in the agency-based empirical compensation literature and opens up opportunities to revisit studies that investigate limitations of RPE.

Defenders of high executive pay argue that there are a limited number of talented executives who compete in a well-developed executive labor market. Compensation consultants hired to evaluate and design executive compensation packages make extensive comparisons with peer-group pay packages. Under the ex-post settling up and multi-period agency models, changes in executive pay are determined with reference to observed performance. Under the moral hazard and self-selection models, incentive pay is tied to performance. In all of these models, the risk borne by the executive and the cost of the plan to the firm can be reduced through RPE without sacrificing the incentives to managers. We document that these predictions of agency theory hold in an empirical analysis that recognizes the two-way relations between pay and performance that are central to the agency models.

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Table 1
Description of variables used in the analysis

Variable Name	Description	Mean	Std. Dev.
ln(Total pay)	ln(Salary + bonus + other annual + market value of restricted stock + Black-Scholes value of options granted + LTIP pay-outs + all other)	6.91	0.90
ROA	(Earnings before extraordinary items + interest expense (1 – corporate tax rate)) * 100 / Average total assets	5.47%	9.12%
PeerROA	Average ROA for two-digit SIC industry	5.39%	3.40%
RET	((Δstock price + dividends) / beginning stock price) * 100	13.28%	50.93%
PeerRET	Average RET for two-digit SIC industry	30.30%	128.65%
Stockholdings / total pay	(# of shares held at end of year * ending stock price) / Total pay	9.63	105.46
Option holdings / total pay	(intrinsic value of exercisable and unexercisable options at end of year) / Total pay	11.03	705.33
ln(Sales)	ln(sales revenue)	7.07	1.59
Sales growth	Percentage change in sales from previous year	15.58%	37.57%
Asset growth	Percentage change in assets from previous year	17.85%	39.50%
Volatility	Annualized volatility of daily stock returns over previous 5 years	0.36	0.15
Debt to assets	Total debt at end of year / Total assets at end of year	0.56	0.21

Table 2
Results of two-stage least squares estimation of system of equations relating total compensation to ROA and PeerROA

Equation 1

$$ln(Total\ pay_t) = \alpha_1 + \beta_1 * ln(Total\ pay_{t-1}) + \beta_2 * ROA_t + \beta_3 * PeerROA_t + \beta_4 * ROA_{t-1} + \beta_5 * PeerROA_{t-1} + \gamma_1 * Stock\ holdings/total\ pay_t + \gamma_2 * Option\ holdings/total\ pay_t + \gamma_3 * ln(Sales_t) + \varepsilon$$

Independent variable	Parameter estimate	p-value*
Intercept	1.81976	0.0001
ln(Total pay_{t-1})	0.64504	0.0001
ROA_t	0.03572	0.0001
$PeerROA_t$	-0.00792	0.0138
ROA_{t-1}	-0.02110	0.0001
$PeerROA_{t-1}$	-0.01315	0.0001
Stock holdings/total pay_t	-0.00026	0.0008
Option holdings/total pay_t	-0.00004	0.0060
ln($Sales_t$)	0.11181	0.0001
number of observations = 5,335, adjusted R^2 = 0.5772		

*p-values are for one-tailed tests where a predicted sign is given

Equation 2

$$ROA_t = a_1 + b_1 * ln(Total\ pay_t) + b_2 * ln(Total\ pay_{t-1}) + b_3 * PeerROA_t + b_4 * ROA_{t-1} + b_5 * PeerROA_{t-1} + c_1 * Stock\ holdings/total\ pay_t + c_2 * Option\ holdings/total\ pay_t + c_3 * Sales\ growth_t + c_4 * Asset\ growth_t + c_5 * Debt\ to\ assets_t + e$$

Independent variable	Parameter estimate	p-value*
Intercept	-14.69168	0.0001
ln(Total pay_t)	8.03439	0.0001
ln(Total pay_{t-1})	-5.39719	0.0001
$PeerROA_t$	0.23758	0.0001
ROA_{t-1}	0.54574	0.0001
$PeerROA_{t-1}$	0.00570	0.8944
Stock holdings/total pay_t	0.00280	0.0094
Option holdings/total pay_t	0.00053	0.0008
Sales $growth_t$	0.00074	0.8436
Asset $growth_t$	-0.00755	0.0748
Debt to $assets_t$	-0.06026	0.0001
number of observations = 5,335, adjusted R^2 = 0.3322		

*p-values are for one-tailed tests where a predicted sign is given

Table 3
Results of two-stage least squares estimation of system of equations relating total compensation to RET and PeerRET

Equation 1

$$ln(Total\ pay_t) = \alpha_1 + \beta_1 * ln(Total\ pay_{t-1}) + \beta_2 * RET_t + \beta_3 * PeerRET_t + \gamma_1 * Stock\ holdings/total\ pay_t + \gamma_2 * Option\ holdings/total\ pay_t + \gamma_3 * ln(Sales_t) + \varepsilon$$

Independent variable	Parameter estimate	p-value*
Intercept	1.50687	0.0001
$ln(Total\ pay_{t-1})$	0.65272	0.0001
RET_t	0.00739	0.0013
$PeerRET_t$	-0.00015	0.0450
$Stock\ holdings/total\ pay_t$	-0.00030	0.0004
$Option\ holdings/total\ pay_t$	-0.00003	0.0134
$ln(Sales_t)$	0.12933	0.0002
number of observations =5373, adjusted R^2 = 0.5679		

*p-values are for one-tailed tests where a predicted sign is given

Equation 2

$$RET_t = a_1 + b_1 * ln(Total\ pay_t) + b_2 * ln(Total\ pay_{t-1}) + b_3 * PeerRET_t + c_1 * Stock\ holdings/total\ pay_t + c_2 * Option\ holdings/total\ pay_t + c_3 * Volatility_t + c_4 * Debt\ to\ assets_t + e$$

Independent variable	Parameter estimate	p-value*
Intercept	-0.78111	0.9376
$ln(Total\ pay_t)$	11.63690	0.0001
$ln(Total\ pay_{t-1})$	-9.35404	0.0045
$PeerRET_t$	0.02131	0.0029
$Stock\ holdings/total\ pay_t$	0.01120	0.0892
$Option\ holdings/total\ pay_t$	0.00161	0.0992
$Volatility_t$	12.97608	0.0062
$Debt\ to\ Assets_t$	-0.15089	0.0001
number of observations =5373, adjusted R^2 = 0.0084		

*p-values are for one-tailed tests where a predicted sign is given

Table 4
Results of OLS estimation of the
reduced form specification of the ROA model

$$ln(Total\ pay_t) = \alpha + (\beta_1 + \beta_2 b_2)/(1- \beta_2 b_1)*ln(Total\ pay_{t-1}) + (\beta_2 b_3 + \beta_3)/(1- \beta_2 b_1)* PeerROA_t + (\beta_2 b_4 + \beta_4)/(1- \beta_2 b_1)* ROA_{t-1} + (\beta_2 b_5 + \beta_5)/(1- \beta_2 b_1)* PeerROA_{t-1} + (\beta_2 c_1 + \gamma_1)/(1- \beta_2 b_1)* Stock\ holdings/total\ pay_t + (\beta_2 c_2 + \gamma_2)/(1- \beta_2 b_1)* Option\ holdings/total\ pay_t + \gamma_3/(1- \beta_2 b_1)* ln(Sales_t) + \beta_2 c_3/(1- \beta_2 b_1)* Sales\ growth_t + \beta_2 c_4/(1- \beta_2 b_1)* Asset\ growth_t + \beta_2 c_5/(1- \beta_2 b_1)* Debt\ to\ assets_t + \mu$$

Independent variable	Parameter estimate	p-value*
Intercept	1.70111	0.0001
$ln(Total\ pay_{t-1})$	0.62807	0.0001
$PeerROA_t$	0.00086	0.7630
ROA_{t-1}	-0.00131	0.1102
$PeerROA_{t-1}$	-0.01666	0.0001
$Stock\ holdings/total\ pay_t$	-0.00024	0.0006
$Option\ holdings/total\ pay_t$	-0.00002	0.0504
$ln(Sales_t)$	0.14413	0.0001
$Sales\ growth_t$	0.00118	0.0001
$Asset\ growth_t$	0.00173	0.0001
$Debt\ to\ Assets_t$	0.00018	0.6737
number of observations =5335, adjusted R^2 = 0.6421		

*p-values are for one-tailed tests where a predicted sign is given

Table 5
Results of OLS estimation of the
reduced form specification of the RET model

$$ln(Total\ pay_t) = \alpha + (\beta_1 + \beta_2 b_2)/(1-\beta_2 b_1)*ln(Total\ pay_{t-1}) + (\beta_2 b_3 + \beta_3)/(1-\beta_2 b_1)*PeerRET_t + (\beta_2 c_1 + \gamma_1)/(1-\beta_2 b_1)*Stock\ holdings/total\ pay_t + (\beta_2 c_2 + \gamma_2)/(1-\beta_2 b_1)*Option\ holdings/total\ pay_t + \gamma_3/(1-\beta_2 b_1)*ln(Sales_t) + \beta_2 c_3/(1-\beta_2 b_1)*Volatility_t + \beta_2 c_4/(1-\beta_2 b_1)*Debt\ to\ assets_t + \mu$$

Independent variable	Parameter estimate	p-value*
Intercept	1.49568	0.0001
$ln(Total\ pay_{t-1})$	0.63161	0.0001
$PeerRET_t$	0.00002	0.7692
$Stock\ holdings/total\ pay_t$	-0.00023	0.0010
$Option\ holdings/total\ pay_t$	-0.00002	0.0450
$ln(Sales_t)$	0.14651	0.0001
$Volatility_t$	0.34855	0.0001
$Debt\ to\ assets_t$	0.00005	0.8951
number of observations = 5373, adjusted R^2 = 0.6233		

*p-values are for one-tailed tests where a predicted sign is given