Exchange Rate Risk and Relative Performance Evaluation

by

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ABSTRACT

The relative performance evaluation (RPE) hypothesis holds that executive compensation should not depend on uncontrollable exogenous shocks. Nevertheless, prior studies often find limited empirical support for this hypothesis in part because it is difficult to identify peers exposed to the same exogenous shocks. I propose a new way to identify peers and to test the RPE hypothesis in the context of a specific shock. In particular, I select peers based on the sensitivity of their stock returns to exchange rate fluctuations. I find evidence that firms respond to large exchange rate movements by ex post adjusting their peer selection to include peers with similar exchange rate risk exposure. Moreover, after allowing for ex post peer group adjustments, I find a much stronger support for the RPE hypothesis than most of prior work.

DEDICATION

In memory of my beloved father

Guangxi Chen

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1. INTRODUCTION

Setting Chief Executive Officer (CEO) compensation is one of the most important issues for firms. Paying for performance is crucial to mitigate agency cost, and this is especially important for CEOs whose unobservable efforts and actions can significantly affect the distribution of firm performance. However, it is difficult to accurately measure the degree of firm performance for which CEOs are responsible. Firm performance is associated with both CEO decisions and exogenous shocks that are outside of CEO's control. It is well understood that firms should not reward or punish CEOs for performance reflecting exogenous shocks because it will be wasteful and costly. Greater uncertainty in CEO compensation necessitates a greater risk premium for the additional compensation risk (Holmstrom, 1979).

A large stream of literature examines how exogenous shocks can be filtered out from executive compensation. The relative performance evaluation (RPE) hypothesis implies that this can be achieved by making compensation contingent on peer performance (Holmstrom, 1982; Holmstrom and Milgrom, 1987). Despite the theoretical appeal of this hypothesis, prior studies do not find consistent empirical evidence to support it (Murphy, 1999; Abowd and Kaplan, 1999; Prendergast, 1999). An important difference among the empirical studies of testing RPE is the selection of peer firms. Some use firms covered by the stock market index (Garvey and Milbourn, 2003), others choose firms in the same industry (Aggarwal and Samwick, 1999a; Antle and Smith, 1986), and still others select firms in the same geographic region

(Barro and Barro, 1990). Clearly, the choice of peers determines the extent to which exogenous shocks can be filtered out and critically affects tests of the RPE hypothesis. At the same time, it is practically difficult to consider all relevant dimensions, such as industry, size, growth, diversification, and financial constraints, that affect the capacity of a peer group to filter out common shocks. Thus, one possible explanation for the failure to get consistent empirical results to support RPE is that prior studies do not identify the appropriate peer group.

Albuquerque (2009) contributes to the literature by showing that peer selection based on both industry and frim size captures many of the important dimensions of risk exposure. Gong et al. (2011) corroborate this finding using data on compensation benchmarking peers from proxy statement disclosures. Nevertheless, two important issues remain unaddressed. First, all prior studies assume that peers are selected ex ante, which is inconsistent with the theory predicting that firms should use all information available to ex post filter out exogenous shocks. In particular, major macroeconomic shocks cannot be predicted and ex ante selected peers may not be effective in the presence of some specific shocks. Second, the testing power of most existing studies is low because they cannot measure the magnitude of exogenous shocks and identify sub-samples where the effect of RPE should be most pronounced.[1]

[1] There are two necessary conditions for firms to apply for RPE to filter out the effect of exogenous shocks on firm performance: (1) there are exogenous shocks; and (2) the exogenous shocks have effect on performance of firms included in the sample. Some firms may only suffer from some specific types of shocks, such as exchange rate shock or oil price shock, while are insensitive to other shocks. Most studies test RPE generally in the context of overall external shocks across all time periods for all firms.

In this paper, I test RPE in the context of a specific macroeconomic shock.[2] With the growth of global economy, the US firms strengthen their connections to international market. The exchange rate volatility can affect firm performance (Itagaki, 1981; Dominguez and Tesar, 2006), and cause different exposures to exchange rate risk (Allayannis and Ofek, 2001). Clearly, firms with divisions abroad or with significant transactions in foreign countries are directly exposed to exchange rate fluctuations. However, even firms with no significant international transactions are exposed indirectly as long as they compete against international firms for US market share. I predict that exposure to exchange rate risk is a criterion in identifying peers and that this criterion is more important for peer selection when large exchange rate movements actually occurred. My empirical analyses examine whether firms select peers ex ante, as assumed in all prior work, or whether they adjust their peer selection ex post, depending on the magnitude of exchange rate movements. Moreover, my research design also allows me to increase testing power by excluding firm-year observations with little or no exposure to exchange rate movements.

Specifically, I first regress firm stock return on the return of dollar index to compute the sensitivity (exposure) of each firm to exchange rate risk, and then calculate the stock return of peers with similar exposure to exchange rate risk. To test for RPE, I

Under this condition, we cannot distinguish observations for which there are shocks and firms suffer from these shocks from other observations.

[2] I mainly focus on exchange rate risk although I also present additional analyses that pertain to oil price and interest rate risk.

use three ways to select firm-year observations exposed to large exchange rate movements. The first sub-sample only includes observations during the time periods within which the fluctuation of dollar index is large; the second sub-sample only consists of firms in industries that are most sensitive to the fluctuation of dollar index; the third sub-sample only comprises observations in the overlap of the first and second sub-samples.

Using peers with similar exposure to exchange rate risk, I find strong support for the RPE hypothesis using both aggregate and firm-specific regressions. I also show that performance of peers with similar exposure to exchange rate risk is significantly more effective in filtering out shocks in the sub-samples where large exchange rate movements actually occurred. This implies that firms adjust peer selection ex post after exchange rate shock happened. In additional analyses, I find similar results for oil price risk, but no significant results for interest rate risk.

This paper contributes to the literature in three ways. First, it provides evidence that exposure to a specific macroeconomic shock is an important criterion in selecting peers. Second, this paper shows that firms adjust peer selection for optimal risk sharing purposes whenever large macroeconomic shocks occur. This finding casts doubt on the common assumption in prior work that peers are selected ex ante and/or that peer selection remains largely constant over time. Third, this paper introduces a new research design that considerably increases the statistical power when testing the RPE hypothesis.

The rest of this paper is organized as follows: section 2 reviews prior literature and states hypotheses, section 3 discusses the research design, section 4 presents the empirical results, section 5 considers extensions to oil price and interest rate risk, and section 6 concludes.

2. LITERATURE AND HYPOTHESES

2.1. Theoretical Background

There is a moral hazard problem in setting CEO compensation contract because CEOs' unobservable efforts and actions can significantly affect the distribution of firm performance. Holmstrom (1979) shows that the CEO compensation contract can be improved by including any ex post available information signal even if it is only imperfectly reflective of the CEO's actions. Based on this theory, the hypothesis of relative performance evaluation (RPE) argues that firms can filter out the effect of exogenous shocks by making compensation contingent on the performance of peer firms (Holmstrom, 1982; Holmstrom and Milgrom, 1987).

Several studies caution that the RPE argument only holds in the absence of strategic interaction among peer firms (Vrettos, 2013; Aggarwal and Samwick, 1999; Fumas, 1992), e.g., in the absence of collusion among peers. Also, RPE may give rise to excessive risk taking if the CEO anticipates that exogenous risks will always be fully filtered out. For example, RPE may reduce incentives to engage in hedging activities, to purchase insurance, or to exercise prudence when entering risky foreign countries.

2.2. Literature Review

Many empirical studies examine whether firms use RPE to filter out the effects of external shocks on firm performance. The results of exiting empirical studies are mixed. Some find evidence to support RPE, while others fail to do so.

Aggarwal and Samwick (1999a) identify peer firms as those in the same industry and find evidence to support RPE in compensation level analyses, but not in the change in compensation level analyses. Garvey and Milbourn (2003) find evidence to support RPE for firms with younger and less wealthy managers, but the results do not support RPE for average firms. Antle and Smith (1986) identify peer firms as those in the same industry and use stock return to measure firm performance, and they find that only 16 out of 39 firms support RPE. The results of Gibbons and Murphy (1990) support RPE when firm performance is measured by stock return. With the same sample of Gibbons and Murphy (1990) but different measures of compensation and performance, Jensen and Murphy (1990) do not find evidence to support RPE. The results of Janakiraman et al. (1992) support RPE when peer firms are identified as those in the same industry and firm performance is measured by stock return. Barro and Barro (1990) do not find evidence to support RPE with peer firm identification of the US largest commercial banks within the same geographical region. Bertrand and Mullainathan (2001) find that CEOs are paid for luck when peer firms are identified by industry, and this is more likely for poorly governed firms.

One main difference among the above studies is the criterion to choose peer firms,

and it is also the big challenge to implement (Gibbons and Murphy, 1990; Baker, 2002) or test (Parrino, 1997) RPE. The most popular and easy way is to use stock market index or firms in the same industry as peer firms, assuming that they have similar exposure to exogenous shocks. However, there are many aspects that are related with similar exposure, such as the cost to respond to shocks (Thomas, 1990), the financial and borrowing credit constraint (Fazzari et al., 1988 and Gertler and Gilchrist, 1994), the degree of diversification (Kogut and Kulatilaka, 1994), the operating leverage, and the growth options. There are two problems if we include all these characteristics in selecting peer firms. First, it is hard to accurately measure some characteristics, such as the cost to respond to shocks and the growth option. Second, we will identify too few peer firms if we consider all these characteristics, and this will cause very noisy results in filtering out external shocks.

Even though these characteristics capture different aspects of firms, they are dependent on each other. They are all related to firm size (Albuquerque, 2009). Small firms tend to have lower diversification, larger financial and borrowing credit constraints, and smaller operating leverage. Albuquerque (2009) implicitly shows that firm size is monotonically associated with these firm characteristics and is a good indicator to identify peer firms in testing RPE. In addition, Gong et al. (2011) explicitly shows that firms actually select firms in the same industry and same firm size quartile as peers.

Albuquerque (2009) contributes to the literature by showing that peer firms should be

identified by both industry and firm size and that different peer selection criterion may explain the prior inconsistent results in testing RPE. However, the industry-size criterion is not the only criterion to choose peers and cannot rule out other possible peer selection criteria. In addition, it is unclear whether firms adjust peer selection ex post after one macroeconomic shock happened.

The above studies test RPE implicitly by determining peers ex ante with one uniform rule, such as in the same industry or in the same industry and same firm size quartile. Other studies test RPE explicitly by analyzing the actual selected peers released in firm proxy statements (Gong et al., 2011). Even for these actual selected peers, they are chosen ex ante. Black et al. (2012) argue that firms may use peers which are not disclosed in their proxy statements. It is difficult for firms to predict macroeconomic shocks before peer selection released in firm proxy statements. However, firms have intention to adjust peer selection ex post after one specific macroeconomic shock occurred. Very few existing studies find evidence to support this argument.

There is another branch of literature that explains why RPE does not hold in empirical tests. One possible reason is the peer selection issue (Albuquerque, 2009). The other potential reason is firm's ability to find peers. Albuquerque (2014) argues that high growth firms do not use RPE to filter out the effects of exogenous shocks because each of them has some unique characteristics and thus it is difficult to find appropriate peers.

2.3. Hypotheses

To solve the moral hazard problem in setting CEO compensation, firms need to filter out the effect of exogenous shocks on firm performance by the performance of peer firms. The desirable peers should have similar exposure to and ability to deal with exogenous shocks, and the peer selection determines the extent to which the effect of exogenous shocks can be filtered out. Ideal peer firms should be similar in several aspects, such as industry, size, diversification, financial constraints, etc., and Albuquerque (2009) shows that industry and size can seize most of these aspects. Based on the results of Albuquerque (2009), I propose the following hypothesis:

H1: There is a negative relation between CEO compensation and performance of industry peers with similar size.

However, the industry-size criterion cannot rule out other possible peer selection criteria. Another way to generate peer firms is to calculate the effect of a specific macroeconomic shock on firm performance and then identify firms with similar exposure to that shock as peers. An important criterion to choose peer firms could be similar exposure to exchange rate shock. The US firms are more likely to connect to international market either directly or indirectly with the growth of global economy. The exchange rate volatility can affect firm performance (Itagaki, 1981; Dominguez and Tesar, 2006). This leads to the next hypothesis.

H2: There is a negative relation between CEO compensation and performance of peers with similar exposure to exchange rate risk.

Most existing studies test RPE in the context that peers are selected ex ante. Even for the actual selected peers released in firm proxy statements, they are chosen ex ante. However, the theoretical foundation of RPE (Holmstrom 1979) argues that firms should choose peers ex post. Firms could adjust peer selection ex post when exchange rate shock occurred, and the new included peer firms should have similar exposure to the exchange rate shock. Since it is difficult to predict exchange rate shock, firms cannot identify the desirable peers in advance. If they want to apply for RPE, they have to adjust peer selection ex post. In addition, this type of peer adjustment is for effective risk sharing, while not for self-service to justify high CEO payment. This motivates my last hypothesis.

H3: The relationship in H2 will be stronger when the fluctuation of exchange rate is high.

3. RESEARCH DESIGN

3.1. Data and Sample Selection

I get CEO compensation data from the ExecuComp dataset, financial measures from the Compustat dataset, monthly stock returns from the Center for Research in Security Price (CRSP), inflation measure from the CRSP-US Treasure and Inflation Indexes, dollar index (Trade Weighted U.S. Dollar Index: Broad – TWEXB, end of period monthly) from the Federal Reserve Bank of St. Louis, crude oil monthly price from the website of Index Mundi (it is a “simple average of three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh, US Dollars per Barrel”), and one year

bond index from CRSP-US Treasury and Inflation Indexes.

The time period is from Jan. 1995, when dollar index data are available, to Dec. 2015. I only include observations covered by both CRSP and ExecuComp with valid values for all variables. Small firms whose total asset is less than 10M and firms with less than 10 years observations are excluded. Table 1 shows the details of sample selection process. Finally, 20,830 observations with 1334 firms are included in the sample.

3.2. Variables

The dependent variable $(CEOPay_{it})$ is the natural log of inflation adjusted total CEO annual compensation in Jan. 1992 dollar. Stock return is used to measure firm and peer performance. The firm stock return is computed by $log\left(\frac{1+annual\ stock\ return/100}{1+annual\ inflation\ rate\ calculated\ by\ CPI}\right)$. For the calculation of one key independent variable---industry-size peer return $(PeerRetIS_{it})$, I just follow the process of Albuquerque (2009). First, I merge CRSP and Compustat and exclude small firms whose total asset is less than 10M. I then calculate the quartile of firm market value at the beginning of the year based on all firms in the merged dataset for each year. Under this design, the relative peer firms will be included even though they may not be covered by ExecuComp. For each firm, the industry-size peer stock return is calculated by the equal-weight average of stock returns of the peer firms that are in the same industry (two-digits SIC) and same firm size (firm market value at the beginning of the year) quartile in that year, excluding the firm itself. If the number of peer firms is less than two, the industry-size peer stock return is calculated by the

industry average.

To calculate the other key independent variable---stock return of peers with similar exposure to exchange rate risk ($PeerRetEX_{it}$), I first run the regression, for each firm, of real firm stock return on real dollar index return in the annual level across different years. Only firms with at least 10 observations are kept in the sample. The estimated coefficient is a measure of the firm's sensitivity to exchange rate risk. Then, I rank the coefficients in the order of scale into 7 groups. Firms in the same group have similar exposure to exchange rate risk. The stock return of peers with similar exposure to exchange rate risk is computed by the average of annual stock returns of peers, in the same exchange rate exposure group and same year, that are calculated at the end of each peer's fiscal year, excluding the firm itself. The stock returns of peers with similar exposure to other risks are computed in the same way.

According to prior literature, the following control variables are also included in the regressions: firm size measured by the natural log of sales, growth options measured by the ratio of the firm market value to the book value of assets at the beginning of a year, CEO tenure measured by the natural log of the length of time period of being CEO[3], idiosyncratic variance measured by the difference between the variance of firm stock return and the variance of industry stock return over the past 35 months, CEO chair dummy (whether the CEO is also the board chair), CEO ownership dummy (whether the CEO ownership share is smaller than the sample median in the year),

[3] If the length of time period of being CEO is less than one year, the observation is excluded.

and interlock dummy (whether the CEO is involved in the interlock relationship that asks disclosure in the proxy statement).

The variables of CEO compensation and stock return of peers with similar exposure to exchange rate risk are winsorized at the top and bottom 1 percent.[4] Table 2 shows the descriptive statistics. The variables have similar mean values as the ones in Albuquerque (2009), expect for the interlock dummy variable whose mean is smaller.

3.3 Selection of Specific Shocks

The purpose of this paper is not to find an effective way to select peers that can filter out exogenous shocks. I try to find an easy way to select peers under one specific macroeconomic shock. Thus, the selection of specific macroeconomic shock is a crucial part of the research design. A desirable specific shock for RPE testing should meet three criteria. First, it should be possible to measure its effect on firm performance and identify when and for which firms it affects. Second, it should have a substantial effect on firm performance so that firms are motivated to use RPE to filter out the shock. Third, it should have different effects on different firms so that peer selection becomes a non-trivial issue.

I select exchange rate (main test), oil price, and interest rate shocks for the RPE testing in this paper. Intuitively, these are common and significant specific shocks that firms are facing. Since we have observed measures for exchange rate, interest rate, and oil price, and we can calculate their effects on firm performance, the first criterion

[4] Since Albuquerque (2009) does not winsorize any variable, I only winsorize these two variables to make the results comparable with the ones in Albuquerque (2009).

is met. Even though, intuitively, those shocks also meet the second criterion, I quantitatively show their effects on firm performance in table 3.

The top section of panel A in table 3 shows the mean real monthly returns of dollar index, interest rate index, oil price index, and S&P500 index and their standard deviations in the period from Jan. 1992 to Dec. 2015.

In the aggregate level analysis, I regress real monthly firm return on real monthly return of each index.

$$FirmRet_{it} = \alpha_0 + \alpha_1 IndexRet_{it} + \epsilon_{it} \quad (1)$$

where $\hat{\alpha}_1$ is the index elasticity of stock price. It measures the percentage change of stock price for 1% change of the index. The results are shown in the middle section of panel A in table 3. The minimum absolute value of elasticity is 0.09 for oil price index, which is roughly 10% of the S&P 500 index elasticity (1.02). Since the volatility of each index may be quiet different, I also calculate the absolute value of the product of each elasticity and the standard deviation of monthly return for each index, which measures the effect on firm return for the change of one standard deviation. The minimum value (0.0037 for dollar index) is roughly 10% of the value for S&P 500 index (0.0426).

Since some firms respond positively, while other firms respond negatively, to the change in the index, some effects are cancelled out in the aggregate level analysis. To solve this problem, I run regression (1) for each firm, and then calculate the mean absolute value of elasticity across firms. The results are reported in the bottom section

of panel A in table 3. The minimum value of the product of the elasticity and standard deviation (0.0218 for dollar index) is roughly 40% of the value for S&P 500 index. The above results show that the selected shocks have significant effects on firm performance. In addition, the big difference between the aggregate level and firm level analysis indicates that these three shocks affect some firms positively and others negatively. This provides some support for the third criterion.

Panel B in table 3 shows the result of sensitivity analysis for some major world currencies. Some sensitivities are larger than the sensitivity to dollar index, while others are smaller. To capture the overall effect, I use dollar index for the analysis in this paper.

3.4. Models

Based on the model in Albuquerque (2009), the following model (2) is used to test H1.

$$CEOPay_{it} = C_0 + \alpha_1 FirmRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 ControlVariables_{it} + \epsilon_{it} \quad (2)$$

where CEOPay is the natural log of inflation adjusted total CEO annual compensation in Jan. 1992 dollar; FirmRet is real firm stock return; and PeerRetIS is real stock return of peers in the same industry and size quartile, excluding the firm itself. If H1 is true, we expect $\alpha_2 < 0$. It means that firms use industry-size peer performance to filter out external shocks.

H2 is tested by model (3).

$$CEOPay_{it} = C_0 + \alpha_1 FirmRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 PeerRetEX_{it} + \alpha_4 ControlVariables_{it} + \epsilon_{it} \quad (3)$$

PeerRetEX is real stock return of peers in the same exchange rate risk exposure group, excluding the firm itself. If H2 is supported, then $\alpha_3 < 0$. It indicates that performance of peers with similar exposure to exchange rate risk has incremental power to filter out the effect of external shocks. This test is conservative because some peers with similar exposure to exchange rate risk are already included in the industry-size peer group. To mitigate this effect, I also run model (3) without industry-size peer performance.

To test H3, I run model (3) with three sub-samples under which the effect of exchange rate risk is larger. The first sub-sample only includes observations during the time periods within which the fluctuation of dollar index is large; the second sub-sample only consists of firms in industries that are most sensitive to the fluctuation of dollar index; the third sub-sample only comprises observations in the overlap of the first and second sub-samples. Additional, I also run the full-sample regression with sub-sample indicator.

4. EMPIRICAL RESULTS

4.1. Full Sample Analysis

Table 4 shows the regression results for the full sample. The dependent variable is the CEO total compensation. Consistent with Albuquerque (2009), the estimated coefficient of industry-size peer return is significantly negative at 1% level in model

(1). This provides support for H1. The estimated coefficient of stock return of peers with similar exposure to exchange rate risk is also significantly negative at 10% level in model (2) and (3). Thus, performance of peers with similar exposure to exchange rate risk has incremental power to filter out the effect of external shocks in the general RPE testing. H2 is supported. In this sense, this paper finds another significant dimension in identifying right peers in the general RPE testing.[5]

4.2. Sub-sample Analysis

In this section, I test H3 using sub-samples with which the effect of exchange rate risk is more salient. I generate three sub-samples: the variance sub-sample only includes observations in the time periods when the volatility of dollar index is high (the variance of dollar index across the past 12 months is larger than 5); the industry sub-sample only includes observations in the industries that are most sensitive to the change of dollar index (top 36 industries); the variance-industry sub-sample only includes observations in both of the above two sub-samples.

The results are shown in table 5. There are three interesting findings in this table. First, for the variance and variance-industry sub-samples, both the magnitude and significance level of the estimated coefficient for the exchange rate peers increase, compared with the result in the full sample. Even though the significance level does not increase, the magnitude is larger in the industry sub-samples. It indicates that

[5] In alternative specifications (untabulated), I use return on equity (ROE) instead of stock return in my analyses. Similar to prior studies, I find no supportive evidence for RPE using accounting returns. I also use salary, bonus, and equity compensations as alternative measures of the dependent variable but find little supportive evidence for RPE (untabulated).

firms adjust CEO compensation ex post when the exchange rate risk is high. Thus, H3 is supported. Additional, this result shows that the testing power of the model becomes stronger in the sub-samples after I exclude the noisy observations. Second, the estimated coefficient for industry-size peers becomes smaller and insignificant in the industry and variance-industry sub-samples, compared with the result in the full sample. Its significance level in the variance sub-sample also decreases. Third, the estimated coefficient for exchange rate peers is larger than the estimated coefficient for industry-size peers for all the sub-samples. These results indicate that firms use the performance of peers with similar exposure to exchange rate risk, while not industry-size peers, to filter out the effect of exchange rate risk when the exchange rate shock occurred. More generally, we can argue that firms may use different criteria to identify peers to filter out the effect of different shocks. The results for oil price shock and interest rate shock also provide some supports to this argument.

The last column in table 5 shows the regression results for the full sample with an indicator variable for the variance-industry sub-sample and an interaction variable that is the product of that indicator variable and the stock return of peers with similar exposure to exchange rate risk. Consistent with the above results, the estimated coefficient of the interaction is significantly negative.

As a robustness check, I also do the similar analysis for the case that the dependent variable is the change in CEO total compensation, which captures the variable part of CEO compensation. Table 6 presents the result. The results are consistent with the

ones in table 5. Thus, H3 is also supported under this condition.

4.3. Firm Specific Analysis

For the regressions in table 5, the data are pooled time-series and cross-sectional, and then the model assumes that the estimated RPE coefficient is constant across different firms. However, the RPE coefficient can be different for different firms. To release this constrain, I run firm-specific regressions for each firm. In these regressions, only the constant, firm performance, and peer performance are included as independent variables. The mean and median of estimated coefficients are reported in table 7. The t-statistics for the test that the mean of estimated coefficient is equal to zero are also reported.

Panel A shows the results when only one single peer return is included in the regression. Consistent with the results in table 4, the mean estimated RPE coefficient is significantly negative when peer performance is measured by the industry-size peer stock return and exchange rate peer stock return. This indicates that the exchange rate peer stock return is a good candidate to filter out external shocks. Thus, H2 is also supported by the firm specific analysis.

Panel B exhibits the results when both peer returns are included in the regression. The mean estimated RPE coefficient is significantly negative when peer performance is measured by the exchange rate peer stock return, but is insignificant and positive when peer performance is measured by the industry-size peer stock return. This shows that the effect of shocks is more likely to be filtered out by the performance of

exchange rate peer firms than by the performance of industry-size peer firms.

5. EXTENSION TO OTHER SHOCKS

If the arguments that firms adjust peer selection ex post after one specific macroeconomic shock happened and that the RPE testing power will increase if we exclude the noisy observations from the sample are true, we should observe similar results for the analyses of other specific shocks. With the same procedure, I analyze for oil price shock and interest rate shock in this section.

5.1. Oil Price Shock

Table 8 presents the results for oil price shock. I argue that firms would like to use the performance of peers with similar exposure to oil price risk to filter out the effect of oil price shock ex post, and this result is more likely to be supported in the sub-sample without noisy observations. The results are consistent with my arguments.

The variance sub-sample only includes observations in the time periods when the volatility of oil price is high (the variance of oil price across the past 12 months is larger than 20); the industry sub-sample only includes observations in the industries which are most sensitive to the change of oil price (top 36 industries).

For the full sample, the estimated coefficient for oil price peers is not significant, even though it is negative. But, it becomes significantly negative, and the magnitude is much larger, in the variance and variance-industry sub-samples. Interestingly, the estimated coefficient for industry-size peers becomes insignificant in the variance and variance-industry sub-samples. These results show that firms are like to use the

performance of peers with similar exposure to oil price risk to filter out the effect of oil price shock.

5.2. Interest Rate Shock

Table 9 shows the results for interest rate shock. The variance sub-sample only includes observations in the time periods when the volatility of interest rate index is high (the variance of interest rate index across the past 12 months is larger than 30); the industry sub-sample only includes observations in the industries that are most sensitive to the change of interest rate index (top 36 industries).

The results are consistent with my general argument, but not significant. The estimated coefficients for interest rate peers in the industry and variance-industry sub-samples are larger than that in the full sample, but not significant. A potential reason for insignificant results is that interest rate risk is more predictable and/or well hedged by firms, then firms do not need to apply for RPE to filter out its effect on firm performance.

6. CONCLUSION

This paper tests RPE in the context of one specific macroeconomic shock. Under this condition, we can have an easier way to identify peers---firms having similar exposure to the macroeconomic shock, and we can test whether firms adjust peer selection ex post after one macro shock occurred. Additional, the model's testing power will be higher because we can exclude noisy observations for the specific macroeconomic shock.

This paper has three main findings. First, I find another significant dimension in identifying right peers---similar exposure to exchange rate risk. It has some incremental power to filter out the effect of external shocks in the general RPE testing, based on the model in Albuquerque (2009). Second, firms adjust peer selection ex post after one macroeconomic shock happened. Most prior studies select peers ex ante in a somewhat arbitrary way. Even for those actual peers released in firm proxy statements, they are chosen ex ante. However, firms may adjust peer selection ex post after one macro shock occurred, using peers with similar exposure to that shock. The results in this paper support this argument. Third, firms may use different criteria to identify peers to filter out the effect of different shocks. In addition, the research design in this paper increases the RPE testing power because the models exclude noisy observations.

There are also some limitations in this paper. First, since it is very hard to find a suitable measure of firms' hedging for macroeconomic shocks, I do not analyze the case that firms actively hedge macroeconomic shocks. Second, only three macroeconomic shocks are discussed in this paper. More analyses for other macroeconomic shocks, such as employment, consumer confidence, et., are left for future research.

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APPENDIX A

VARIABLES DEFINITION

CEOPay: the natural log of inflation adjusted total CEO annual compensation in Jan. 1992 dollar.
ChgCEOPay: the change in natural log of inflation adjusted total CEO annual compensation in Jan. 1992 dollar.
Firm Ret: real firm stock return calculated by $log\left(\frac{1+annual\ stock\ return/100}{1+annual\ inflation\ rate\ calculated\ by\ CPI}\right)$.
PeerRetIS: real stock return of peers in the same industry and size quartile, excluding the firm itself.
PeerRetEX: real stock return of peers in the same exchange rate risk exposure group, excluding the firm itself.
PeerRetOP: real stock return of peers in the same oil price risk exposure group, excluding the firm itself.
PeerRetIN: real stock return of peers in the same interest rate risk exposure group, excluding the firm itself.
Indicator: whether in the var- industry sub-sample.
Interaction: PeerRetEX (PeerRetOP, PeerRetIN) ×Sub-sample (var- industry) indicator.
Ln (Sale): the natural log of inflation adjusted sale in Jan. 1992 dollar at the beginning of fiscal year.
GrowOption: the ratio of market value to total asset at the beginning of fiscal year. The market value is calculated by "total asset – book value of equity + market value of equity", and the market value of equity is calculated by the product of the number of outstanding shares and the closed stock price.
CeoTenure: the number of years since the CEO takes office.
IndVar: idiosyncratic variance calculated by the variance difference between the firm stock return and the average industry stock return over the past 35 months.
ChairD: a dummy variable to indicate whether the CEO is also the board chair
CeoEquityOwnD: a dummy variable to indicate whether the percentage share ownership of the CEO is less than the median in that year. The percentage share ownership of the CEO is computed by the ratio of the number of shares owned by the CEO and the number of total outstanding shares.
InterlockD: a dummy variable to indicate whether the CEO is listed in the compensation committee.

APPENDIX B

TABLES

Table 1: Sample Selection

	Num. of obs.
Obs. From Compustat	233,868
-neither coverd by CRSP nor have valid stock return	77,302
-total asset less than 10M	33,709
-not covered by ExecuComp	85,082
-negative CEO compensation, sale, market value, equity	6,040
-missing values for independent variables	998
-firms with less than 10 years observations	9,907
Final sample	20,830

This table shows the sample selection process.

Table 2: Description Statistics

	No. of obs.	Mean	Std. dev.	Min	Max
Ln (CEO Compensation)	20,830	7.684451	1.009566	5.36144	10.0208
FirmRet	20,830	0.0609877	0.4198664	-3.2193	3.34937
PeerRetIS	20,825	0.0797373	0.2846554	-1.8401	2.09826
PeerRetEX	20,830	0.1326293	0.1812927	-0.5687	0.61349
Ln (Sale)	20,830	7.081909	1.601076	-2.7646	12.5431
GrowOption	20,830	1.945952	1.811247	0.40065	105.09
CeoTenure	20,830	8.864378	7.716551	1	61.789
IndVar	20,830	0.0119997	0.0826528	-0.0221	6.28942
ChairD	20,830	0.6277004	0.4834292	0	1
CeoEquityOwnD	20,830	0.5259241	0.4993395	0	1
InterlockD	20,830	0.0422468	0.2011564	0	1

This table shows the statistics of all variables.

The variables are defined in the Appendix.

Table 3: Sensitivity Measurement

Panel A: Macro Shocks				
	Dollar return	Interest rate return	Oil price return	SP 500 return
Mean of monthly return	-0.0007	0.0009	0.0007	0.0036
Std. dev. of monthly return	0.0154	0.0045	0.0785	0.0419
No. of obs.	252	288	288	288
Aggregate Level				
Elasticity	-0.2375	-1.9087	0.0904	1.0161
Abs(Elasticity*S.D.)	0.0037	0.0086	0.0071	0.0426
No. of obs.	1,551,942	1,799,101	1,799,101	1,799,101
Firm Level				
Elasticity (absolute value)	1.4159	6.3099	0.3141	1.1496
Abs(Elasticity*S.D.)	0.0218	0.0284	0.0247	0.0482
No. of firms	15,757	17,115	17,115	17,115

Table 3: Sensitivity Measurement

Panel B: Specific Currency					
	Euro return	CNY return	GBP return	JPY return	CHF return
Mean of monthly return	-0.0015	-0.0013	-0.0012	-0.0021	-0.003
Std. dev. of monthly return	0.0257	0.0246	0.0229	0.0261	0.0269
No. of obs.	203	288	288	288	288
Aggregate Level					
Elasticity	-0.5446	0.1009	-0.2671	0.1031	-0.0605
Abs(Elasticity*S.D.)	0.0140	0.0025	0.0061	0.0027	0.0016
No. of obs.	1,160,781	1,799,101	1,799,101	1,799,101	1,799,101
Firm Level					
Elasticity (absolute value)	1.0278	4.1935	0.9669	0.7347	0.7257
Abs(Elasticity*S.D.)	0.0264	0.1032	0.0221	0.0192	0.0195
No. of firms	12,559	17,115	17,115	17,115	17,115

This table shows the sensitivity of each macro index or currency.

Mena of monthly return: the average monthly return of each macro index or currency.

Std. dev. of monthly return: the standard deviation of monthly return of each macro index or currency in the sample.

Elasticity: the estimated coefficient $(\hat{\alpha}_1)$of the regression

$$FrimRet_{it} = \alpha_0 + \alpha_1 IndexRet_{it} + \epsilon_{it}$$

CNY: Chinese Yuan, GBP: British Pound, JPY: Japanese Yen, CHF: Swiss Franc.

Table 4: Full Sample Analyses

Independent variables	CEO Total compensation		
	(1)	(2)	(3)
Intercept	4.8599***	4.8563***	4.8647***
	(1.2618)	(1.2638)	(1.2635)
FirmRet	0.2211***	0.2064***	0.224***
	(0.0187)	(0.0184)	(0.0188)
PeerRetIS	-0.0837***		-0.0817***
	(0.0234)		(0.0233)
PeerRetEX		-0.063*	-0.055*
		(0.0324)	(0.0322)
Ln (Sale)	0.2778***	0.2772***	0.2779***
	(0.025)	(0.025)	(0.025)
GrowOption	0.0477*	0.0475*	0.0476*
	(0.0246)	(0.0247)	(0.0246)
CeoTenure	0.1239	0.1271	0.1227
	(0.3931)	(0.394)	(0.3936)
IndVar	-0.0365	-0.0383	-0.0345
	(0.0563)	(0.0545)	(0.0552)
ChairD	0.0336	0.0333	0.0337
	(0.0208)	(0.0208)	(0.0208)
CeoEquityOwnD	-0.034*	-0.0342*	-0.0339*
	(0.019)	(0.019)	(0.0189)
InterlockD	0.0245	0.0244	0.0246
	(0.0444)	(0.0444)	(0.0444)
Year dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
CEO-fixed effects	Yes	Yes	Yes
Adjusted R2	0.7527	0.7524	0.7527
Number of observations	20,825	20,830	20,825

This table shows the following regression results for the full sample.

$$CEOPay_{it} = C_0 + \alpha_1 FirmRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 PeerRetEx_{it}$$

$$+ \alpha_4 ControlVariables_{it} + \epsilon_{it}$$

*, **, and *** denote statistically significance level of 10%, 5%, and 1% respectively.

The variables are defined in the Appendix.

Table 5: Sub Sample Analyses-CEO Total Compensation

Independent variables	CEO Total Compensation			
	Variance	Industry	Var- Industry	Full Sample
Intercept	4.9636***	3.3583**	2.8777***	4.8421***
	(0.907)	(1.695)	(0.9441)	(1.2672)
FirmRet	0.2161***	0.2083***	0.1974***	0.2247***
	(0.0253)	(0.0255)	(0.0364)	(0.0188)
PeerRetIS	-0.0883**	-0.0385	-0.0532	-0.0769***
	(0.037)	(0.0329)	(0.0535)	(0.0234)
PeerRetEX	-0.114**	-0.0852*	-0.1615**	0.0047
	(0.0457)	(0.0451)	(0.0646)	(0.0387)
Interaction				-0.1404***
				(0.0513)
Indicator				0.0336*
				(0.0175)
Ln (Sale)	0.2449***	0.3473***	0.3085***	0.2774***
	(0.0335)	(0.0423)	(0.0535)	(0.025)
GrowOption	0.0704***	0.0342	0.0592***	0.0474*
	(0.0164)	(0.0236)	(0.0161)	(0.0246)
CeoTenure	-0.0203	-0.3052	-1.6799***	0.1206
	(0.502)	(0.5268)	(0.4431)	(0.3947)
IndVar	0.0592	-0.0056	0.1227***	-0.0321
	(0.0644)	(0.0532)	(0.0394)	(0.0533)
ChairD	0.0365	0.0247	-0.0028	0.0338
	(0.0348)	(0.0306)	(0.0566)	(0.0208)
CeoEquityOwnD	-0.0411	-0.0307	-0.0734**	-0.0342*
	(0.0275)	(0.0269)	(0.0373)	(0.0189)
InterlockD	0.1182	0.0828	0.2236*	0.0248
	(0.0761)	(0.0628)	(0.1239)	(0.0444)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
CEO-fixed effects	Yes	Yes	Yes	Yes
Adjusted R2	0.7575	0.7210	0.7327	0.7528
Number of observations	10,011	10,265	4,884	20,825

This table shows the following regression results for the sub-sample.

$$CEOPay_{it} = C_0 + \alpha_1 FrimRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 PeerRetEX_{it}$$

$$+ \alpha_4 ControlVariables_{it} + \epsilon_{it}$$

*, **, and *** denote statistically significance level of 10%, 5%, and 1% respectively.

The variables are defined in the Appendix.

Table 6: Sub Sample Analyses-the Change in CEO Total Compensation

Independent variables	The Change in CEO Total Compensation			
	Variance	Industry	Var- Industry	Full Sample
Intercept	0.5897	0.0649	-0.5255	7.6697*
	(0.6435)	(0.8425)	(1.4931)	(4.2942)
FirmRet	0.311***	0.3317***	0.2945***	0.3434***
	(0.0343)	(0.0368)	(0.0521)	(0.0253)
PeerRetIS	-0.0796	-0.0253	-0.0323	-0.0676*
	(0.0556)	(0.0493)	(0.0805)	(0.0348)
PeerRetEX	-0.179**	-0.0868	-0.2166*	-0.0149
	(0.0725)	(0.0794)	(0.1113)	(0.0568)
Interaction				-0.1667**
				(0.0718)
Indicator				0.0422
				(0.0261)
Ln (Sale)	-0.0723**	-0.1281***	-0.133**	-0.1007***
	(0.0369)	(0.0325)	(0.0621)	(0.0196)
GrowOption	-0.005	0.0004	-0.0127	0.0046
	(0.027)	(0.0194)	(0.0296)	(0.0151)
CeoTenure	-0.6785	-0.3242	-1.1748	-0.3249
	(0.4215)	(0.3895)	(1.1808)	(0.2146)
IndVar	0.5084	-0.0572	0.3874	-0.0424
	(0.3373)	(0.0362)	(0.3431)	(0.0454)
ChairD	-0.0084	-0.0642	-0.0729	-0.0384
	(0.0508)	(0.0408)	(0.0812)	(0.0246)
CeoEquityOwnD	0.0256	0.0121	-0.0027	0.0165
	(0.0375)	(0.0322)	(0.0539)	(0.0208)
InterlockD	0.0816	0.0419	0.1716	0.0359
	(0.0987)	(0.0672)	(0.1764)	(0.0426)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
CEO-fixed effects	Yes	Yes	Yes	Yes
Adjusted R2	0.2541	0.1215	0.2524	0.1177
Number of observations	8,789	8,693	4,284	17,655

This table shows the following regression results for the sub-sample.

$$ChgCEOPay_{it} = C_0 + \alpha_1 FirmRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 PeerRetEX_{it}$$

$$+ \alpha_4 ControlVariables_{it} + \epsilon_{it}$$

*, **, and *** denote statistically significance level of 10%, 5%, and 1% respectively.

The variables are defined in the Appendix.

Table 7: Firm Specific Regression

Estimated coefficients	Median	Mean	Std. dev.	N	t-Stat.
Panel A: for single return					
FirmRet	0.1136	0.1457	0.7586	1334	7.0150
PeerRetIS	-0.0615	-0.1031	0.9430	1334	-3.9932
R2	0.1020	0.1502			
FirmRet	0.1491	0.1897	0.6996	1334	9.9037
PeerRetEX	-0.2662	-0.2902	1.3251	1334	-7.9988
R2	0.1164	0.1629			
Panel B: for multiple returns					
FirmRet	0.1598	0.1990	0.8217	1334	8.8454
PeerRetIS	0.0174	0.0112	1.2183	1334	0.3358
PeerRetEX	-0.2445	-0.3119	1.6713	1334	-6.8161
R2	0.1934	0.2366			

This table shows the statistics of estimated coefficients of following regression for each firm.

$$CEOPay_{it} = C_0 + \alpha_1 FirmRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 PeerRetEX_{it} + \epsilon_{it}$$

The variables are defined in the Appendix.

Table 8: Oil Price Risk Analyses

Independent variables	CEO Total compensation				
	Full Sample	Variance	Industry	Var-Industry	Full Sample
Intercept	4.8633***	6.4114***	3.73***	5.5613***	4.8603***
	(1.2604)	(0.3002)	(1.2955)	(0.4341)	(1.268)
FirmRet	0.2237***	0.194***	0.211***	0.1799***	0.2239***
	(0.0189)	(0.026)	(0.0232)	(0.0359)	(0.0189)
PeerRetIS	-0.0826***	0.0095	-0.0772**	0.0126	-0.0788***
	(0.0234)	(0.0359)	(0.0314)	(0.0499)	(0.0233)
PeerRetOP	-0.0345	-0.1303***	-0.0338	-0.1104**	0.0159
	(0.0303)	(0.0424)	(0.0382)	(0.0517)	(0.0391)
Interaction					-0.1179**
					(0.0513)
Indicator					0.014
					(0.0232)
Ln (Sale)	0.2778***	0.2374***	0.3032***	0.2412***	0.278***
	(0.025)	(0.036)	(0.0357)	(0.0492)	(0.0251)
GrowOption	0.0477*	0.0151	0.0389*	0.0076	0.0476*
	(0.0246)	(0.037)	(0.0233)	(0.033)	(0.0246)
CeoTenure	0.1234	-0.3778	-0.3076	-1.1662**	0.1258
	(0.3926)	(0.5126)	(0.3857)	(0.5163)	(0.395)
IndVar	-0.0354	-0.0759*	0.0107	-0.0431	-0.0327
	(0.0554)	(0.0415)	(0.0606)	(0.0363)	(0.0543)
ChairD	0.0338	0.0471*	0.0349	0.0671*	0.0338
	(0.0208)	(0.0285)	(0.0287)	(0.0393)	(0.0208)
CeoEquityOwnD	-0.0341*	-0.0486**	-0.0332	-0.0589*	-0.0345*
	(0.019)	(0.0238)	(0.0255)	(0.0332)	(0.019)
InterlockD	0.0243	0.0104	0.0955	0.0153	0.0242
	(0.0443)	(0.1042)	(0.0585)	(0.1258)	(0.0444)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
CEO-fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.7527	0.7799	0.7413	0.7815	0.7527
Number of observations	20,825	10,625	12,407	6,361	20,825

This table shows the following regression results.

$$CEOPay_{it} = C_0 + \alpha_1 FirmRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 PeerRetOP_{it}$$

$$+ \alpha_4 ControlVariables_{it} + \epsilon_{it}$$

*, **, and *** denote statistically significance level of 10%, 5% and 1% respectively.

The variables are defined in the Appendix.

Table 9: Interest Rate Risk Analyses

Independent variables	CEO Total compensation				
	Full Sample	Variance	Industry	Var-Industry	Full Sample
Intercept	4.8613***	5.7133***	3.3145***	5.8472***	4.8251***
	(1.2617)	(0.4327)	(1.2907)	(0.4832)	(1.2611)
FirmRet	0.2221***	0.2385***	0.1966***	0.196***	0.2226***
	(0.0188)	(0.0241)	(0.0244)	(0.0311)	(0.0187)
PeerRetIS	-0.0834***	-0.0862***	-0.0533*	-0.0405	-0.077***
	(0.0234)	(0.0329)	(0.0309)	(0.0423)	(0.0235)
PeerRetIN	-0.0214	-0.019	-0.0035	-0.032	-0.0154
	(0.0346)	(0.0429)	(0.0434)	(0.0525)	(0.0432)
Interaction					-0.0115
					(0.0553)
Indicator					0.0588***
					(0.0199)
Ln (Sale)	0.2776***	0.2837***	0.321***	0.3066***	0.2782***
	(0.025)	(0.0318)	(0.0397)	(0.0477)	(0.025)
GrowOption	0.0477*	0.0401	0.0374	0.0312	0.0473*
	(0.0246)	(0.0269)	(0.0246)	(0.0268)	(0.0245)
CeoTenure	0.1226	0.1259	-0.4365	-0.3234	0.1131
	(0.3932)	(0.4929)	(0.4347)	(0.55)	(0.393)
IndVar	-0.0358	0.1195	-0.0156	0.1172	-0.0375
	(0.0559)	(0.0956)	(0.0574)	(0.0768)	(0.0545)
ChairD	0.0337	0.0514*	0.0426	0.0866**	0.034
	(0.0208)	(0.0284)	(0.0308)	(0.0425)	(0.0208)
CeoEquityOwnD	-0.034*	-0.0222	-0.0315	-0.0037	-0.0344*
	(0.019)	(0.03)	(0.0268)	(0.0444)	(0.0189)
InterlockD	0.0245	0.003	0.0404	0.0192	0.0252
	(0.0444)	(0.0504)	(0.0588)	(0.0702)	(0.0444)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
CEO-fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.7526	0.7273	0.7117	0.6762	0.7528
Number of observations	20,825	12,304	10,847	6,425	20,825

This table shows the following regression results.

$$CEOPay_{it} = C_0 + \alpha_1 FirmRet_{it} + \alpha_2 PeerRetIS_{it} + \alpha_3 PeerRetIN_{it}$$

$$+ \alpha_4 ControlVariables_{it} + \epsilon_{it}$$

*, **, and *** denote statistically significance level of 10%, 5%, and 1% respectively.

The variables are defined in the Appendix.