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Abstract

There is scant evidence on how risk-taking incentives impact specific firm risks. This has implications for board oversight of managerial risk taking, firms' development of comparative advantage in taking particular risks, and compensation design. We examine this question for exchange rate risk. Using multiple identification strategies, we find that vega increases exchange rate exposure for purely domestic and globally engaged firms. Vega's impact increases with international operations, declines post-SOX, and is robust to firm-level governance. Our results suggest that evidence that exposure reduces firm value can be viewed, in part, as a wealth transfer from shareholders and debt-holders to managers.

Keywords: Risk-taking Incentives, Managerial Compensation, Exchange Rate Exposure, Risk Management, Corporate Governance

JEL Classification: G32

1. Introduction

Several studies document that managerial risk-taking incentives are associated with corporate activities, such as leverage, R&D, cash holdings, and the firm's diversification strategy, that are supposed to manifest managerial risk taking (e.g., Coles, Daniel, and Naveen, 2006; Armstrong and Vashishtha, 2012; Gormley, Matsa, and Milbourn, 2013). Low (2009), instead of relying on inferences drawn from the impact of managerial risk-taking incentives on firms' financial and investment policies, focuses on the volatility of firms' stock returns. However, the firm's volatility "reflects the net effect of all managerial risk-taking activities, including some that cannot be easily measured (Low, 2009, p. 470)". Further, as Armstrong and Vashishtha (2012) point out, realized volatility may not reflect a manager's desired level and composition of the risk she wishes to take. Therefore, our understanding of the effect of managerial risk-taking incentives on firm risk is incomplete as existing studies do not indicate how these incentives affect particular risks that managers care about. The purpose of this paper is to examine how managerial risk-taking incentives, as reflected in managerial compensation contracts, affect one particular risk to which many U.S. firms have a significant and growing pre-hedged exposure, simultaneously with managers having substantial discretion regarding whether and how to manage this risk. This is foreign exchange rate risk.

Given that firms are exposed to a number of risks, there are several benefits to examining how risk-taking incentives affect specific risks. First, focusing on specific risks can enhance our understanding of the existing evidence based on the overall risk. This is because theory has conflicting predictions about whether managerial risk-taking incentives increase firm risk (see Jensen and Meckling, 1976; Smith and Stulz, 1985; Lambert, Larcker, and Verrecchia, 1991; Carpenter, 2000; Ross, 2004). Hence, it is not necessarily the case that incentive compensation increases all aspects of corporate risk taking even if these incentives have a positive effect on overall firm risk. Therefore, understanding how managerial incentives affect specific risks enhances our understanding of the existing evidence.

Second, understanding how incentive compensation affects particular risks facilitates boards' oversight of the risk-taking decisions of managers. Gormley, Matsa, and Milbourn (2013) note that there is a "two-way" relation between managerial compensation and risk taking because, while incentives may motivate managers to increase firm risk, boards may alter managers' incentives in response to excessive managerial risk taking. Therefore, having knowledge of how risk-taking incentives affect specific risks that have potentially large consequences for the firm and which are easily observed and monitored by the board and can be relatively straightforwardly managed, could enhance firm governance.

Third, focusing on the impact of incentive compensation on particular risks furthers our understanding of the development of a firm's comparative advantage in taking certain risk(s). Stulz (1996) notes that managers can enhance firm value by developing a comparative advantage in risk taking, but this requires that the firm be prepared to take substantial exposure to that risk while it manages the exposure to other risks. To be successful with this approach, it is imperative that managers are not taking excessive risks in the particular risks that the firm should be managing because they are being induced to do so by their compensation scheme.[1] As Stulz also notes, "When devising a compensation scheme for those managers that can make a bet, it is of crucial importance to provide appropriate incentives so that they only take those bets that increase shareholder wealth (p. 20)."

[1] For instance, a firm may, because of its extensive global network, wish to develop comparative advantage in taking currency risk, but may wish to balance that by hedging commodity price and interest rate risks and so would not want managers to take excessive exposure to these risks because doing so would enhance the value of their stock options. Similarly, an airline may have a comparative advantage in taking oil price risk, but managers may wish to have foreign currency exposure to enhance the value of their options. It is important to note that managers may be inclined to take substantial risks even if the firm has no comparative advantage in risk taking.

We believe that foreign exchange rate risk is the ideal risk with which to initiate an investigation into the effects of managerial risk-taking incentives on specific firm risks. This is for several reasons. For instance, because of increased globalization exchange rate is one of the most important prices in the U.S. economy and, as such, is important to managers. Citing derivatives use by non-financial firms reported in a Wharton survey (Bodnar, Hayt, and Marston, 1998), Mello and Ruckes (2005) declare that exchange rate changes are the single most important determinant of performance for many U.S. firms, a sentiment echoed by the prominence given to this risk in numerous surveys of managers. Relatedly, Graham and Harvey (2001) find that about a third of firms adjust their cash flows and discount rates to account for exchange rate risk in project evaluation. They point out that, except for the market risk, this is the highest incidence of adjustments for any single risk. Theoretically, exchange rate changes should have a significant impact on the performance of firms, especially for those involved in international activities (e.g., Dumas, 1978; Adler and Dumas, 1980; Hodder, 1982), and potentially for those that are not (see, e.g., Bodnar and Gentry, 1993; Goldberg, 1993). In line with this theoretical argument, recent studies have shown that exchange rate changes impose a substantial amount of risk on firms and as such, have a direct influence on corporate operations (Brown, 2001; Graham and Rogers, 1999), cost of capital (Francis, Hasan and Hunter, 2008; Bergbrant, Francis, and Hunter, 2017), and firm value (Graham and Rogers, 1999; Bartram, Brown and Conrad, 2011).

In addition, while it is well accepted that managerial stock options have been increasing as a component of CEO compensation (Murphy 2012), there is an ongoing debate regarding the extent to which U.S. firms manage currency risk. Guay and Kothari (2003) find that the value of outstanding derivatives amount to a small fraction of firms' exposed assets, which would be consistent with the notion that managers do not hedge much of their firms' exposure to exchange rate risk.[2] Consequently, this implies that managerial risk-taking incentives are positively related to currency risk-taking. In sharp

[2] See Rampini, Sufi, and Viswanathan (2014) for oil price risk.

contrast, Bartram, Brown, and Minton (2010) find that managers aggressively hedge their exposure to exchange rate risk, successfully eliminating 70% of firms' pre-hedged exposure, which results in weak estimates of post-hedged exposure. This implies a negative relation between managerial risk-taking incentives and exchange rate risk. Therefore, whether risk-taking incentives increase exchange rate exposure is an empirical question, the answer to which can provide valuable insight to boards in their oversight of managerial risk-taking and can deepen our understanding of the nexus between risk-taking incentives and firm risk.

Using a two-stage least squares (2SLS) model to address potential endogeneity concerns, we find evidence consistent with the prediction that risk-taking incentives increase firms' exchange rate exposure. In particular, we find that exposure increases with the sensitivity of CEOs' wealth to the volatility of stock returns (vega) and declines with the sensitivity of CEOs' wealth to stock prices (delta). We instrument CEOs' risk-taking incentives with the cash compensation ratio of their overall compensation. It is reasonable to argue that it satisfies the exclusion restriction as it is difficult to perceive cash compensation affecting firms' exposure except through the risk-taking component of compensation. As added instruments, we follow Armstrong and Vashishitha (2012) and use firms' previous two years of stock returns and the previous year's return on assets. The evidence indicates that the impact of risk-taking incentives is economically important in that a 1% increase in vega is associated with an increase of approximately 26% of the sample mean exposure to a broad currency index, while the same increase in delta is associated with a decrease of 35% of the sample mean exposure. Similar economic effects hold for exposures measured with other currency indices.

To further address endogeneity concerns, we conduct five additional tests. First, we estimate a dynamic panel GMM model (Arellano and Bond, 1991) using the lagged value and the difference of the risk-taking incentives as instruments. Second, we select firms that initiate stock option grants in our sample period and test how the sudden jump in risk-taking incentives impacts exposure. Next, we design three quasi-experimental tests, one with the installment of the golden parachute anti-takeover provision, a second with the passage of Financial Accounting Standards (FAS) 123R regarding the accounting treatment of stock option grants, and a third in which we use exogenous CEO turnovers to examine the possibility that boards are in control of both the exchange rate exposure and risk-taking incentives. Our central findings are robust under all five tests. Collectively, these results indicate that risk-taking incentives cause an increase in firms' exchange rate exposure.

It would be expected that managers of firms with indirect exposure (purely domestic firms) do not have the same opportunity to measure and manage exchange rate risk as firms with direct exposure, potentially weakening the nexus between exposure and risk-taking incentives. We examine this and find that risk-taking incentives increase the exposure of both purely domestic and globally engaged firms, though as expected, the impact is greater for the latter firms. While vega's impact on exposure increases with firms' international operations, the relation is not linear.

Finally, we examine how certain mechanisms designed to reduce value-destroying risk-taking activities affect our results. First, we examine the effect of SOX on our results and find that while the impact of risk-taking incentives on exposure is more pronounced in the pre-SOX period, it remains economically robust post-SOX. Second, we find that although firm-level corporate governance generally helps to reduce exposure, our results remain qualitatively similar when it is accounted for.

This paper makes several contributions to the finance literature. First, it contributes to the literature on managerial risk-taking incentives; more specifically, to the link between risk-taking incentives and the specific risks to which firms are exposed. Our work complements Tufano (1996), who also finds that risk-taking incentives increase firm risk, but is distinct in several ways. First, whereas gold price risk affects a relatively small number of firms, exchange rate risk is much more pervasive, potentially affecting all firms including those that are regarded as purely domestic by virtue of a lack of direct involvement in foreign trade or operations (Hodder, 1982; Levi, 1994; Marston, 2001; Aggarwal and Harper, 2010; Bergbrant, Campbell, and Hunter, 2014). Second, changes in exchange rates are much more volatile than changes in most other prices, including gold price, implying that exchange rate risk is greater than gold price risk. Our main result suggests that exposure to exchange rates is highly valuable to managers holding stock options because, exchange rate risk is pervasive among firms, substantial in magnitude for many firms, and tend to have a short- to medium-term impact on firm operations relative to the more long-term effects of several of the measures previously studied (e.g., R&D and diversification). And third, given the extant evidence that managers take active views on the foreign exchange market that reflect their personal preferences, attitudes toward risk, and specific skills and opinions (Beber and Fabbri, 2012), prior evidence that exchange rate exposure increases firms' cost of capital and lowers firms' value can be viewed, in part, as a shift of interest from shareholders and debt-holders to managers.

Second, our work contributes to the literature on exchange rate exposure. Although several papers examine the determinants of exposure (see summary in Bergbrant, Campbell, and Hunter, 2014), to the best of our knowledge, this is the first attempt to examine a direct link between the level of firms' exchange rate exposure and managerial contracting, as represented by managers' risk-taking incentives. Recent evidence indicates that, although managers hedge a large part of their firms' exchange rate exposure, they leave unhedged a portion that is of material importance to many firms (Bartram, Brown, and Minton, 2010). Our results suggest that this may be because it is directly beneficial to managers not to fully hedge given their compensation schemes. This implies that future work should account for managerial compensation in their bid to either estimate exposure or to understand its cross-sectional and time variation.

The rest of the paper proceeds as follows: Section 2 briefly reviews the literatures on exchange rate exposure and CEO risk-taking incentives to develop our main hypothesis. Section 3 discusses the methodology and describes the data. Section 4 presents the main results. In section 5, we perform several robustness checks. Section 6 concludes.

2. Literature Review

Adler and Dumas (1984) define exchange rate exposure as the variation in firm value due to unexpected changes in exchange rates. In the spirit of the definition, Adler and Dumas provide a single factor model measuring exposure as the sensitivity of stock returns to changes in exchange rates. Jorion (1990) augments the above model with market returns to capture other potential macroeconomic risks that affect stock returns and finds that the correlation between the two estimates of exposure is as high as 0.968.

It is important to note that exchange rate risk affects not only multinational firms or firms that directly engage in exports and imports, but also firms without foreign operations or international trade or foreign-currency denominated assets and liabilities (purely domestic firms). Purely domestic firms could be affected indirectly because, they are likely to have customers that are, or they are customers of, direct exporters or importers; they are competitors of firms that are sensitive to exchange rate changes; they provide goods and services that are complements to those of exchange-rate-sensitive firms; they have creditors that are sensitive to exchange rate changes; they are affected by changes in equilibrium economic demand brought on by changes in currency values; and they are affected by resource reallocation (e.g., of capital to globally engaged firms and away from purely domestic firms) (see, e.g., Bodnar and Gentry, 1993; Goldberg, 1993).

Recent studies provide evidence that exchange rate exposure has a material impact on both the cost of equity and the cost of debt. Francis, Hasan and Hunter (2008) find a significant currency premium that adds about 2.47 percentage points to the cost of equity and accounts for approximately 11.7% of total risk premium in absolute value. Bergbrant, Francis, and Hunter (2017) find that an increase in the magnitude of exchange rate exposure is associated with a significant increase in loan spread. In addition, exchange rate exposure affects firm value. Bartram, Brown, and Conrad (2010) find strong evidence that (currency) risk management with financial derivatives is associated with significantly higher firm value, abnormal returns, and larger profits during the economic downturn from 2001 to 2002. Graham and Rogers (1999) show that firms hedge to increase debt capacity and, therefore, firm value. Both studies imply that higher exposure is related to lower firm value.

Given the evidence that exchange rate exposure substantially increases the cost of capital and reduces firm value, it is therefore, worthwhile to investigate the key determinants of the level of exposure. Extant studies have shown that firm characteristics (firm size, industry structure, international operations, tax convexity, liquidity, etc.) and firms' decisions on operational activities (such as hedging policy or the use of foreign debt) are related to exchange rate exposure.[3] Some of these determinants – such as international operations and financial policies regarding risk management – are actually the products of managers' decision-making. Therefore, this poses the question as to whether these determinants are in fact influenced by managerial risk-taking incentives embedded in the compensation contract.

In addition, top managers have discretion over exchange rate risk management. Using survey information, Bodnar, Hayt and Marston (1998) and Brown (2001) note that managers have power in setting the policy on exchange rate exposure management. Similarly, CEOs' pay-performance sensitivities are related to the firms' risk management policies. Beber and Fabbri (2012) indicate that managers take active views on the foreign exchange market that reflect their personal preferences, individual attitudes toward risk, and specific skills and opinions.

[3] See, among others, Allayannis (1997); Bodnar, Hayt and Marston (1998); Bodnar, Dumas and Marston (2002); Allayannis and Ihrig (2001); Graham and Rogers (2002). See summary in Bergbrant, Campbell, and Hunter (2014).

Hence, although the management of exchange rate risk could increase firm value and lower the cost of capital, managers' attitude toward risk management is tied to their own wealth-maximizing interest. It is, therefore, natural to examine whether the principal-agent conflict contributes to the currency exposure of the firm, thus shifting the interest of shareholders to managers. Based on the extant evidence on risk management,[4] we expect vega to be positively related to firms' ex post exchange rate exposure while delta is expected to be negatively related.

3. Methodology and Data

3.1 Methodology

Our main goal is to determine if managerial risk-taking incentives have a causal effect on firms' exchange rate exposure. Research on risk management inevitably faces the endogeneity challenge and the current setting is no exception. That is, any empirical relationship between exchange rate exposure and managerial risk-taking incentives could be because firms' exchange rate exposure influences managerial risk-taking incentives, or because both are jointly determined.

Though we can use the contemporary measure of firm characteristics and managerial incentives to explain the ex-post exchange rate exposure in the next period, endogeneity could still occur when a compensation committee anticipates the effect of a CEO's risk-taking incentives on his or her decision making and thus incorporates the expectation into the contract,[5] or the risk-taking incentives display time series correlations.

To address potential endogeneity and, therefore, to establish causality, we examine the relation between exposure and risk-taking incentives using a two-stage least squares (2SLS) approach. A valid

[4] See, e.g., Tufano (1996), Rogers (2002), Rajgopal and Shevlin (2002), and others.

[5] Prendergast (2002) argues that firms that compete in riskier environments (such as in specific industries) would like to hire CEOs with higher risk-taking preference. However, it is unlikely that a firm's currency exposure stays constant or remains positive or negative (see Francis, Hasan, and Hunter, 2008). Thus, it is much less likely that selection bias would drive our results.

instrument should be correlated with CEOs' risk-taking incentives, but should have no direct impact on firms' exchange rate exposure. Murphy (1999) points out that a CEO's cash compensation (including base salary and bonus) is correlated with his or her risk-taking incentives. More specifically, all things equal, higher cash compensation reduces the equity grant and gives the CEO the opportunity to reduce his or her exposure to firm risk by making an external investment. Additionally, CEOs who receive less equity are protected by the lower bound of cash compensation in the worst state of the world. Thus, we use the cash compensation ratio, defined as cash compensation scaled by annual total compensation, as a CEO-specific instrument. We argue that the instrument satisfies the exclusion restriction as it is difficult to envision a scenario in which the CEO's cash compensation is a determinant of the firm's next period exchange rate exposure except through its correlation with the CEO's incentive compensation.

We also utilize a second set of instruments. Following Armstrong and Vashishitha (2012) these are a firm's previous two years' annual stock returns and the previous year's return on assets (ROA). Both stock return and ROA are likely to affect CEOs' risk-taking incentives and the grant of new equity, thus satisfying the instrument relevance criterion. However, it is unlikely that stock returns and ROA affect future exchange rate exposure, except through their effect on risk-taking incentives.[6]

The basic model for the second stage of our 2SLS model is:

$$\beta\widehat{(FX)}_{i,t} = \alpha + \beta_1 Vega_{i,t} + \beta_2 Delta_{i,t} + X'_{i,t} \cdot \Gamma + \sum \rho_j + \sum \delta_t. \quad (1)$$

$\beta\widehat{(FX)}_{i,t}$ is the estimate of firm *i*'s ex-post exchange rate exposure. β_1 and β_2 are the coefficients of interest and $X_{i,t}$ is a vector of control variables. In the estimation we follow Peterson (2009) and account for industry and year fixed effects, ρ_j and δ_t, respectively. We discuss the control variables for the above model in section 3.2.3 below.

[6] ROA may be correlated with stock return; we perform the test with only ROA or stock return included, and the results are qualitatively the same.

3.2 Data

3.2.1 Exchange Rate Exposure

To obtain a measure of a firm's exchange rate exposure, we follow the standard Adler and Dumas (1984) approach and estimate individual firms' exchange rate exposure over a 52-week window ending at the fiscal year end:[7]

$$R_{i,t} = \mu + \beta(FX)_{i,t} \cdot R_{FX_t} + v_{i,t}. \tag{2}$$

$R_{i,t}$ is the one-week continuously compounded return on firm *i* and R_{FX_t} is the one-week continuously compounded change in a real exchange rate index (both calculated from Wednesday to Wednesday). The coefficient estimate $\widehat{\beta(FX)}_{i,t}$ is the proxy for the firm's exchange rate exposure. We follow the literature and assume that $\widehat{\beta(FX)}_{i,t}$ measures the sensitivity of the firm's cash flows to changes in exchange rates. This measure is based on the assumption that the exchange rate index is exogenous to other priced risk factors and the market is aware of the impact of currency movements on stock value. We also perform all tests using estimates of exposure from Jorion's (1990) two-factor model, and the results remain statistically and economically similar to those reported below.

We use three exchange rate indices in our analysis. These are the trade-weighted indices of the bilateral exchange rates between the U.S. dollar and (i) the major currencies that trade freely outside of their country of issue (MAJOR); (ii) the currencies of several developing economies comprising the "other important trading partners" of the U.S. (OITP); and (iii) the currencies of the countries in both the MAJOR and the OITP indices (BROAD). All exchange rates are quoted as foreign currency per

[7] The CEO compensation information is updated annually; thus it is best if exposure reflects the sensitivity of firms' stock return to the contemporary currency movement within one year. The conventional practice uses three or five years of monthly return and performs rolling regression. This is problematic in this paper's setting because rolling regression generates overlapping exposure that may obscure the correlation between the contemporary risk-taking incentives and ex-post exposure, while using daily stock returns yield a noisy measure.

U.S. dollar. Hence, an increase in the index represents an appreciation of the U.S. dollar. We convert daily exchange rate indices into weekly indices. The daily OITP (and thus the BROAD) index is available only since 1995, hence we confine our sample to the 1995-2015 period. The index data are obtained from the Federal Reserve database.[8]

3.2.2 Managerial Risk-taking Incentives

The extant literature uses the Black-Scholes-Merton option valuation model to measure the value of stock option grants to executives. The model provides an intuitive approach to estimate the sensitivity of the option value to a change in stock price (delta) and stock return volatility (vega). Delta represents the sensitivity of the manager's compensation to stock price changes, and increases in delta have been found to induce risk-aversion in managers, whereas increases in vega stimulate risk-taking behavior. These measures have been successfully used in the literature to examine the relationship between managerial incentives and firms risk-taking behavior (see, e.g., Burns and Kedia, 2006; Low, 2009; and Fahlenbrach and Stulz, 2011). For example, Coles, Daniel, and Naveen (2006) show that higher sensitivity of CEO wealth to stock return volatility (vega), after controlling for levels of risk-aversion (delta), motivates managers to implement riskier investment and financing options.

Empirically, we follow Guay (1999) and Core and Guay (2002) to calculate values of delta and vega for CEOs' compensation. As mentioned above, delta measures the sensitivity of stock option holdings to a (1 %) change in stock price and vega measures the sensitivity of stock option holdings with respect to a (0.01) change in the volatility of stock return. Thus, a higher delta implies that CEOs have a greater incentive to increase stock price while a higher vega measures a CEO's incentive to increase stock price volatility. We use the logarithm of both variables to account for the skewness of

[8] The data can be found at: http://www.federalreserve.gov/releases/h10/summary/

the data. CEO compensation data are obtained from ExecuComp, which covers the S&P 500, the S&P Mid-Cap 400, and the S&P Small-Cap 600.

3.2.3 Control Variables

We include control variables that have been previously documented to impact exchange rate exposure in both theoretical and empirical studies. Graham and Rogers (2001) find that risk management increases with firm size, consistent with the more direct empirical evidence in Dominguez and Tesar (2001) of an inverse relationship between size and exposure. In contrast, He and Ng (1998) find a positive relationship. We control for firm size with the natural log of total assets. Geczy, Minton and Schrand (1997) argue that firms with greater growth opportunities are more likely to use currency derivatives. Following He and Ng (1998), we use the market-to-book ratio to represent growth opportunities. We also use the net investment in property, plant, and equipment (PP&E) and sales growth. Firms' short-term liquidity is related to hedging activities (Froot, Scharfstein and Stein 1993; He and Ng, 1998). We follow the literature and use the dividend payout ratio and the quick ratio as proxies for liquidity. In addition, a firm's international operations could influence its exposure (Jorion, 1990; Bodnar and Gentry, 1993; Allayannis and Ihrig; 2001). We use foreign sales (scaled by total sales) and foreign assets (scaled by total assets) as our proxies. Furthermore, given that the tax structure can influence firm hedging (Smith and Stulz, 1985), we include tax loss carryforwards available to the firm (scaled by the total assets).

Smith and Stulz (1985) argue that the stock holding of the CEO could influence his or her decision-making toward risk management. We use CEO stock holding, scaled by the total number of shares outstanding, as a control. Also, as shown in a number of studies (e.g., Guay, 1999; Beber and Fabbri, 2012), a CEO's personal characteristics impact his or her views on exchange rate risk. Thus we use the natural log of the CEO's age and tenure as measures of personal characteristics.

Financial statement data are collected from Compustat. We obtain daily stock returns from CRSP to calculate weekly stock returns. In matching the compensation data from ExecuComp, we lose a large number of observations. Our final sample consists of 2,231 firms and 14,748 firm-year observations over the 1995-2015 period.[9] A description of the variables is contained in the appendix.

3.2.4 Summary Statistics

Table 1 reports summary statistics for exchange rate exposure as well as for firm and CEO characteristics. In the following analysis, we use the absolute (or positive) value of exchange rate exposure as our dependent variable.[10]

The summary statistics indicate that firms are more sensitive to the OITP currency index than to the MAJOR currency index. This is understandable, because managers have a greater capacity and it is less costly to hedge and otherwise manage the exposure to the currencies in the MAJOR index (Francis, Hasan and Hunter (2008)). When we separate exposure into its positive and negative components, we find that there are more firms with a mean negative exposure, especially to the OITP index, implying that the majority of firms in our sample are exposed as if they are net exporters (see Section 5.2.4).

The firm and CEO characteristics are consistent with the extant literature. The sample firms have an average total asset of $5,644 million. Because our sample is constrained by the ExecuComp universe it is biased toward large firms. Foreign sales constitute 25% of total sales, on average, while foreign asset is about 6.5% of total assets. For risk-taking incentives, on average, a 1% increase in stock price (delta) increases CEOs' wealth by approximately $752,000, and a 1% increase in stock volatility (vega) increases CEOs' wealth by about $150,000.

[9] The total number of observations varies across regressions due to missing variables or the use of lagged variables.
[10] For the tests with either positive or negative exchange rate exposure (see, Section 5.2.4), we conduct regressions with both OLS and Tobit model, and the results are very similar. We only report the results with OLS.

Table 2 reports correlations between managerial risk-taking incentives and firm's absolute exchange rate exposure. Consistent with our hypothesis, we find that delta is negatively related to exchange rate exposure. However, vega is also negatively related to the three estimates of exposure, contrary to our conjecture. Considering the fact that managers' risk-taking incentives and firms' exchange rate exposure are simultaneously determined, this further suggests the necessity of controlling for endogeneity.

4. Empirical Results

We report the results of the second-stage models of the 2SLS tests described in Equation (1) in Table 3. In unreported results, available on request, the evidence from the first-stage model indicates that the instruments are significantly correlated with vega and delta and a number of statistical tests support the validity of the instruments.[11] In the reported second-stage results, we regress the absolute exchange rate exposure on the predicted estimates of the risk-taking incentives (vega and delta) and the control variables. The results indicate a significant association between managerial risk-taking incentives and exposure. Specifically, we find that an increase in vega causes a significant increase in exposure. Because firms with higher exchange rate exposure have greater exchange-rate-induced stock return volatility, which increases option values, we can infer that CEOs with higher sensitivity of their wealth to stock return volatility are more likely to leave exchange rate risk unmanaged.

On the contrary, but consistent with our expectations, the evidence indicates that higher delta significantly reduces exchange rate exposure. It is very likely that since higher exchange rate exposure

[11] We conduct a number of tests to ensure the appropriateness of the instruments. The Cragg-Donald Wald statistics generate greater value than the Stock-Yogo weak identification test critical values (Stock and Yogo, 2004), rejecting the null hypothesis that the instruments are weak. The Sargan statistic for the overidentification tests of all instruments yield large *p*-values, which fails to reject the null hypothesis that all instruments are exogenous. The Anderson LM statistics strongly reject the null hypothesis that the instruments are underidentified.

lowers firm value, CEOs whose wealth is strongly tied to their firms' stock price (higher delta) are more likely to reduce the level of exposure. This finding is consistent with that of Tufano (1996).

Delta and vega are simultaneously determined by the CEO's compensation package, thus the opposing effects of delta and vega on exchange rate exposure can obscure the direction and magnitude of the net influence of managerial risk-taking incentives on exposure. While it is well known that vega generally motivates mangers to *increase* their firms' systematic risk, such as that related to exchange rate changes, delta has an ambiguous impact on systematic risk (see, e.g., Armstrong and Vashishtha, 2012). The latter is because with a higher delta the manager's wealth is more exposed to the risk of his firm and, consequently, he might be inclined to reduce the firm's systematic (and total) risk. Hence, the negative impact of delta on exchange rate exposure is consistent with existing evidence of a negative relation between delta and systematic risk (e.g., Coles, Daniel, and Naveen, 2006).

Decomposing the BROAD exchange rate index (Column (1)) into its components, OITP (Column (2)) and MAJOR (Column (3)), reveals that risk-taking incentives have a greater impact on exposure to the OITP index than on exposure to the MAJOR index. This finding is not surprising given the greater magnitude of exposure to the currencies in the OITP index (see Table 1) as well as the generally greater volatility of these currencies. That is, because of these effects, it is reasonable to expect that, to the extent that managers exploit the volatility in firm values arising from the volatility of exchange rate changes, there would be greater opportunities to do so using currencies that are more volatile and to which firm value is more sensitive.

The results are not only highly statistically significant, but they are also economically meaningful. The coefficient estimate in Column (1) indicates that a 1% increase in vega, which shifts the mean from roughly 150 to 151.5, increases the absolute exposure to the BROAD exchange rate index by 0.36.[12] Given that the sample mean exposure to this index is 1.38, the coefficient estimate

[12] A coefficient estimate of 0.36 for log(vega) means that a 1% increase in vega increases absolute exposure by 0.36.

implies an increase of approximately 26% of the sample mean. Simultaneously, a 1% increase in delta (from 752 to about 760), decreases the mean exposure by 0.48 or about 35% of the sample mean exposure. Together, these results imply that a 4% increase in vega would be required to offset the decline in exposure due to a 3% increase in delta [4×0.36=3×0.48]. Further, these results imply that a 3.6% increase in vega increases exposure to the BROAD exchange rate index by one standard deviation [3.6×0.36=1.296; see Table 1], while a 2.7% increase in delta reduces exposure by one standard deviation. When considered in the context of the existing evidence that exposure has a material effect on firm value (see Section 2), these results suggest that managerial risk-taking incentives can exert significant impact on firm value through the exchange rate exposure channel.

The coefficient estimates on several of the control variables are statistically significant and their signs are largely consistent with our expectations. As in previous studies (e.g., He and Ng, 1998), we find that exposure increases when leverage and (various proxies for) growth opportunities are greater and internal liquidity is tight (smaller dividend payout ratio). We also find that the foreign assets ratio is positively related to exposure (to the MAJOR exchange rate index). However, the foreign sales ratio is negatively associated with exposure. Although the received knowledge is that exposure increases linearly with foreign sales, the sign of this relation is an empirical issue. For instance, as the proportion of foreign revenues increases beyond a certain level firms' foreign operations tend to become a natural hedge. Bergbrant, Campbell, and Hunter (2014) find that a firm's exposure is not necessarily associated with its multinationality, which is consistent with the finding that some firms can reduce their exposure through engaging in foreign operations (Williamson, 2001). Furthermore, since many firms with foreign sales also have foreign costs, they manage to achieve a near balance of foreign revenues and costs (Bodnar and Marston, 2002).

Interestingly, we also find some evidence that exposure increases with tax loss carryforwards. This finding is inconsistent with studies by Mian (1996), Tufano (1996), Geczy, Minton and Schrand

(1997), Allayannis and Ofek (2001) and Knopf, Nam and Thornton (2002) that fail to find a significant relationship between tax loss carryforwards and risk management. However, it is consistent with the tax reduction theory that argues that tax loss carryforward should be positively related to risk management activities. It should also be noted that the positive coefficient is in line with Froot, Scharfstein and Stein (1993).

We also document a link between exposure and CEO characteristics. In particular, we find that CEO's share ratio is positively associated with exposure. Since CEO's share ratio contains both stocks and stock options, this positive association may be indicative of the greater influence of stock options in CEOs' share ratio, on average, over our sample period. The evidence also indicates that exposure increases with CEOs' tenure. One possible reason for this is that CEOs' tenure reflects CEOs' experience and more experienced CEOs' might not hedge exchange rate risk because of the view that over long periods the negative and positive effects of exposure offset each other.

5. Robustness checks

In the previous section, we find that CEOs' risk-taking incentives have statistically significant and economically meaningful impact on firm's exchange rate exposure. To ensure the robustness of our results and to gain further insight into the relation between exposure and risk-taking incentives, we conduct two additional sets of tests. First, we use *five* different approaches to further address potential endogeneity. Second, we examine whether our inferences are altered when we account for various mechanisms that can potentially influence the extent of managerial risk-taking.

5.1 Additional Controls for Potential Endogeneity

In this subsection we report the results of additional tests designed to address potential endogeneity between exchange rate exposure and managerial risk-taking incentives.

5.1.1 Dynamic Panel GMM Approach

The Arellano and Bond (1991) dynamic panel GMM estimator is designed to be used to address potential endogeneity where one or more of the independent variables are not strictly exogenous and there are few time periods and many units of observations (firms). This method of addressing endogeneity utilizes appropriate lags of the change in the dependent variable (exchange rate exposure) and the potential endogenous independent variable (risk-taking incentives), thus reducing the burden of finding valid instruments. The results from the dynamic panel GMM model are reported in Panel A of Table 4 and indicate that the results are qualitatively similar to those previously reported using the 2SLS model.

5.1.2 First Inclusion of Stock Option Grants in CEOs' Compensation

A subsample of firms began using stock options as a part of CEOs' compensation during our sample period.[13] This provides an opportunity to examine how the sudden change in the risk-taking incentives of CEOs affects firms' exchange rate exposure. Because stock option grants impact both delta and vega, we first test how the initial grant of stock options changes delta and vega. As reported in Panel B of Table 4, we find that both delta and vega increased significantly after the adoption of stock option grants as a part of CEOs' compensation. Hence, if the previous evidence of a strong relation between managerial risk-taking incentives and exposure is robust, then this implies that risk-taking incentives could have a positive and significant impact on these firms' exchange rate exposure. We report univariate tests of the change in the absolute level of exposure that are consistent with this argument. That is, the mean change in exposure after the initiation of stock option grants is

[13] A total of 347 firms initiated the use of stock options during our sample period, excluding those firms that simultaneously started to grant both restricted stocks and stock options.

significantly different from (greater than) zero for exposure to the Broad and Major exchange rate indices.

5.1.3 Quasi-experiment with the Adoption of Golden Parachute

Firms' anti-takeover provisions greatly impact CEOs' risk-taking incentives, but not necessarily firms' exchange rate exposure. This provides us with a quasi-experimental opportunity to identify the effect of CEOs' risk-taking incentives on exchange rate exposure. That is, we consider the adoption of a golden parachute as a quasi-exogenous event. As shown by Bebchuk, Cohen, and Ferrell (2009), a golden parachute is one of six governance provisions that matter the most to shareholders, which is also directly related to CEO compensation. With golden parachutes in place, managers are shielded from the downside risk of aggressive risk-taking, so even with a similar level of risk-taking incentives, CEOs with golden parachute are expected to be less risk-averse (Manso, 2011).

In Table 4, Panel C, we examine the impact of a golden parachute on exposure for a sample of 519 firms that adopted golden parachutes during our sample period. First, on average, we observe a significantly higher vega and delta subsequent to the adoption of a golden parachute is in place. The increase in vega is consistent with Low (2009) who find that when managers become more entrenched (golden parachutes are put in place on their behalf), they are granted higher compensation. To further examine the impact of risk-taking incentives on exchange rate exposure, we create a control sample of a matching firm (that did not install a golden parachute provision during the same period, or previously) for each firm in our treatment group (firms that adopted the golden parachute). The matching firm is from the same 2-digit SIC industry as the treatment firm and has firm size within 20% of that of the treated firm in the same year. Then among all the candidate firms, we choose the one with the market-to-book ratio closest to the treated firm.

We compare the exchange rate exposure between treated and matching samples, both before and after the change in the golden parachute provision. As shown in Table 4, Panel C, the exposures are not significantly different between the two samples before the treated sample adopted the golden parachute. However, after the adoption of the golden parachute, mean exposure is significantly higher for the treated sample. This reinforces our argument that an increase in risk-taking incentives increases firms' exchange rate exposure.

5.1.4 Quasi-experiment with Regulation FAS 123R

In 2005, the accounting treatment of stock option grants changed with the passage of FAS 123R.[14] Prior to this, the accounting cost to the firm of granting stock options was calculated as the difference between the market price of the stock and the exercise price on the grant date. For most firms, the exercise price is set to be the grant day market price; thus, the accounting cost of stock option grants was usually zero. In 2004, the Financial Accounting Standards Board (FASB) required the use of the Black-Scholes value of the stock options on the grant date as the cost of the stock option grant. FAS 123R became effective for large businesses on the first reporting period that begins after Jun 15, 2005.[15] Because the new requirement imposes significant accounting cost on firms that grant stock options, the use of stock options began to decrease and were replaced by restricted stocks (Murphy, 2012). This creates a quasi-experiment for us to test how the exogenous change in compensation structure impacts exchange rate exposure.

We report the results of this test in Table 4, Panel D. First, the results show that there is a significant decline in CEOs' risk-taking incentives from 2005 to 2006, as evidenced by the decline in

[14] See http://www.fasb.org/pdf/fas123r.pdf.
[15] For a detailed discussion, see Hayes, Lemmon, and Qiu (2012)

vega (the increase in delta is not statistically significant). Contemporaneously, there was also a substantial decline in exchange rate exposure, by about 20% for exposure to the Broad index. This test further validates our hypothesis that CEOs' risk-taking incentives significantly impact firms' exchange rate exposure.

5.1.5 Quasi-experiment with Exogenous CEO Turnover

It is possible that the association between the CEO's risk-taking incentives and the firm's ex-post exchange rate exposure is actually determined by the board of directors. That is, the board can decide the compensation package with the desired level of risk-taking (or choose the CEO with the desired level of risk preference) and the level of exchange rate exposure. This could induce a simultaneity bias in favor of us finding the reported results.

To address this possibility, we identify firms with exogenous CEO turnover (Eisfeldt and Kuhnen 2013) and design a difference-in-differences test based on the exogenous turnovers.[16] To perform the difference-in-differences test we create two dummy variables: "*New*" equals one for the new CEO in the firm, and zero for the original CEO and "*Exog*" equals one if the turnover is exogenous, and zero if it is endogenous, as defined in Eisfeldt and Kuhnen (2013). The test investigates how a change in risk-taking incentives, before and after a CEO turnover, for firms with exogenous CEO turnovers leads to a change in the level of exchange rate exposure. The model is:[17]

$$\Delta\beta\widehat{(FX)}_{it} = \psi_1 New \times Exog \times \Delta Vega_{i,t-1} + \psi_2 New \times Exog \times \Delta Delta_{i,t-1} + \cdots + \varepsilon. \quad (3)$$

[16] We thank Eisfeldt and Kuhnen for generously providing the CEO turnover data. As we need to distinguish the "new" CEO from the "old" CEO we choose only those firms that had a single CEO turnover in the sample period. This leaves us with 607 distinct firms and 4,320 firm-year observations. We do not find any systematic difference between this sub-sample and the main sample, in terms of CEO risk-taking incentives and exchange rate risks.

[17] Note that the model includes all the double interaction terms that can be formed from the triple interaction terms plus the relevant controls.

If there was a CEO turnover in period *t*-1, we record the change in vega (delta) between *t*-1 and *t*, given the new (replacement) CEO's contract. We also find a control firm without turnover and measure its change in risk-taking incentives between *t*-1 and *t*. $\Delta vega_{i,t-1}$ represents the change in risk-taking incentives between *t* -1 and *t*, where *i* = firms without and firms with (either exogenous or endogenous) CEO turnovers. *Exog* represents a subset of turnovers, those that are exogenous to (not determined by) the board, such as the death of a previous CEO. When *New* is equal to one it identifies the replacement CEO and when it is zero it identifies a control firm's CEO (which has not had a turnover between *t*-1 and *t*). Hence, the coefficient estimates on the interaction terms in Equation (3) represent the effect of a change in risk-taking incentives on exchange rate exposure (relative to the control group) when there has been a turnover and the turnover was exogenous. As shown in Table 4, Panel E, the coefficient estimate on the interaction term including ΔVega is positive and significantly different from zero. Hence, using CEO turnover as a quasi-experimental setting, we show that an increase in risk-taking incentives (specifically vega) causes an increase in exchange rate exposure. Importantly, this relation is not because the board of directors jointly determines risk-taking incentives and firm-level exchange rate exposure. There is some marginally significant evidence that higher delta causes a decline in exposure. These results are consistent with our previous results.[18]

5.2 Accounting for Mechanisms that Influence Managerial Risk-Taking

In this subsection we attempt to deepen our understanding of the relation between risk-taking incentives and exposure by examining whether the Sarbanes-Oxley Act (SOX) and/or firm-level governance weakens the above relation. We also provide evidence on how certain firm characteristics

[18] In untabulated tests we also find qualitatively similar results to those reported when we estimate a change regression.

(intensity of firms' international operations and whether they are globally exposed through exports or imports) influence the impact of risk-taking incentives on exposure.

5.2.1 Effect of SOX

To the extent that our core finding reflects agency conflicts, the passage of the Sarbanes-Oxley (SOX) Act, which has had a substantial influence on firm governance, could potentially mitigate agency conflicts thereby weakening this relation. To examine the effect of SOX on the impact of risk-taking incentives on exposure, we modify Equation (1) in two ways. First, we augment the model with the interaction terms (vega × SOX dummy) and (delta × SOX dummy). Second, we replace the year fixed effects (yearly dummies) with the SOX dummy defined as one in the period after SOX (2003-2015), and zero otherwise. This is necessary because, otherwise the SOX dummy and the year fixed effects would be perfectly collinear as the SOX dummy can be formed from the individual year dummies.[19] If SOX is associated with a decline in the impact of vega on exposure, then the coefficient estimate on the interaction term will be negative and statistically significant. The standalone coefficient estimate on vega represents the pre-SOX impact of risk-taking incentives, while the post-SOX effect is the sum of the coefficients on vega and the interaction term.

The results are reported in Table 5. We find that vega (delta) is positively (negatively) and significantly associated with exposure in both the pre-Sox and post-SOX periods. However, the evidence indicates that the effect of vega on exposure is economically smaller, by about 15%, in the post-SOX period than in the pre-SOX period, consistent with the idea that the enactment of SOX altered managerial risk-taking behavior that influenced the magnitude of firms' exchange rate exposure.

[19] Inclusion of the post-SOX dummy as a standalone variable facilitates interpretation of the interaction effects.

5.2.2 Governance

The failure of SOX to completely sever the relation between risk-taking incentives and exposure still leaves open the possibility that firms' *internal* governance mitigates the principal-agency conflict to such an extent that it effectively eliminates this relation. It is possible, therefore, that our results arise from our failure, so far, to account for firm-level corporate governance. To examine this, we augment the 2SLS model in Equation (1) with a proxy for firm-level governance.

To proxy for governance, we use Bushee's (1998) classification of institutional investors. Institutional investors, especially those with long-term investment horizons, are associated with better governance. Following Bushee (1998), we categorize institutional investors into *Dedicated*, *Quasi-index*, and *Transient*, and construct the variable *relative institutional holding* using the amount of shares held by *Dedicated* institutions divided by the amount of shares held by *Transient* institutions. R*elative institutional holding* increases with good governance. We do not use the Governance Index from Gompers, Ishii, and Metrick (GIM, 2003) as our main measure because, it is relatively static over our sample period. However, our results are qualitatively similar when we use the GIM Index.

The second-stage results are reported in Table 6. They indicate that our main findings are robust to controlling for firm-level corporate governance. However, strong corporate governance reduces exchange rate exposure and, judging from the magnitude of the coefficient estimates on the risk-taking incentives (relative to the coefficient estimates in Table 3), it does reduce, though not eliminate, the impact of CEOs' risk-taking incentives on exchange rate exposure.

5.2.3 Effect of International Operations

In this subsection we examine the effect of risk-taking incentives on the exposure of purely domestic firms (indirect exposure) and firms that are globally engaged (direct exposure). While there is no denying that many purely domestic firms will be affected by currency changes through the channels identified in Section 2 (see, also, evidence of exposure of purely domestic firms in Aggarwal and Harper, 2010 and Bergbrant, Campbell, and Hunter, 2014), it is more difficult for these firms to measure and manage their indirect exposure (given the absence of transaction exposure, which is the easiest to measure and manage). However, although purely domestic firms might not actively engage in derivatives-based risk management strategies or operational hedging such as the use of foreign-currency-denominated debt, there are a range of operational hedging techniques that purely domestic firms (could) utilize to manage their indirect exposure. First, purely domestic firms could use promotional strategies to offset a currency-induced disadvantage arising from, say, an unanticipated appreciation of the dollar that benefits competing importers. Second, purely domestic firms could set their pricing strategy such that prices are sensitive to changes in indirect exposure. Third, purely domestic firms can alter their input or product mix to manage the potential effects of indirect exposure. For instance, to alter their indirect exposure, purely domestic firms can change their sales volume to customers that are exporters or they can vary the amount of input procured from importers. Likewise, they can change both the input from and output sold to exchange-rate-sensitive firms in order to offset indirect exposure through the cost and revenue channels. [20]

There are two relevant implications of the above. First, we expect that the exchange rate exposure of purely domestic firms will be sensitive to managerial risk-taking incentives. Second, the impact of risk-taking incentives on the exposure of purely domestic firms is expected to be economically smaller than the impact on the exposure of firms with direct exposure. That is, the impact of vega on exposure is expected to increase with international operations. To examine these implications we estimate an augmented version of our 2SLS model in which we include interactions between vega and dummy variables that represent the following ranges of foreign sales as a proportion

[20] These and several other operational hedges are frequently utilized by U.S. and global firms (Bodnar, Giambona, Graham, and Harvey (2016)).

of total sales: (0, 0.25], (0.25, 0.5], (0.5, 0.75], and (0.75, 1]. We use separate dummy variables of the level of foreign sales instead of the continuous variable to ease the interpretation of interaction terms with continuous variables.[21] In this specification the coefficient estimate on the standalone vega represents the impact of risk-taking incentives on the exchange rate exposure of purely domestic firms, while the interactions, if significant, indicate whether the impact of risk-taking incentives on exposure increases (positive coefficient) or decreases (negative coefficient) with the level of foreign sales.

The results are reported in Table 7. Consistent with our expectations, they indicate that vega is positively related to both direct and indirect exposure. The coefficient estimate on the standalone vega is positive, economically large, and statistically significant, indicating that risk-taking incentives increase exposure for purely domestic firms. In addition, we find that vega has an economically larger effect on direct exposure than on indirect exposure because in all three models reported at least one of the interaction terms has a positive and significant coefficient estimate. Moreover, the results for the Broad index indicate that the impact of vega on exposure increases with foreign sales up to the second quartile of foreign sales ratio, but is not significantly different from zero for the upper two quartiles of foreign sales. Hence, while vega's impact on exposure increases with foreign sales, the relation is not linear.

5.2.4 Evidence Related to Exporters and Importers

In this subsection we provide additional support for our main finding by examining the effect of risk-taking incentives on the exposure of firms with positive and negative exposure. Previous studies treat firms with positive exchange rate exposure as net importers and those with negative exchange rate exposure as net exporters, when the exchange rate index is quoted as foreign currency per dollar. Managers of net importers and net exporters may have different opportunities to manage

[21] We use foreign sales as our proxy of international operations primarily because the data on foreign assets are very limited.

exchange rate risk. For instance, because net exporters earn foreign currency, managers of net exporting firms can exercise greater flexibility in managing currency risk by, for example, deciding whether and how much to borrow in foreign currency. Hence, separating the sample into positive and negative exposures could enhance our understanding of the relation between exposure and risk-taking incentives. We estimate equation (1) for the absolute value of the negative exposures and the positive exposures separately, using the three currency indices. We use the absolute value of negative exposures to make clear and consistent comparison of the coefficients to our previous results and the results for the positive exposures. The results, reported in Table 8, are qualitatively similar to those previously reported. Interestingly, we find that managerial risk-taking incentives have a greater impact on firms with negative exposure (net exporters) than on firms with positive exposure (net importers).

6. Conclusion

For many U.S. firms exchange rate risk is one of the most important determinants of overall firm performance. Because managers have discretion over risk management policies and could have a different opinion from shareholders on the optimal level of risk for the firm, the structure of their compensation might be tied to the level of exchange rate risk to which their firms are exposed. This paper examines whether the risk-taking incentives in CEOs' compensation influences the level of firms' exchange rate exposure.

We find that risk-taking incentives reflected in CEOs' compensation significantly affect firms' exchange rate exposure. More specifically, we find that the sensitivity of CEOs' wealth to stock return volatility (vega) increases firms' exchange rate exposure while the sensitivity of CEOs' wealth to stock prices (delta) decreases exposure. We also find that vega increases exposure both for firms that do not engage in foreign trade or have foreign assets and for globally engaged firms, with the impact being greater for firms with international operations and for those that are exposed as net exporters compared to those exposed as net importers. Although the evidence indicates that the impact of risk-taking incentives on exposure declined after SOX, it remains economically robust and is also not qualitatively different when we account for firm-level governance.

Since exchange rate risk significantly reduces firm value, our results suggest that the existing evidence of significant exchange rate exposure can partly be viewed as a shift of interest from shareholders to managers.

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Appendix Variable description

Variable Name	Description	Calculation
Delta	Sensitivity of option with respect to a 1% change in stock price	Estimated by methods of Core and Guay (2002)
Vega	Sensitivity of option with respect to a 0.01 change in stock-return volatility	Estimated by methods of Core and Guay (2002)
Cash Compensation	Cash compensation (salary + bonus), scaled by annual total compensation	
ROA	Return on assets	#172/#6
Return	Annual stock return	
Leverage	Total debt scaled by total assets	(#9+#34)/#6
Firmsize	Log of total assets	log(#6)
PP&E	Net spending on property, plant and equipment scaled by total assets	
MTB	Market to book ratio of a firm	(#60-#6-#199*#25)/#6
Sales Growth	Annual sales growth rate	
CEO Share Ratio	CEO's total shareholdings scaled by total outstanding shares	
Foreign Sales Ratio	Firm's foreign sales, scaled by total sales	
Foreign Assets Ratio	Firm's foreign assets, scaled by total assets	
Tax Loss Carryforwards	Firm's tax loss carryforwards, scaled by total assets	
Dividend Payout Ratio	Dividends paid to common and preferred shareholders scaled by operating income before depreciation	(#19+#21)/#13
Quick Ratio	Cash and short-term investments divided by current liabilities	#1/#5
Age	CEO's age	ExecuComp Item
Tenure	CEO's tenure	
Beta (Broad) Beta (Major) Beta (OITP)	Exchange rate exposure (Beta) calculated with three U.S. level exchange rate indices: trade-weighted indices of the real bilateral exchange rates between the U.S. dollar and (i) the major currencies that trade freely outside of their country of issue (MAJOR); (ii) the currencies of several developing economies comprising the "other important trading partners" of the U.S. (OITP); (iii) the currencies of the countries in both the MAJOR and the OITP indices (BROAD).	
Relative Institutional Holding	Share held by *Dedicated* institutions divided by the amount of share held by *Transient* institutions	Bushee's (1998) sorting of institutional investors
HHI	Herfindahl Hirschman Index	Sum of the square of market share of all the firms in the industry

is the number of the item in Compustat

Table 1 Summary Statistics

This table reports summary statistics. The variable definitions are defined in the Appendix.

Variables	N	Mean	SD	p5	p25	p50	p75	p95
Exchange rate exposure								
Beta (Broad)	14748	-0.518	1.821	-3.791	-1.446	-0.388	0.521	2.231
Beta (OITP)	14748	-1.619	2.758	-6.610	-2.966	-1.252	0.088	2.263
Beta (Major)	14748	-0.072	1.141	-2.004	-0.670	-0.046	0.546	1.776
Abs(Beta Broad)	14748	1.382	1.294	0.087	0.452	1.012	1.894	4.068
Abs(Beta OITP)	14748	2.317	2.203	0.145	0.746	1.697	3.183	6.610
Abs(Beta Major)	14748	0.839	0.777	0.052	0.274	0.610	1.146	2.514
Positive(Beta Broad)	5762	1.105	1.025	0.065	0.354	0.800	1.530	3.329
Positive(Beta OITP)	3888	1.325	1.154	0.084	0.436	0.999	1.906	4.004
Positive(Beta Major)	7055	0.802	0.751	0.052	0.261	0.582	1.085	2.360
Negative(Beta Broad)	8986	-1.559	1.413	-4.448	-2.135	-1.159	-0.537	-0.103
Negative(Beta OITP)	10860	-2.673	2.374	-7.453	-3.627	-2.053	-0.952	-0.190
Negative(Beta Major)	7693	-0.873	0.799	-2.523	-1.199	-0.636	-0.287	-0.053
Firm Characteristics								
Total Assets	14748	5644.460	15731.461	154.356	524.637	1410.599	4239.105	24937.000
Leverage	14748	0.216	0.187	0.000	0.054	0.201	0.323	0.534
Cash Compensation	14748	0.335	0.215	0.077	0.162	0.285	0.472	0.758
PP&E	14748	0.274	0.214	0.037	0.109	0.211	0.386	0.733
Market-to-Book	14748	2.090	1.354	0.937	1.263	1.672	2.401	4.800
Sales Growth	14748	0.130	0.662	-0.185	0.004	0.081	0.183	0.509
ROA	14748	0.042	0.115	-0.133	0.021	0.055	0.092	0.167
CEO Share Ratio	14748	0.017	0.042	0.000	0.001	0.003	0.012	0.080
Return	14748	0.094	0.481	-0.574	-0.205	0.049	0.305	0.911
Foreign Sales Ratio	14748	0.250	0.228	0.000	0.000	0.227	0.437	0.626
Foreign Assets Ratio	14748	0.065	0.155	0.000	0.000	0.000	0.000	0.500
Tax Loss Carryfowards	14748	0.121	0.842	0.000	0.000	0.001	0.054	0.445
Dividend Payout Ratio	14748	0.075	0.140	0.000	0.000	0.016	0.117	0.275
Quick Ratio	14748	0.960	1.742	0.025	0.124	0.385	1.062	3.742
CEO Characteristics								
Delta	14748	751.940	1220.063	24.331	129.023	344.277	820.139	2904.785
Vega	14748	149.779	249.299	0.000	15.862	56.707	165.481	634.985
Age	14748	55.39	6.972	44	51	55	60	67
Tenure	14748	7.392	6.913	1	3	5	10	22

Table 2 Correlation between Exposure and Risk-taking Incentives

This table reports the pair-wise correlation between managerial risk-taking incentives and exchange rate exposure. The variable definitions are in the Appendix. The values in parentheses are *p*-values.

		1	2	3	4	5
1	Vega	1				
2	Delta	0.620***	1			
		(0.000)				
3	Abs(Beta Broad)	-0.118***	-0.0196**	1		
		(0.000)	(0.027)			
4	Abs(Beta OITP)	-0.100***	0.0214**	0.607***	1	
		(0.000)	(0.000)	(0.000)		
5	Abs(Beta Major)	-0.123***	-0.0296***	0.804***	0.381***	1
		(0.000)	(0.000)	(0.000)	(0.000)	

Table 3 Main Results

This table reports the main results from the second stage of the 2SLS model in Equation (1) for the absolute value of exchange rate exposure. Exchange rate exposure is estimated for period t+1, while other variables are from time t. The table also contains the statistical tests of weak identification, over-identification, and under-identification for the instrument. The values in parentheses are the standard errors. *, **, and *** denote a p-value less than 10%, 5% and 1%, respectively. Exchange rate exposure is estimated following Adler and Dumas (1984) with individual firms' exchange rate exposure over a 52-week window prior to the fiscal year end. Three exposures are obtained with respect to three exchange rate indices: trade-weighted indices of the real bilateral exchange rates between the U.S. dollar and (i) the major currencies that trade freely outside of their country of issue (MAJOR); (ii) the currencies of several developing economies comprising the "other important trading partners" of the U.S. (OITP); and (iii) the currencies of the countries in both the MAJOR and the OITP indices (BROAD). Compensation data are for CEOs, obtained from ExecuComp. Delta and Vega represent the sensitivity of the CEO's equity portfolio value to 1% change in stock price and 1% change in stock volatility, respectively, as calculated using the method described in Core and Guay (2002). Firm characteristics are calculated with data from Compustat. Firm Size is the natural log of total assets. PP&E is net spending on property, plant and equipment scaled by total assets. Sales Growth is the growth rate of total sales over the past year. Market-to-Book is the market-to-book ratio calculated as (total common equity-total asset-total market value)/total assets. Leverage is debt scaled by total assets. ROA is the return on assets. Tax Loss Carryforwards is the tax loss carryforwards available to the firm scaled by the total assets. Dividend Payout Ratio is the dividends paid to common and preferred shareholders scaled by operating income before depreciation. Quick Ratio is the cash and other short-term investments divided by current liabilities. Foreign Sales Ratio is the foreign sales scaled by total sales. Foreign Assets Ratio is the foreign assets scaled by total assets. CEO Share Ratio is the CEO's holding of firm share scaled by the total outstanding shares. Age and Tenure are CEO based characteristics. All the continuous variables are winsorized at 1% and 99% level.

	(1)	(2)	(3)
VARIABLES	Abs(Beta Broad)	Abs(Beta OITP)	Abs(Beta Major)
log(vega) Predicted	0.36***	1.26***	0.15***
	(0.032)	(0.052)	(0.020)
log(delta) Predicted	-0.48***	-1.36***	-0.28***
	(0.048)	(0.082)	(0.029)
Leverage	0.16**	0.12	0.10**
	(0.071)	(0.122)	(0.043)
Firm Size	-0.02	-0.05	0.00
	(0.022)	(0.039)	(0.013)
PP&E	0.02	0.38***	0.05
	(0.082)	(0.132)	(0.050)
Market-to-Book	0.16***	0.37***	0.10***
	(0.018)	(0.033)	(0.010)
Sales Growth	0.15***	0.36***	0.08**

	(0.053)	(0.093)	(0.033)
CEO Share Ratio	6.80***	19.77***	3.80***
	(0.690)	(1.181)	(0.412)
Foreign Sales Ratio	-0.21***	-0.84***	-0.04
	(0.053)	(0.086)	(0.033)
Foreign Assets Ratio	-0.01	-0.17	0.10**
	(0.066)	(0.111)	(0.042)
Tax Loss Carryforwards	0.02	0.04**	-0.00
	(0.014)	(0.020)	(0.006)
Dividend Payout Ratio	-0.88***	-1.74***	-0.48***
	(0.073)	(0.126)	(0.046)
Quick Ratio	-0.00	0.00	-0.00
	(0.007)	(0.014)	(0.004)
log(age)	0.05	0.25	-0.03
	(0.094)	(0.156)	(0.058)
log(tenure)	0.14***	0.33***	0.10***
	(0.023)	(0.040)	(0.014)
Constant	2.35***	2.89***	1.74***
	(0.414)	(0.706)	(0.258)
Industry Control	Yes	Yes	Yes
Year Control	Yes	Yes	Yes
Observations	14,096	14,096	14,096
Adj. R-squared	0.08	0.11	0.07
Underidentification test (Anderson LM statistic)	281.2	281.2	281.2
P-value	0.000	0.000	0.000
Weak identification test (Cragg-Donald Wald F statistic)	71.43	71.43	71.43
Stock-Yogo weak ID test critical values	11.04	11.04	11.04
Sargan statistic (overidentification test)	0.236	0.004	1.317
P-value	0.627	0.952	0.251

Table 4 Additional Tests for Endogeneity

This table presents the results for additional robustness checks regarding the potential endogeneity concerns from the risk-taking incentive and firms' ex-post exchange rate exposure. Panel A reports the dynamic panel GMM model (Arellano and Bond, 1991) using the lagged value and the difference of the risk-taking incentives as instruments. Panel B reports the univariate test on firms that began to first grant their CEOs with stock options during our sample period. The mean column stands for mean of the change of the underlying variables after the first grant of options. Panel C reports the univariate test when the firm adopted the golden parachute anti-takeover provision. The matching sample is matched within the same year and same 2-digit SIC industry, with firm size no larger than 120% and no less than 80% of the treated firm, and the market-to-book ratio the closest to the treated firm. Panel D reports the univariate test regarding the passage of FAS 123R. The t-statistics and p-values refer to the results for the t-test on the difference of means. Panel E reports the difference-in-difference OLS test using CEO's exogenous turnovers as exogenous event. The coefficients of control variables are suppressed. The definition of the variables are the same as in the previous tables. The values in parentheses are the standard errors. *, **, and *** denote the p-value less than 10%, 5% and 1%, respectively.

Panel A: Dynamic panel GMM approach

VARIABLES	(1) Abs FX(Beta Broad)	(2) Abs FX(Beta OITP)	(3) Abs FX(Beta Major)
log(vega)$_{t-1}$	0.16***	0.25***	0.09***
	(0.037)	(0.055)	(0.022)
log(delta)$_{t-1}$	-0.54***	-0.60***	-0.27***
	(0.071)	(0.107)	(0.042)
Firm Characteristics	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes
Year Control	Yes	Yes	Yes
Observations	14,747	14,747	14,747

Panel B: First inclusion of the stock option grant in the compensation

	Mean	Std	t-stat (Mean=0)	p-value
Δlog(vega)	3.914***	0.090	43.28	0.000
Δlog(delta)	1.245***	0.096	12.92	0.000
ΔAbs(Beta Broad)	0.295**	0.134	2.197	0.030
ΔAbs(Beta OITP)	0.160	0.194	0.826	0.410
ΔAbs(Beta Major)	0.169**	0.077	2.186	0.031

Panel C: Quasi-experiment with the installment of golden parachute

	Mean	Std	t-stat (Mean=0)	p-value
Δlog(vega)	0.097***	0.035	2.801	0.005
Δlog(delta)	0.144***	0.035	4.110	0.000

	Mean(Treated Sample)	Mean(Matched Sample)	Difference	t-stat (Difference=0)	p-value
Before golden parachute					
Abs(Beta Broad)	1.73	1.75	-0.03	-0.901	0.37
Abs(Beta OITP)	2.86	2.88	-0.01	-0.291	0.77
Abs(Beta Major)	1.02	1.03	-0.02	-0.872	0.38
After golden parachute					
Abs(Beta Broad)	1.40	1.32	0.07***	2.22	0.01
Abs(Beta OITP)	2.35	2.20	0.15***	2.85	0.00
Abs(Beta Major)	0.82	0.78	0.04**	2.03	0.02

Panel D: Quasi-experiment with the regulation FAS 123 R

	Mean(Before FAS 123R)	Mean(After FAS 123R)	Difference	t-stat (Difference=0)	p-value
log(vega)	4.19	3.91	0.29***	3.76	0.00
log(delta)	5.46	5.49	-0.03	-0.45	0.67
Abs(Beta Broad)	2.02	1.62	0.39***	7.00	0.00
Abs(Beta OITP)	3.45	3.31	0.14*	1.63	0.05
Abs(Beta Major)	1.02	0.83	0.18***	5.64	0.00

Panel E: Quasi-experiment with CEO's exogenous turnovers

	(1)	(2)	(3)
VARIABLES	ΔAbs FX(Beta Broad)	ΔAbs FX(Beta OITP)	ΔAbs FX(Beta Major)
Δlog(vega) $_{t-1}$ × (New CEO × Exog Turnover)	0.39**	0.25	0.27***
	(0.168)	(0.310)	(0.102)
Δlog(delta) $_{t-1}$ × (New CEO × Exog Turnover)	-0.34*	-0.27	-0.19
	(0.201)	(0.401)	(0.124)
Firm Characteristics	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes
Year Control	Yes	Yes	Yes
Observations	3,472	3,472	3,686
Adj. R-squared	0.12	0.19	0.10

Table 5 Effect of Sarbanes-Oxley Act (SOX)

This table shows the robustness check incorporating the effect of Sarbanes-Oxley Act of 2002. The results are based on the 2SLS method, with predicted delta and vega calculated from the first-stage regression. SOX is a dummy variable that equals one for year 2003 and onwards, and zero otherwise. The variable calculations are same as in Table 3. Control variables are also the same as in Table 3 (not reported for space saving). The values in in parentheses are the standard errors. *, **, and *** denote the p-value less than 10%, 5% and 1%, respectively.

VARIABLES	(1) Abs(Beta Broad)	(2) Abs(Beta OITP)	(3) Abs(Beta Major)
log(vega) Predicted	0.40***	1.38***	0.14***
	(0.039)	(0.066)	(0.024)
log(delta) Predicted	-0.46***	-1.29***	-0.20***
	(0.055)	(0.093)	(0.033)
log(vega) Predicted × SOX	-0.06**	-0.19***	-0.01
	(0.026)	(0.045)	(0.016)
log(delta) Predicted × SOX	-0.02	-0.04	-0.01
	(0.023)	(0.040)	(0.014)
SOX	0.31***	0.79***	-0.05
	(0.097)	(0.161)	(0.059)
Constant	2.23***	2.62***	1.75***
	(0.419)	(0.710)	(0.258)
Control Variables	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes
Observations	14,096	14,096	14,096
Adj. R-squared	0.08	0.12	0.08

Table 6 Effect of Governance

This table shows the robustness check incorporating the corporate governance. The results are based on the 2SLS method, with predicted delta and vega calculated in the first-stage regression. Governance level is proxied by Relative Institutional Holding. It is calculated as the percentage of share held by dedicated investors over the percentage of share held by transient investors. The classification of dedicated and transient investors is based on Bushee (1998). Higher Relative Institutional Holding stands for more dedicated investors, thus proxies for better governance. The variable calculations are same as the Table 3. Control variables are also the same as in Table 3 (not reported for space saving). The values in parentheses are the standard errors. *, **, and *** denote the p-value less than 10%, 5% and 1%, respectively.

	(1)	(2)	(3)
VARIABLES	Abs(Beta Broad)	Abs(Beta OITP)	Abs(Beta Major)
log(vega) Predicted	0.13**	0.16	0.07**
	(0.059)	(0.101)	(0.036)
log(delta) Predicted	-0.26***	-0.41***	-0.14***
	(0.072)	(0.123)	(0.043)
Relative Institutional Holdings	-0.02**	-0.05***	-0.00
	(0.007)	(0.010)	(0.005)
Constant	2.30***	3.02***	1.72***
	(0.443)	(0.773)	(0.287)
Control Variables	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes
Year Control	Yes	Yes	Yes
Observations	11,560	11,560	11,560
Adj. R-squared	0.19	0.28	0.17

Table 7 Purely Domestic Firms vs. Globally Engaged Firms

This table shows the impact of international operations on the link between CEO risk-taking incentives and firm's exchange rate exposure. The results are based on the 2SLS method, with predicted delta and vega calculated from the first-stage regression. We define four dummy variables to capture the non-linearity of Foreign Sales Ratio, the proxy for international operations. Foreign Sales Ratio (0, 0.25) equals one for values of foreign sales ratio between 0 (not included) and 0.25 (included), and zero otherwise. Foreign Sales Ratio (0.25, 0.5) equals one for values of foreign sales ratio between 0.25 (not included) and 0.5 (included), and zero otherwise. Foreign Sales Ratio (0.5, 0.75) equals one for values of foreign sales ratio between 0.5 (not included) and 0.75 (included), and zero otherwise. Foreign Sales Ratio (0.75, 1) equals one for values of foreign sales ratio between 0.75 (not included) and 1 (included), and zero otherwise. The variable calculations are same as the Table 3. Control variables are also the same as in Table 3 (not reported for space saving). The values in in parentheses are the standard errors. *, **, and *** denote the p-value less than 10%, 5% and 1%, respectively.

VARIABLES	(1) Abs(Beta Broad)	(2) Abs(Beta OITP)	(3) Abs(Beta Major)
log(vega) Predicted	0.31***	1.19***	0.13***
	(0.037)	(0.060)	(0.023)
log(vega) Predicted × Foreign Sales Ratio (0, 0.25]	0.06**	0.04	0.04**
	(0.031)	(0.054)	(0.019)
log(vega) Predicted × Foreign Sales Ratio (0.25, 0.5]	0.05*	0.11**	0.02
	(0.031)	(0.054)	(0.020)
log(vega) Predicted × Foreign Sales Ratio (0.5, 0.75]	-0.07	-0.10	-0.05
	(0.051)	(0.082)	(0.033)
log(vega) Predicted × Foreign Sales Ratio (0.75, 1]	-0.00	-0.11	0.01
	(0.085)	(0.129)	(0.050)
log(delta) Predicted	-0.44***	-1.25***	-0.27***
	(0.050)	(0.085)	(0.030)
log(delta) Predicted × Foreign Sales Ratio (0, 0.25]	-0.04	-0.01	-0.02
	(0.022)	(0.038)	(0.013)
log(delta) Predicted × Foreign Sales Ratio (0.25, 0.5]	-0.03	-0.08**	0.00
	(0.022)	(0.038)	(0.014)
log(delta) Predicted × Foreign Sales Ratio (0.5, 0.75]	0.04	0.01	0.04
	(0.037)	(0.059)	(0.024)
log(delta) Predicted × Foreign Sales Ratio (0.75, 1]	-0.07	-0.12	-0.03
	(0.064)	(0.097)	(0.038)
Constant	2.30***	2.67***	1.75***
	(0.414)	(0.706)	(0.258)
Control Variables	Yes	Yes	Yes
Industry Control	Yes	Yes	Yes
Year Control	Yes	Yes	Yes
Observations	14,096	14,096	14,096
Adj. R-squared	0.08	0.11	0.08

Table 8 Positive and Negative Exchange Rate Exposure

This table shows the results with same models as the one in Table 3, Panel B, using positive and negative foreign exchange exposures. Columns (1)-(3) and Columns (4)-(6) report the results on subsamples of positive and negative exchange rate exposure, respectively. Note that, to make clear and consistent comparison of the coefficients, we also use the *absolute value* of the negative exchange rate exposure in the separated sample test. The variable calculations are the same as in Table 3. Control variables are also the same as in Table 3 (not reported for space saving). The values in parentheses are the standard errors. *, **, and *** denote the p-value less than 10%, 5% and 1%, respectively.

VARIABLES	(1) Positive(Beta Broad)	(2) Positive(Beta OITP)	(3) Positive(Beta Major)	(4) Negative(Beta Broad)	(5) Negative(Beta OITP)	(6) Negative(Beta Major)
log(vega) Predicted	0.27***	-0.04	0.15***	0.43***	1.42***	0.18***
	(0.068)	(0.096)	(0.046)	(0.045)	(0.071)	(0.027)
log(delta) Predicted	-0.40***	-0.17*	-0.21***	-0.53***	-1.55***	-0.26***
	(0.081)	(0.106)	(0.055)	(0.070)	(0.108)	(0.042)
Leverage	0.11	0.02	0.16***	0.21**	0.23	0.12*
	(0.086)	(0.121)	(0.058)	(0.102)	(0.158)	(0.061)
Firm Size	-0.04	-0.02	-0.05**	-0.03	-0.04	-0.01
	(0.030)	(0.043)	(0.020)	(0.031)	(0.047)	(0.019)
PP&E	0.01	-0.31**	-0.03	-0.06	0.46***	-0.05
	(0.104)	(0.149)	(0.068)	(0.113)	(0.164)	(0.070)
Market-to-Book	0.10***	0.08**	0.04**	0.19***	0.42***	0.09***
	(0.024)	(0.033)	(0.017)	(0.025)	(0.040)	(0.015)
Sales Growth	0.04	0.00	0.04	0.19**	0.46***	0.09*
	(0.039)	(0.039)	(0.035)	(0.084)	(0.130)	(0.050)
CEO Share Ratio	5.91***	2.17	2.83***	7.31***	22.61***	3.72***
	(1.136)	(1.496)	(0.783)	(0.999)	(1.540)	(0.586)
Foreign Sales Ratio	-0.17**	-0.15	-0.05	-0.28***	-0.77***	-0.10**
	(0.069)	(0.092)	(0.047)	(0.074)	(0.114)	(0.045)
Foreign Assets Ratio	-0.03	-0.08	-0.01	-0.08	-0.27*	-0.08
	(0.089)	(0.125)	(0.061)	(0.092)	(0.136)	(0.059)
Tax Loss Carryforwards	0.03	-0.01	0.01	0.02	0.14**	0.01
	(0.021)	(0.014)	(0.011)	(0.021)	(0.056)	(0.012)
Dividend Payout Ratio	-0.64***	-0.44***	-0.37***	-1.05***	-2.01***	-0.54***
	(0.085)	(0.119)	(0.062)	(0.110)	(0.168)	(0.064)
Quick Ratio	0.00	-0.03*	0.00	-0.00	0.01	0.00
	(0.009)	(0.013)	(0.006)	(0.010)	(0.017)	(0.006)
log(age)	-0.01	-0.06	-0.10	0.09	0.13	0.06
	(0.116)	(0.162)	(0.079)	(0.130)	(0.194)	(0.080)
log(tenure)	0.11***	0.08*	0.06***	0.15***	0.38***	0.07***
	(0.033)	(0.044)	(0.022)	(0.033)	(0.050)	(0.020)
Constant	2.03***	1.45**	2.18***	2.63***	3.77***	1.44***
	(0.490)	(0.675)	(0.365)	(0.575)	(0.862)	(0.346)
Industry Control	Yes	Yes	Yes	Yes	Yes	Yes
Year Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,380	3,633	6,656	8,716	10,463	7,440
Adj. R-squared	0.17	0.15	0.20	0.10	0.13	0.10

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