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MULTINATIONALITY AND DOWNSIDE RISK: THE ROLES OF OPTION PORTFOLIO AND ORGANIZATION

RENÉ BELDERBOS,[1,2,3] TONY W. TONG,[4] and SHUBIN WU[5]*
[1] *Department of Managerial Economics, Strategy and Innovation, University of Leuven, Leuven, Belgium*
[2] *UNU-MERIT, Maastricht, The Netherlands*
[3] *School of Business and Economics, Maastricht University, Maastricht, The Netherlands*
[4] *Leeds School of Business, University of Colorado, Boulder, Colorado, U.S.A.*
[5] *School of International Business Administration, Shanghai University of Finance and Economics, Shanghai, China*

Multinational operations confer firms a portfolio of switching options that offer potential operating flexibility in the context of input cost variability, helping firms reduce downside risk. We suggest that two conditions may shape the relationship between multinationality and downside risk. When subadditivity is present in a firm's option portfolio, such as when the firm operates affiliates in host countries with similar labor cost developments, multinationality is less likely to reduce downside risk since less valuable opportunities exist for shifting operations. Multinationality is more likely to reduce downside risk if a firm's organization facilitates the coordination of cross-border activities, enabling the exploitation of the shifting opportunities. Analysis of a comprehensive panel dataset of Japanese manufacturing firms and their foreign manufacturing affiliates provides support for these conjectures. Copyright © 2013 John Wiley & Sons, Ltd.

INTRODUCTION

One important characteristic of multinational firms is that they invest in multiple countries and operate international affiliates across heterogeneous external environments. According to real options theory, the network of international operations provides the multinational firm with a portfolio of switching options, which confer the firm the right, but not the obligation, to shift operating activities among its cross-country affiliates in response to changes in environmental conditions (e.g., Chi and Seth, 2009; Kogut, 1985; Kogut and Kulatilaka, 1994; Li and Rugman, 2007). Theoretical research suggests that, to the extent that such options offer valuable switching opportunities that the firm is able to exploit, they should enhance the firm's operational flexibility and reduce its downside risk; i.e., performance that falls below certain target (Huchzermeier and Cohen, 1996). Empirical studies have reported that multinational firms do shift sourcing, production, and other activities in response to input cost movements, though such shifts might be relatively modest (e.g., Rangan, 1998). International investments also reduce multinational firms' economic exposures to foreign exchange rate fluctuations, yet greater multinationality does not necessarily lead to lower levels of downside risk (e.g., Miller and Reuer, 1998; Reuer and Leiblein, 2000; Tong and Reuer, 2007).

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*Correspondence to: Shubin Wu, School of International Business Administration, Shanghai University of Finance and Economics, 777 Guoding Road, Shanghai, China.
E-mail: wu.shubin@mail.shufe.edu.cn

In keeping with prior arguments that an options approach to strategy has a distinguishing focus on firms' investments for limiting downside risk (Bowman and Hurry, 1993), our study investigates the downside risk implications of multinational investment. Specifically, our research emphasizes the need to examine more closely real options theory's boundary conditions in multinational firms and to incorporate more explicitly organizational contingencies that may facilitate or obstruct firms' implementation of real options. We aim to make two contributions. First, our study examines how characteristics of the firm's foreign affiliate portfolio, in terms of host countries' environment, may shape the relationship between multinationality and downside risk. Research has suggested that multiple options within a portfolio can interact negatively if the characteristics of the options are correlated; in such cases, the options in the portfolio are considered subadditive (McGrath, 1997; Trigeorgis, 1996), and the value of the option portfolio is smaller than the sum of the values of the individual options. We argue that in the context of multinational switching options, subadditivity can arise from positive correlations in the host countries' economic conditions such as labor cost developments. Positive correlations decrease the benefit of flexibility available from shifting operations across countries and thus weaken the negative impact of multinationality on downside risk, whereas negative correlations enhance the benefit of flexibility. Our study's focus on the implications of subadditivity for firms' performance outcomes complements prior real options research showing that subadditivity in option portfolios affects firms' corporate strategy decisions such as market entry and exit (e.g., Belderbos and Zou, 2009; McGrath and Nerkar, 2004; Vassolo, Anand, and Folta, 2004).

Second, we examine how particular organizational characteristics of the multinational firm's portfolio of foreign affiliates can shape the relationship between multinationality and downside risk. We argue that greater equity share as well as expatriate assignment in the firm's affiliates give the firm increased control and system-wide coordination of multinational operations and therefore strengthen the negative impact of multinationality on downside risk. We further suggest that these moderating effects will be stronger for firms that have potentially the greatest switching opportunities in their affiliate portfolios. Our theoretical arguments are consistent with Kogut's seminal idea that whereas switching options provide the potential for operating flexibility, the firm must possess the 'organizational wherewithal' to coordinate cross-border activities between affiliates in order to benefit from flexibility (Kogut, 1985: 27). Although the importance of organizational factors is well recognized in the literature (e.g., Bowman and Moskowitz, 2001; Coff and Laverty, 2007; Kogut and Kulatilaka, 2004), few empirical studies have examined such factors, and to our knowledge no study in the real options literature has tested the joint and interactive effects of organizational characteristics and external conditions in an *integrated* manner.

We empirically test our arguments using a comprehensive panel dataset of 1,010 Japanese manufacturing firms and their foreign manufacturing affiliates from 1985 to 2006. Our empirical findings confirm our hypotheses and support the central thesis that subadditivity in an option portfolio and organizational factors jointly and interactively affect multinational firms' ability to benefit from operating flexibility conferred by the global dispersion of activities.

THEORY AND HYPOTHESES

Initial applications of real options theory in the strategy field appeared in the context of multinational firms and the coordination of their operating activities dispersed across country borders. Kogut (1983) first argued that multinational operations provide firms with a string of options that offer the potential for flexibility by allowing the switching of activities within the multinational network. Compared to other theories of multinational firms, real options theory emphasizes downside risk reduction and dynamic production efficiency gains, as well as the unique opportunities to shift activities in response to changes in environmental conditions (e.g., Kogut, 1985, 1989). Research has sought to extend these pioneering ideas in several ways. For example, a large amount of work has applied real options theory to examine multinational firms' strategies under uncertainty, such as their market entry and exit decisions, sequential investments, entry mode choices, and ownership strategies (e.g., Belderbos and Zou, 2009; Brouthers, Brouthers, and Werner, 2008; Chi and McGuire, 1996; Chi and Seth, 2009; Cuypers and

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Martin, 2010; Kouvelis, Axarloglou, and Sinha, 2001; Li and Li, 2010; Rangan, 1998).

Theoretical and empirical research has also examined the implications of switching options for multinational firms' performance outcomes and risk levels. For example, Kogut and Kulatilaka (1994) develop an analytical model to study the option to switch production between two host countries. They find that the value of the switching option increases with uncertainty concerning the exchange rate between the currencies of the two countries and that the flexibility to switch production to a location offering lower input costs can reduce firms' downside risk that profits are negatively affected by adverse exchange rate fluctuations. Kogut and Kulatilaka (1994) clarify that the option value of multinationality is different from that of the benefits of geographic diversification (Rugman, 1976). For instance, as these authors argue, '[T]he benefits of diversification are created by the reduction in variance of the overall portfolio of subsidiary results. An option, on the other hand, is valuable because it gives managerial discretion to respond profitably to the realization of uncertain events' (p. 125). Empirical research that followed the real option approach has sought to understand further the conditions under which multinational operations can enhance firms' market value (e.g., Allen and Pantzalis, 1996; Lee and Makhija, 2009; Tang and Tikoo, 1999; Tong, Reuer, and Peng, 2008) or reduce firms' downside risk (e.g., Driouchi and Bennett, 2011; Reuer and Leiblein, 2000; Tong and Reuer, 2007).

This study seeks to advance existing knowledge of the flexibility benefits afforded by multinational operations, particularly downside risk reduction due to multinationality given option theory's distinctive focus on limiting downside risk (e.g., Bowman and Hurry, 1993). Specifically, our arguments emphasize the need to examine more closely real options theory's boundary conditions in multinational firms, and to incorporate more explicitly organizational contingencies that may facilitate or obstruct firms' implementation of real options, as will be seen in our hypotheses below.

The role of subadditivity in option portfolios

Researchers have suggested that firms undertaking multiple investment projects can be viewed as possessing a portfolio of real options (e.g., Bowman and Hurry, 1993; Luehrman, 1998; Zingales, 2000). However, the values of the individual options in a portfolio may be subadditive because of option interactions; i.e., the value of a portfolio of options may be less than the summation of the values of these options if they were independent. Milgrom and Roberts (1990) develop the notion of subadditivity in terms of correlated cost functions and optimal designs of organization practices. Extending their notations to options, subadditivity between two real options, A and B, in an option portfolio can be defined as: $V(A, B) < V(A) + V(B)$, where V(A, B) denotes the value of the option portfolio and V(A) and V(B) denote the value of the two individual options, respectively.

Real options research recognizes that individual options within a portfolio may be subadditive in their values due to redundancies or overlaps among multiple investments (e.g., McGrath, 1997; Trigeorgis, 1996), reducing the option value of the portfolio as a whole. For example, consistent with this logic, McGrath and Nerkar (2004) find that firms are less likely to take out additional options (i.e., patents) in technological areas where they previously have acquired options. In the context of divestments, Vassolo *et al.* (2004) show that an alliance's technological proximity to that of other alliances in the firm's portfolio increases the likelihood of the alliance being divested.

The idea that options may be subadditive also applies to multinational firms operating a portfolio of manufacturing affiliates in multiple countries that confers switching options for manufacturing activities. Such subadditivity is a function of potential correlations in economic conditions in the external environments of the countries in which the firm operates. For instance, Kogut and Kulatilaka (1994) show through an analytical model that as the input costs in host countries become more correlated, the value of switching operations between the affiliates in these countries will decrease, as there are fewer opportunities to reduce costs by switching manufacturing activities between locations. Consistent with this notion of subadditivity in foreign affiliate portfolios, Belderbos and Zou (2009) find that a foreign affiliate is more likely to be divested when the economic conditions of the affiliate's host country are highly correlated with those of the other countries in which the firm operates.

Hereby we emphasize that the notion of subadditivity in the multinational firm's option portfolio

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is conceptually different from the idea of decreasing marginal benefit with increasing multinationality (e.g., Lu and Beamish, 2004; Qian *et al.*, 2010). Subadditivity focuses on the *correlations* between options (their characteristics) in a firm's option portfolio, rather than the number of options in the firm's portfolio. As will be seen below, in our study, subadditivity focuses on the correlation in labor cost developments of the host countries in which the firm operates, rather than the sheer number of countries in which the firm has operations.

We suggest that subadditivity will shape the impact of multinationality on firms' downside risk. The higher the degree of subadditivity, the smaller the contribution of investing in multiple countries to the flexibility potential of shifting the firm's activities across countries and the less such investment will help to contain downside risk. One important source of subadditivity in multinational operations that has received the most research attention is correlations in labor costs among the countries in which the firm operates affiliates (e.g., Dasu and Li, 1997; de Meza and van der Ploeg, 1987). For manufacturing firms, labor cost development is a particularly critical consideration in international manufacturing and a major driver of foreign direct investment (e.g., Kouvelis *et al.*, 2001). This focus is consistent with prior research on multinational plant configurations and operating flexibility, where minimizing production cost is one of the primary objectives (e.g., de Meza and van der Ploeg, 1987). Given the role of subadditivity in shaping the value of option portfolios as discussed, we propose that the negative impact of multinationality will be weaker for firms that experience high correlations in labor costs among the host countries in which they operate than firms that experience low correlations:

> *Hypothesis 1: The negative impact of multinationality on downside risk is stronger for firms operating in host countries with relatively low correlations in labor costs*.

The organization of affiliate portfolios

Heterogeneous economic conditions such as labor cost movements in the multinational firm's international operations provide more valuable shifting opportunities and greater potential for the firm to benefit from operating flexibility. However, whether such flexibility is realized and downside risk reduction materializes might also depend on the firm's ability to control and coordinate the shifting of cross-border activities among the dispersed affiliates. Research has long emphasized the need to attend to organizational issues and coordination problems that can surround the management of a portfolio of switching options in multinational firms. This point has been made clear in Kogut's (1989: 388) work: 'having the potential to exercise flexibility is a far cry from having the management system to do it.' Recent research echoes this view, arguing that organizational forms and management systems can play a critical role in facilitating or inhibiting the implementation of real options and thus affecting flexibility in multinational firms (Kogut and Kulatilaka, 1994; Kouvelis *et al.*, 2001; Rangan, 1998; Tong and Reuer, 2007).

Consistent with these ideas, we examine two ways in which multinational firms can organize their foreign affiliates to achieve flexibility and reduce risk. One important factor that may affect firms' control and coordination of shifting production and other activities is the equity ownership of their foreign affiliates, because such ownership affects the distribution of incentives and control rights throughout the firms' international operations. The idea that equity ownership may shape incentive alignment in foreign affiliates and affect firms' pursuit of system-wide operating flexibility can be traced to Stopford and Wells' (1972) seminal work on multinational firms. Stopford and Wells analyzed the conflict between serving subsidiary versus system-wide goals in the context of subsidiary equity ownership; and they suggested that, when local partners have greater equity stakes and control in a subsidiary, partner conflicts are more likely to increase and firms may lose flexibility as a result. This argument is consistent with recent research suggesting that partnering firms tend to differ in goals, values, routines, and cultural backgrounds, and that these differences likely lead to conflicts over their affiliates' strategic directions and operational practices (e.g., Hennart, Kim, and Zeng, 1998). In the real options literature, such conflicts dampen the system-wide objectives to exercise the option to coordinate multinational activities and obstruct operating flexibility (Kogut and Kulatilaka, 1994).

Equity ownership can also determine the firm's ability to exercise control over its foreign affiliates and coordinate cross-border operations (e.g., Gatignon and Anderson, 1988). Control and

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coordination are important for achieving operating flexibility, since the firm would need to manage its affiliates as an integrated operation network in order to adjust production optimally in response to environmental conditions among the host countries (e.g., Kogut, 1985; Kogut and Kulatilaka, 1994). Everything else constant, the control and coordination required for operating flexibility may be more difficult to obtain, when firms have a smaller equity share in their foreign affiliates (e.g., Kogut, 1989; Stopford and Wells, 1972). In fact, in such cases, greater control rights are put in the hands of partners in the host country, whose objectives are more likely to be country-specific, rather than consistent with the interests of the multinational firms as a whole. Combined with the earlier argument on partners' incentives and conflicts, this line of reasoning suggests that firms having greater equity share in their affiliates will be better able to exploit the opportunities for switching. Using real option terms, the improved incentive alignment and superior control and coordination should facilitate the firm's evaluation and exercise of the switching options, leading to lower downside risk. Thus, we hypothesize that the firm's equity share in its foreign affiliates will strengthen the negative impact of multinationality on downside risk; namely:

Hypothesis 2a: The greater the firm's equity share in its portfolio of foreign affiliates, the stronger the negative impact of multinationality on downside risk.

The above hypothesis indicates a moderating effect of equity share on the relationship between multinationality and downside risk for multinational firms in general. Considering the role of subadditivity in shaping the value of option portfolios emphasized in Hypothesis 1 earlier, we suggest that this moderating effect may also vary across specific firms confronting differing input cost conditions in their host countries. Specifically, when labor cost developments in the firms' host countries are less correlated (i.e., less subadditive), more valuable opportunities exist for switching activities (de Meza and van der Ploeg, 1987). Effective implementation of switching opportunities to reduce downside risk requires greater coordination (e.g., Kogut, 1985; Kogut and Kulatilaka, 1994), which will be more readily available with a greater equity share. By contrast, when labor cost movements are more correlated (i.e., more subadditive), less valuable scope exists for switching and the organizational demands for coordinating affiliates are also lower; in this situation, greater equity share will be less useful for facilitating cross-border coordination to implement switching options. This suggests the following hypothesis:

Hypothesis 2b: The moderating effect of equity share on the relationship between multinationality and downside risk will be greater for firms operating in host countries with relatively low correlations in labor costs.

Another factor that can affect multinational firms' control and coordination of foreign affiliates is their human resource management policies, and specifically we suggest that firms' assignment of expatriates to their affiliates can shape the relationship between multinationality and downside risk. Prior research has shown that multinational firms often assign expatriates overseas to exercise control and to coordinate foreign affiliates' activities with the headquarters and with sister affiliates (e.g., Boyacigiller, 1990; Edström and Galbraith, 1977). The assignment of expatriates to an affiliate helps to ensure that the way the affiliate is managed is in line with the global interest of the parent company to enhance system-wide coordination (e.g., Fang *et al.*, 2010; Geringer and Frayne, 1990; Gupta and Govindarajan, 2000). Japanese multinational firms in particular often assign expatriates to assume top management positions in their overseas affiliates to achieve these benefits and better perform the control and coordination functions (Baliga and Jaeger, 1985; Belderbos and Heijltjes, 2005).

We argue that increased control and coordination through expatriate assignment can enhance the firm's ability to implement the switching options embedded in its multinational operations, contributing to flexibility and downside risk reduction. A firm's human resource management system is one important type of organizational control system to help the firm coordinate activities among dispersed affiliates in order to benefit from operating flexibility (Kogut, 1985; Kogut and Kulatilaka, 1994), and the use of expatriates is an important means to achieve this objective (e.g., Bartlett and Ghoshal, 1989; Hedlund, 1986). By contrast, weak control systems such as particular administrative heritage in firms' foreign affiliates might increase affiliate managers' local mandates, detract from the

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interest of the corporation, and reduce flexibility as a whole (Rangan, 1998). In general, it is critical to have the appropriate management systems and control processes in place for firms to follow the optimal policies in implementing real options and benefit from their investments (Alessandri, Tong, and Reuer, 2012; Tong and Reuer, 2007). Considering the role of firms' expatriate assignment policy in coordinating their multinational operations leads to the following hypothesis on the moderating effect of expatriate assignment on the relationship between multinationality and downside risk:

> *Hypothesis 3a: The greater the firm's assignment of expatriates in its portfolio of foreign affiliates, the stronger the negative impact of multinationality on downside risk*.

We further suggest that the moderating effect of expatriate assignment will likely vary across firms operating in host countries with differing levels of labor cost correlations. When labor costs in the firms' host countries are less correlated (i.e., less subadditive), more valuable opportunities exist for switching activities, thus requiring more organizational coordination in order to achieve operating flexibility and downside risk reduction (e.g., Kogut and Kulatilaka, 1994); in this situation, greater expatriate assignment will be particularly useful for implementing switching options. By contrast, expatriate assignment will be less useful for this purpose, everything else equal, when labor costs in the host countries are more correlated (i.e., more subadditive). This is because there will be less valuable scope for switching activities, and the organizational demands for coordinating cross-border operations are also lower. This leads to the following hypothesis:

> *Hypothesis 3b: The moderating effect of expatriate assignment on the relationship between multinationality and downside risk will be greater for firms operating in host countries with relatively low correlations in labor costs*.

METHODS

Data and sample

To examine our hypotheses, we constructed a comprehensive panel dataset of all publicly-listed Japanese manufacturing firms and their overseas manufacturing affiliates from 1985 to 2006. Japanese firms are important investors in the international arena; and research has suggested that these firms often take an integrated approach to manage their overseas manufacturing plant networks, making them appropriate for research on multinational flexibility (e.g., Belderbos and Zou, 2009). Our focus on Japanese firms also moves beyond extant real options studies that have often focused on U.S. multinational firms (e.g., Kouvelis *et al.*, 2001; Tong and Reuer, 2007). We first gathered the financial data for all Japanese manufacturing firms listed on Japanese stock exchanges from the database maintained by the Development Bank of Japan. This database derives its information directly from financial reports submitted by Japanese firms to the Ministry of Finance under Japanese reporting requirements. We then matched these firms to various *Directories of Overseas Affiliates* published by Toyo Keizai, Inc. The directories provide detailed information on all the foreign affiliates of listed firms, including the affiliates' industry, establishment year, parent firms' equity stakes, number of employees, and number of Japanese expatriate employees, among others. We used information collected from electronic and hardcopy versions (for early years) of the *Directories*, as well as information from the separate lists of divested affiliates published in the hard copy in order to determine when each affiliate was established and until which year the affiliate survived and was owned by the Japanese parent. Consistent with prior research, affiliates in which the Japanese parent has at least a 10 percent equity stake are included; if there are multiple Japanese parents, the affiliate is assigned to each parent.

Given our interest in studying how the characteristics of the host countries in which firms operate may shape downside risk, we focused our analysis on those manufacturing firms that operated at least one foreign manufacturing affiliate during this period. This produced a sample of 1,010 manufacturing firms that were listed on one of the Japanese stock exchanges and active for at least five years during 1985–2006. The unbalanced sample contains 10,799 firm-year observations for which the dependent variable downside risk can be calculated and for which information on the theoretical and control variables is available. As the number of listed firms has increased over time, the unbalanced sample has a larger number of

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firms in more recent years. Within our study period 1985–2006, 1990 is the first year for which we have full data for calculating our dependent variable, downside risk, as calculating this variable requires the use of a five-year time window (i.e., 1985–1989) to be explained in detail below. We find that in 1990, there are 325 firms for which we are able to calculate the downside risk variable; in 2006, the last year of our study's time window, this number increases to 837. The total number of foreign manufacturing affiliates operated by these firms also increases from 1,359 in 1990 to 4,835 in 2006. Specifically, while the number of affiliates in North America doubled between 1990 and 2006, the major increase in Japanese firms' foreign manufacturing presence took place in Asia (from 806 to 3,619) and particularly in China; by contrast, Africa, Oceania, and South America only saw moderate growth in Japanese firms' manufacturing affiliates.

Variables and measures

Dependent variable

Our dependent variable is the firm's downside risk. Bowman and Hurry (1993) suggest that an organization's option bundle protects it against downside risk, thus a focus on downside risk seems particularly suitable for examining real options theory's core prediction about the firm's ability to limit downside risk. In keeping with prior research, downside risk is a function of the deviation of the firm's return on assets from the industry mean in the preceding year, which is considered the target level (e.g., Reuer and Leiblein, 2000). In contrast to conventional variance-based measures of risk that incorporate the entire distribution of firm performance, the downside risk measure focuses on performance outcomes that only fall below some target level (Miller and Reuer, 1996). Note that this measure is also consistent with Huchzermeier and Cohen's (1996: 108) definition of downside risk as the 'expected deviation of the firm's value over the planning horizon from a profit level' in their analytical model of multinational switching options. Specifically, to calculate *Downside Risk*, we specify downside risk as a function of a firm's annual return on assets relative to a target level that changes over time, in the form of a second-order root lower partial moment:

$$\textit{Downside Risk}_{t=0} = \sqrt{\frac{1}{5}\sum_{t=0}^{t=-4}(\mathrm{IROA}_{t-1}-\mathrm{ROA}_{t})^{2}\ |\mathrm{IROA}_{t-1} > \mathrm{ROA}_{t}}, \quad (1)$$

where ROA_t is the firm's annual return on assets; and IROA_{t-1}, the target performance level, is the average return on assets for the firm's two-digit industry in the preceding year. The difference between the industry's average ROA and the firm's ROA, conditional on this difference being positive (i.e., the firm's ROA falling below the target level), is squared and summed over a five-year period from the focal year ($t=0$) to four years back ($t=-4$). Hence, downside risk is positive in the case of below-target performance and zero in the case where the firm performs better than the target. Note that the focus on the two-digit industry level follows precedents (Tong and Reuer, 2007) and allows us to maintain reasonable within-industry sample sizes for calculating the industry's average ROA, and narrowing the industry definition would result in loss of meaningful data. IROA_{t-1} is calculated based on the full population in the Development Bank of Japan database.

Explanatory variables

To be consistent with the way the time-varying dependent variable downside risk is calculated, construction of all time-varying explanatory and control variables below is based on a five-year moving average. Our longitudinal, panel dataset provides an advantage over prior related studies that relied on cross-sectional data (e.g., Reuer and Leiblein, 2000). Our first explanatory variable is *Multinationality*, which is measured as the number of countries in which the Japanese firm operates manufacturing affiliates, averaged for the same five years as the dependent variable. The use of multinationality as a measure of the switching options embedded in multinational investment reflects the idea that operating subsidiaries located in separate countries can provide the multinational firm with the valuable option to shift production because of fluctuations in variable labor cost, exchange rate, as well as other economic parameters (Kogut,

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1985; Kogut and Kulatilaka, 1994; de Meza and van der Ploeg, 1987).

The variable measuring cost subadditivity in the portfolio of host countries in which the firm operates is calculated based on correlations in labor costs (adjusted for exchange rates) among *all* of the host countries in which the firm has established manufacturing activities. A high correlation indicates high-cost subadditivity, suggesting that labor cost levels, due to labor market conditions, exchange rate movements, price changes, etc., develop in a similar manner across the host countries; as a result, there are limited opportunities for the firm to exploit country differences in labor costs within the multinational network of operations. By contrast, a low or, in particular, a negative correlation indicates that production switching opportunities are more abundant and more valuable. Our focus on labor cost correlations is in line with prior analytical research that examines how the correlations between input cost developments across countries may shape manufacturing firms' operational flexibility (e.g., Kogut and Kulatilaka, 1994; de Meza and van de Ploeg, 1987). This focus also follows from our sampling of manufacturing firms and their overseas manufacturing affiliates. Specifically, our calculation of the variable *Cost Subadditivity* is based on the following formula:

$$Cost\ Subadditivity_{t=0} = \left[\sum_{j=1}^{N} \sum_{k=2}^{N} \frac{\sum_{t=0}^{-4} (C_{jt} - \overline{C_j})\,(C_{kt} - \overline{C_k})}{\delta_j \delta_k} \right] \Big/ \frac{N\,(N-1)}{2}, \text{where } j, k = 1 \cdots N;\ j < k; \tag{2}$$

where C_{jt} and C_{kt} represent dollar-denominated labor costs in host countries j and k for year t, respectively; $\overline{C_j}$ and $\overline{C_k}$ denote average labor costs over the five years including the focal year ($t = 0$) in countries j and k; and δ_j and δ_k are the standard deviations of labor costs within these past five years in countries j and k. N is the total number of countries in which the focal firm operates manufacturing affiliates. Intuitively, we first calculate the labor cost correlation for *any pair* of host countries in the firm's portfolio, sum up all these correlations, and then divide the summed value by the total number of possible host country pairs to obtain an average correlation measure. We use the average to address the situation where larger multinational operations display higher cost subadditivity levels simply because the firms operate in a larger number of countries. Data for labor costs for the host countries (denominated in local currencies) are obtained from the International Labour Organization's Labour Statistics Database. The data are then converted into dollar terms using the exchange rate information obtained from the United Nation's National Accounts Main Aggregates Database—Exchange Rates and Population.

We note that our operationalization of cost subadditivity is consistent with Kogut and Kulatilaka's (1994) conceptualization in their analytical model (i.e., correlation in input cost across host countries). This operationalization also follows recent empirical studies on real option subadditivity in other contexts (e.g., Belderbos and Zou, 2009; Vassolo *et al.*, 2004). By its construction, our measure of labor cost correlations is a continuous variable that captures the full range of values (from −1 to 1). In our study, we expect lower correlations to strengthen the negative effect of multinationality on downside risk more than higher correlations.

Our third hypothesis-testing variable is *Equity Share*, which is calculated as the Japanese firm's average equity stake in its portfolio of foreign manufacturing affiliates, averaged for the five years including the focal year. This operationalization is consistent with research suggesting that a firm's equity share in its affiliates captures the control it has over the affiliates, facilitating the coordination of cross-border activities among its portfolio of affiliates (e.g., Kogut, 1989; Stopford and Wells, 1972; Tong and Reuer, 2007).

The final hypothesis-testing variable is *Expatriate Ratio*, which is similarly calculated as the unweighted average of the ratio of expatriate employees over total employees over all foreign manufacturing affiliates that the firm operates. We

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use a ratio rather than a count measure to account for affiliate size and the associated coordination challenges. This measure reflects the extent to which expatriates have managerial influences in the affiliates and the degree to which the affiliates can be managed in close coordination with corporate headquarters (e.g., Edström and Galbraith, 1977; Fang *et al.*, 2010; Gupta and Govindarajan, 2000). A limitation of this measure is that we are not able to identify fully the roles of all expatriates in the affiliates in the database. Like other time-variant variables, this variable is also averaged for the same five years.

Control variables

Our analysis includes a number of control variables. First, prior research suggests that exporting may provide benefits of operational flexibility (e.g., Rangan, 1998). We therefore include into the model a control variable, *Export Intensity*, which is the value of exports divided by the firm's total sales. Second, we include a measure of *Firm Size*, for which we take the value of consolidated assets in trillion Yen. Third, we include *Organizational Slack*, measured as the sum of the ratios of receivables, inventory, and selling, general, and administrative expenses over total sales. Fourth, we include another control variable, *Tobin's q*. Tobin's q has been used as a proxy for a firm's general intangible assets (Morck and Yeung, 1992), and we incorporate this variable to control for the potential impact of such assets on downside risk. We use Tobin's q because we find the quality of information on advertising and R&D expenditures to be poor in Japanese financial reports, in particular in earlier years in the sample. We calculate Tobin's q as the number of shares issued times the average of the highest and lowest stock price during the year, plus the book value of preferred stock and liabilities, divided by total assets (e.g., Chung and Pruitt, 1994). Since the market valuation element of Tobin's q might be correlated with the firm's profitability and downside risk, we lag the five-year moving average of q by one year (i.e., for the five years from year $t-1$ to year $t-5$). Fifth, we control for the firm's *Product Diversity* (e.g., Tallman and Li, 1996), defined as the number of two-digit industries in which the firm operates in Japan and abroad. Sixth, we control for the firm's *International Experience*, which may affect its international investment performance (e.g., Brouthers *et al.*, 2008; Kogut, 1983). This variable is measured as the average number of years in operation for all of the firm's foreign affiliates; we use the average instead of the sum to address the situation in which larger firms have larger values of international experience simply because they have a larger number of foreign affiliates. Seventh, we include a control for the host countries' *GDP Growth*, measured as the average GDP growth rate for all the host countries in which the Japanese parent firm operates over the past five years. The data source is the Key Global Indicators published by the United Nations. All of the control variables are time-varying, and therefore are calculated based on a five-year moving average. Finally, we include firm fixed effects and year fixed effects when we run fixed effects panel estimations, to be explained in detail below; when we run alternative random effects Tobit panel estimations, we include industry fixed effects and year fixed effects accordingly.

Econometric models

Prior studies have often used cross-sectional data to examine the relationship between multinationality and downside risk. In this paper, we use a panel dataset and apply panel data techniques to examine how the configuration of firms' affiliate portfolios and the organization (coordination and control) of foreign affiliates may shape the impact of multinationality on downside risk. Panel data estimators with firm specific fixed effects allow researchers to better control for unobserved firm heterogeneity that might be relevant to performance outcomes (Hsiao, 2003). Since our dependent variable, *Downside Risk*, is censored at zero, a Tobit panel estimation model with fixed effects would be suitable for our purpose. However, Tobit panel estimators are only available for random effects models (Wooldridge, 2002), and Greene (2004) has shown that fixed effects Tobit panel estimators are likely to produce underestimated standard errors. Random effects models, however, rely on the assumption that the unobserved firm effect is randomly distributed and uncorrelated with the other right-hand-side variables across all periods. If this assumption does not hold, the preferred model would need to include fixed effects. Indeed, Hausman tests rejected the linear random effects model in favor of the fixed effects model ($p < 0.001$), suggesting substantial firm heterogeneity and

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potential inconsistency of estimates if random effects models were to be used. Our preferred specification to address unobserved heterogeneity therefore is the fixed effects panel estimator. This estimation method also allows us to perform statistical tests across subsamples to test our hypotheses (see below). For comparison and to examine the sensitivity of our results to model specification, we also report the results of random effects Tobit panel estimations in the section below.

To test Hypothesis 1's prediction that the negative effect of multinationality on downside risk will vary across firms depending on the labor cost correlations between the host countries represented in the firms' manufacturing affiliate portfolios (i.e., the degree of subadditivity), we perform subsample analysis based on the median of labor cost subadditivity in the sample firms' option portfolios. Using subsample analysis, H1 suggests that the negative impact of *Multinationality* on *Downside Risk* will be stronger (i.e., its coefficient will be more strongly negative) in the low-cost subadditivity subsample (firms with lower-than-median labor cost subadditivity in their portfolios) than in the high-cost subadditivity subsample (firms with higher-than-median labor cost subadditivity in their portfolios).

To test H2a and H3a, we interact *Multinationality* with *Equity Share* and with *Expatriate Ratio*, respectively, and run regressions on the full sample. Findings of a negative coefficient for the interaction terms would support the two hypotheses, indicating that the negative impact of *Multinationality* on *Downside Risk* is strengthened by *Equity Share* and *Expatriate Ratio*. To test H2b and H3b, we rely again on subsample analysis: the hypotheses predict that the above two negative interaction effects will be stronger in the low-cost subadditivity subsample than in the high-cost subadditivity subsample. For ease of comparison, we report regression results obtained for the full sample and the two subsamples for all specifications throughout the tables.

RESULTS

Table 1 provides descriptive statistics and correlations for the variables for the full sample (Panel A), the subsample of firms with high-cost subadditivity (Panel B), and the subsample of firms with low-cost subadditivity (Panel C). To facilitate presentation of the regression results in the tables below, the downside risk measure is multiplied by 100. As Panel A of the table shows, an average firm in the sample operated affiliates in about 3.5 foreign countries, had about 0.32 trillion yen of assets and derived about 9 percent of its sales from export. On average, a firm's equity stake across its portfolio of foreign affiliates was about 58 percent and about 7 percent of affiliate employees were Japanese expatriates. The largest correlation is between *Firm Size* and *Multinationality*, while the other correlations are relatively low. To reduce potential multicollinearity in regression analyses, we mean-centered all of the explanatory variables that constitute the interaction terms and then constructed the interaction terms by multiplying the relevant mean-centered variables. Examination of the variance inflation factor values and condition indices for the variables indicates that multicollinearity is not a concern for us, consistent with Hsiao's (2003) suggestion that one of the major benefits of using panel data is reduced multicollinearity.

Table 2 reports results for the determinants of downside risk based on fixed effects panel estimations. The table consists of four blocks; within each block are three columns reporting the results for the full sample, the high-cost subadditivity subsample, and the low-cost subadditivity subsample, respectively.

Columns 1–3 report the results of the model that includes the main effects of *Multinationality*, *Equity Share* and *Expatriate Ratio*, as well as the full set of control variables. Among the control variables, we find that *Export Intensity* is negative and highly significant, indicating that greater export is related to lower downside risk. *Firm Size* is also significantly negative, suggesting that larger firms have lower downside risk levels. *Organizational Slack* is significant in all models and has a positive sign; when we measure organizational slack using other measures suggested by prior research (e.g., Singh, 1986), we again find similar positive and significant results. Our result is consistent with the recent finding reported by Mizutani and Nakamura (2012) that Japanese firms' performance is negatively related to organizational slack; thus slack might appear more as an indicator of inefficiency for Japanese firms, rather than as a buffer to help firms respond flexibly to environmental changes. *Tobin's q* is negatively significant in the first two columns,

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Table 1. Descriptive statistics and correlations[a]

	Variables	μ	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11
Panel A: full sample (N = 10,799)																
1	Downside risk	1.722	2.892	0.000	63.353	1.000										
2	Export intensity	0.088	0.142	0.000	0.987	0.012	1.000									
3	Firm size	0.321	0.939	0.002	23.148	**−0.045**	**0.141**	1.000								
4	Organizational slack	0.365	0.142	0.023	2.061	**0.194**	**0.202**	**0.079**	1.000							
5	Tobin's q	1.326	0.468	0.421	5.138	**−0.027**	**0.201**	−0.005	**0.128**	1.000						
6	Product diversity	1.438	1.074	0.000	8.000	**−0.083**	**0.072**	**0.339**	**−0.043**	**−0.074**	1.000					
7	International experience	9.536	6.530	0.000	80.333	0.012	−0.007	**0.106**	**0.079**	**−0.077**	**0.170**	1.000				
8	GDP growth	0.070	0.045	−0.044	0.225	**−0.080**	**0.238**	**0.029**	0.011	**0.225**	**0.173**	**0.020**	1.000			
9	Multinationality	3.466	3.427	0.000	30.800	**−0.097**	**0.147**	**0.580**	**−0.016**	**−0.032**	**0.642**	**0.220**	**0.113**	1.000		
10	Equity share	0.578	0.279	0.000	1.000	**0.028**	**0.145**	**0.021**	**0.126**	0.013	**0.244**	**0.253**	**0.297**	**0.195**	1.000	
11	Expatriate ratio	0.071	0.120	0.000	1.000	−0.014	**−0.078**	**−0.038**	**0.062**	−0.005	**0.042**	**−0.024**	**0.017**	−0.015	**0.283**	1.000
12	Cost subadditivity	0.259	0.346	−0.916	0.997	**−0.099**	**0.174**	**0.082**	**−0.039**	**0.107**	**0.254**	**0.067**	**0.426**	**0.277**	**0.187**	**0.047**
Panel B: high-cost subadditivity subsample (N = 5,399)																
1	Downside risk	1.397	2.110	0.000	36.417	1.000										
2	Export intensity	0.114	0.160	0.000	0.983	**0.036**	1.000									
3	Firm size	0.458	1.080	0.004	23.148	**−0.041**	**0.146**	1.000								
4	Organizational slack	0.359	0.134	0.031	1.016	**0.095**	**0.254**	**0.132**	1.000							
5	Tobin's q	1.355	0.431	0.421	5.061	**−0.102**	**0.169**	**−0.032**	**0.117**	1.000						
6	Product diversity	1.821	1.106	0.200	8.000	**−0.078**	0.014	**0.299**	**−0.045**	**−0.093**	1.000					
7	International experience	10.220	5.019	0.000	68.667	−0.013	**−0.028**	**0.113**	**0.077**	**−0.086**	**0.041**	1.000				
8	GDP growth	0.086	0.036	−0.019	0.216	**−0.100**	**0.254**	−0.020	**0.032**	**0.346**	**−0.085**	**−0.206**	1.000			
9	Multinationality	4.926	3.382	0.400	30.800	**−0.098**	**0.111**	**0.572**	0.022	**−0.070**	**0.508**	**0.194**	**−0.111**	1.000		
10	Equity share	0.645	0.188	0.079	1.000	**0.067**	**0.166**	**−0.080**	**0.142**	**0.096**	**−0.126**	**0.044**	−0.012	**−0.099**	1.000	
11	Expatriate ratio	0.078	0.104	0.000	1.000	**−0.032**	**−0.122**	**−0.082**	**0.069**	0.019	**−0.083**	**−0.127**	**−0.071**	**−0.141**	**0.138**	1.000
12	Cost subadditivity	0.543	0.241	0.162	0.997	−0.016	**0.046**	**−0.128**	0.010	**0.134**	**−0.120**	**−0.059**	**0.407**	**−0.267**	**0.029**	0.020
Panel C: low-cost subadditivity subsample (N = 5,400)																
1	Downside risk	2.046	3.473	0.000	63.353	1.000										
2	Export intensity	0.063	0.116	0.000	0.987	**0.034**	1.000									
3	Firm size	0.184	0.747	0.002	19.332	**−0.024**	**0.065**	1.000								
4	Organizational slack	0.371	0.149	0.023	2.061	**0.248**	**0.173**	**0.033**	1.000							
5	Tobin's q	1.298	0.500	0.422	5.138	0.022	**0.234**	0.006	**0.143**	1.000						
6	Product diversity	1.055	0.888	0.000	8.000	**−0.028**	0.002	**0.334**	−0.013	**−0.116**	1.000					
7	International experience	8.853	7.691	0.000	80.333	**0.039**	**−0.027**	**0.086**	**0.089**	**−0.084**	**0.239**	1.000				
8	GDP growth	0.053	0.046	−0.044	0.225	−0.015	**0.133**	**−0.038**	**0.027**	**0.132**	**0.177**	**0.075**	1.000			
9	Multinationality	2.007	2.791	0.000	30.800	**−0.028**	**0.029**	**0.596**	−0.019	**−0.061**	**0.688**	**0.213**	−0.001	1.000		
10	Equity share	0.511	0.333	0.000	1.000	**0.054**	**0.081**	**0.036**	**0.144**	**−0.049**	**0.408**	**0.307**	**0.342**	**0.258**	1.000	
11	Expatriate ratio	0.064	0.133	0.000	1.000	0.003	**−0.062**	−0.012	**0.062**	**−0.027**	**0.130**	0.020	**0.037**	**0.048**	**0.345**	1.000
12	Cost subadditivity	−0.025	0.138	−0.916	0.162	−0.011	**0.063**	**0.084**	**−0.035**	**0.064**	0.019	−0.014	**0.029**	**0.115**	**−0.076**	**−0.027**

[a] Correlations in bold are significant at $p < 0.10$ (two-tailed test).

Table 2. Fixed effects panel estimation of downside risk[a]

Variables	1 Full sample	2 High-cost subadditivity	3 Low-cost subadditivity	4 Full sample	5 High-cost subadditivity	6 Low-cost subadditivity	7 Full sample	8 High-cost subadditivity	9 Low-cost subadditivity	10 Full sample	11 High-cost subadditivity	12 Low-cost subadditivity
Export intensity	−2.41***	−2.41***	−1.20**	−2.42***	−2.43***	−1.23**	−2.39***	−2.41***	−1.14**	−2.41***	−2.41***	−1.17**
	(0.25)	(0.29)	(0.48)	(0.25)	(0.29)	(0.48)	(0.25)	(0.29)	(0.48)	(0.25)	(0.29)	(0.48)
Firm size	−0.14*	−0.12*	−0.42	−0.13*	−0.12*	−0.31	−0.15**	−0.13**	−0.50	−0.15**	−0.13**	−0.41
	(0.07)	(0.07)	(0.32)	(0.07)	(0.07)	(0.33)	(0.07)	(0.07)	(0.33)	(0.08)	(0.07)	(0.33)
Organizational slack	14.25***	7.62***	19.10***	14.21***	7.60***	19.05***	14.24***	7.53***	19.15***	14.21***	7.52***	19.11***
	(0.43)	(0.61)	(0.61)	(0.43)	(0.62)	(0.61)	(0.43)	(0.61)	(0.61)	(0.43)	(0.62)	(0.61)
Tobin's q	−0.11	−0.36***	0.09	−0.10	−0.36***	0.11	−0.11	−0.37***	0.10	−0.10	−0.37***	0.11
	(0.07)	(0.08)	(0.13)	(0.07)	(0.08)	(0.13)	(0.07)	(0.08)	(0.13)	(0.07)	(0.08)	(0.13)
Product diversity	−0.08	−0.15***	0.19	−0.11*	−0.17***	0.05	−0.09	−0.16***	0.13	−0.11*	−0.17***	0.04
	(0.06)	(0.06)	(0.15)	(0.06)	(0.06)	(0.16)	(0.06)	(0.06)	(0.15)	(0.06)	(0.06)	(0.16)
International experience	−0.04***	−0.05***	−0.02	−0.04***	−0.05***	−0.02*	−0.04***	−0.05***	−0.02	−0.04***	−0.05***	−0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
GDP growth	−0.86	−3.23***	0.04	−1.25*	−3.41***	−0.56	−1.00	−3.21***	−0.21	−1.27*	−3.33***	−0.58
	(0.69)	(1.11)	(1.04)	(0.71)	(1.12)	(1.06)	(0.69)	(1.11)	(1.04)	(0.71)	(1.12)	(1.06)
Multinationality	−0.11***	−0.02	−0.25***	−0.10***	−0.01	−0.24***	−0.11***	−0.02	−0.22***	−0.10***	−0.01	−0.22***
	(0.03)	(0.03)	(0.07)	(0.03)	(0.03)	(0.07)	(0.03)	(0.03)	(0.07)	(0.03)	(0.03)	(0.07)
Equity share	−0.01	−0.17	−0.61**	−0.50*	−0.29	−2.20***	−0.09	−0.23	−0.74***	−0.44	−0.30	−1.82***
	(0.18)	(0.34)	(0.28)	(0.28)	(0.35)	(0.65)	(0.18)	(0.34)	(0.28)	(0.28)	(0.35)	(0.67)
Equity share × multinationality	—	—	—	−0.20**	−0.12	−0.58***	—	—	—	−0.14	−0.08	−0.41*
	—	—	—	(0.09)	(0.10)	(0.22)	—	—	—	(0.09)	(0.10)	(0.23)
Expatriate ratio	0.17	0.35	−0.71	0.18	0.33	−0.61	−0.83	0.35	−4.07***	−0.71	0.34	−3.37***
	(0.44)	(0.72)	(0.60)	(0.44)	(0.72)	(0.60)	(0.53)	(0.72)	(1.22)	(0.53)	(0.72)	(1.29)
Expatriate ratio × multinationality	—	—	—	—	—	—	−0.64***	−0.64***	−1.61***	−0.58***	−0.62***	−1.31**
	—	—	—	—	—	—	(0.19)	(0.21)	(0.51)	(0.19)	(0.21)	(0.54)
Constant	−3.02***	0.22	−6.12***	−2.90***	0.26	−5.84***	−2.99***	0.26	−6.02***	−2.91***	0.29	−5.84***
	(0.25)	(0.33)	(0.45)	(0.26)	(0.33)	(0.47)	(0.25)	(0.33)	(0.45)	(0.26)	(0.33)	(0.47)
N	10,799	5,399	5,400	10,799	5,399	5,400	10,799	5,399	5,400	10,799	5,399	5,400
Log likelihood	−20,438.49	−8,746.94	−10,467.13	−20,435.57	−8,746.06	−10,462.81	−20,432.16	−8,741.33	−10,461.13	−20,430.71	−8,740.96	−10,459.27
Log likelihood ratio test (χ^2)												
Expanded model vs. basic model	—	—	—	5.84**	1.75	8.63***	12.67***	11.21***	11.99***	15.56***	11.96***	15.72***
F test of coefficient equality												
Multinationality	—	15.60***		—	15.29***		—	12.65***		—	13.00***	
Equity share × multinationality	—	—		—	5.62**		—	—		—	2.64*	
Expatriate ratio × multinationality	—	—		—	—		—	6.48**		—	3.16*	

[a] Both firm and year fixed effects are included; both are jointly significant at $p < 0.01$ (two-tailed test).
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$ (two-tailed test).

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suggesting that firms with more intangibles have lower downside risk particularly when labor cost correlations across the host countries are high. *Product Diversity* has a negative and highly significant coefficient, indicating that firms operating in more industries have lower downside risk. *International Experience* is negatively significant in the first two columns; thus, firms with greater overseas operating experience have lower downside risk, and this is true for the high subadditivity subsample in particular. *GDP Growth* is negatively significant in the middle column, suggesting that operating in high-growth host countries reduces downside risk. Finally, both firm fixed effects and year fixed effects are jointly significant, indicating that firm heterogeneity and macroeconomic conditions have an impact on firms' downside risk.

We use the results reported in Columns 1–3 to test Hypothesis 1, since the other columns include different interactions with multinationality, and the interpretation of the main effect of multinationality is changed accordingly. Hypothesis 1 predicts that multinationality will have a more negative impact on downside risk for firms operating a low subadditivity option portfolio than for firms operating a high subadditivity option portfolio. In Column 1 focusing on the full sample, the variable *Multinationality* has a negative and significant coefficient (i.e., $p < 0.01$), suggesting that multinationality is negatively related to downside risk as predicted by real options theory. Results in Columns 2–3 further indicate that the negative and significant impact of *Multinationality* on downside risk is only observed in the low subadditivity subsample (i.e., $p < 0.01$ in Column 3) and not in the high subadditivity subsample (i.e., Column 2). A test comparing the coefficients for *Multinationality* across the two columns suggests that the difference in the coefficients is statistically significant (i.e., $F = 15.60$, $p < 0.01$). These results provide strong support for H1.

Columns 4–6 report the results of models testing H2a and H2b by adding the interaction term between *Equity Share* and *Multinationality*. H2a posits that the interaction between *Equity Share* and *Multinationality* will be negatively significant in the full sample, and H2b further predicts that this negative interaction effect will be stronger in the low subadditivity subsample than in the high subadditivity subsample. As shown in the table, the interaction term is significant in the full sample (i.e., $p < 0.05$ in Column 4), providing support for H2a. In subsample analysis, the interaction term is significant in the low subadditivity subsample (i.e., $p < 0.01$ in Column 6) but not significant in the high subadditivity subsample (i.e., Column 5). When we conduct tests comparing the coefficients for the interaction between *Equity Share* and *Multinationality* across Columns 5 and 6, we find that the difference in the coefficients is statistically significant (i.e., $F = 5.62$, $p < 0.05$). This result supports H2b, suggesting that greater equity stake in the firm's foreign affiliates strengthens the negative impact of multinationality on downside risk to a larger degree for firms operating a low subadditivity option portfolio than for firms operating a high subadditivity option portfolio.

Columns 7–9 report the results of models testing H3a and H3b by adding the interaction term between *Expatriate Ratio* and *Multinationality*. H3a posits that the interaction between *Expatriate Ratio* and *Multinationality* will be negatively significant in the full sample, and H3b further predicts that this negative interaction effect will be stronger in the low subadditivity subsample than in the high subadditivity subsample. We find that the interaction term is indeed significant in the full sample (i.e., $p < 0.01$ in Column 7), in support of H3a. The interaction term is also significant in both Columns 8 and 9 (i.e., both $p < 0.01$), and its coefficient in Column 9 is more strongly negative than that in Column 8. A test comparing the coefficients for the interaction term across the two columns confirms that the difference is statistically significant (i.e., $F = 6.48$, $p < 0.05$). This result lends support for H3b, indicating that greater expatriate assignment in the firm's foreign affiliates strengthens the negative impact of multinationality on downside risk more for firms with a low subadditivity option portfolio than for firms with a high subadditivity option portfolio.

Finally, Columns 10–12 report the results of models including all of the variables simultaneously. As shown in these columns, the results for the hypotheses and control variables are consistent with those reported in the previous columns.

Supplementary analyses

We performed a series of sensitivity analyses to check the robustness of our results. We summarize our main findings here; a more detailed description is available in the online Appendix A. First of all, as suggested in the Methods section above,

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we also conducted random effects Tobit panel estimations. As shown in Table 3, the results are largely consistent with those reported in Table 2, indicating that our results are not sensitive to the choice of fixed effects or random effects Tobit specification.

We also examined the role of potential endogeneity, which may occur when firms undertake multinational investment and assign equity shares and expatriates with the objective to reduce downside risk. Such endogeneity concerns may be mitigated because there are reasons to believe that in general a firms' investment objective is not minimizing downside risk *per se*. The various streams of research on multinational firms have identified many other reasons why firms seek to undertake multinational investment, assume smaller or larger equity shares, and make greater or less use of expatriates (see Caves, 1996 for a review). For instance, while having greater equity share facilitates the coordination of switching options and operating flexibility, it can reduce firms' growth option values (e.g., Belderbos and Zou, 2007; Chi and McGuire, 1996; Tong *et al.*, 2008). Furthermore, although firms might be choosing investment strategies to reduce downside risk, the difficulty to predict changes in country environments such as labor cost movements may still lead firms to end up having a suboptimal portfolio in terms of executing switching options and reducing downside risk. The descriptive statistics in Table 1's Panels B and C do not suggest that firms generally choose investment strategies strongly reflecting the objective of minimizing downside risk, as the mean of the two variables *Equity Share* and *Expatriate Ratio* is larger in Panel B (high-cost subadditivity subsample) than in Panel C (low-cost subadditivity subsample). While the above considerations weaken *a priori* expectations of endogeneity, we also conducted a formal test to examine whether there are feedback effects of downside risk on subsequent multinational investment strategies. The Wooldridge test of strict exogeneity (Wooldridge, 2002) indicated that the null hypothesis that forward lags of the variables *Equity Share* and *Expatriate Ratio* were zero could not be rejected, suggesting that the strict exogeneity assumption is not invalid.

Whereas real options theory suggests that portfolio subadditivity moderates the negative relationship between multinationality and downside risk, geographic diversification theory suggests that multinational operation reduces the total variance of the firm's performance (Kogut and Kulatilaka, 1994; Rugman, 1976). It is therefore important to rule out geographic diversification as an alternative explanation for our empirical findings. Specifically, we conducted analyses using the variance of the firm's ROA as a dependent variable instead of downside risk. In these analyses, multinationality was negative and significant in the full sample, but insignificant in either subsample, suggesting that labor cost subadditivity does not play as a moderating effect. In addition, no significant differences were observed between the subsamples in terms of the coefficients for the interaction between multinationality and equity share as well as that between multinationality and expatriate ratio. These findings suggest that multinationality reduces the variability of firms' profits, as diversification theory would suggest; however, the findings are not consistent with a view that cost subadditivity reflecting the active use of switching options matters for overall variability reduction. Hence, the results of our main empirical analyses are not consistent with the geographic diversification explanation. This highlights that the option value of multinationality is different from that of the benefits of geographic diversification, given the specific advantages that real options theory ascribes to multinational operations (e.g., Kogut, 1985, 1989; Tong and Reuer, 2007).

Our results were also robust to controlling for potential decreasing marginal benefits of multinationality (including squared and cubic terms of *Multinationality*). Specifically, we found a U-shaped relationship, rather than an S-shaped relationship, between multinationality and downside risk in the full sample, where we do not account for subadditivity. The U-shaped relationship, however, no longer held when we controlled for subadditivity in subsample analyses. These results confirm that it is the subadditivity of the multinational portfolio, rather than decreasing marginal benefits of multinationality *per se*, that influences downside risk.

DISCUSSION

Our study makes several contributions to research on real options and multinational firms. First, recent real options research emphasizes the importance of investigating the portfolio aspect of real

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Table 3. Random effects Tobit panel estimation of downside risk[a]

Variables	1 Full sample	2 High-cost subadditivity	3 Low-cost subadditivity	4 Full sample	5 High-cost subadditivity	6 Low-cost subadditivity	7 Full sample	8 High-cost subadditivity	9 Low-cost subadditivity	10 Full sample	11 High-cost subadditivity	12 Low-cost subadditivity
Export intensity	−3.21***	−2.82***	−1.90***	−3.23***	−2.83***	−1.91***	−3.18***	−2.80***	−1.85***	−3.20***	−2.81***	−1.88***
	(0.31)	(0.35)	(0.57)	(0.31)	(0.35)	(0.57)	(0.31)	(0.35)	(0.57)	(0.31)	(0.35)	(0.57)
Firm size	−0.23**	−0.13	−0.45*	−0.23**	−0.13	−0.42*	−0.26**	−0.15*	−0.51**	−0.25**	−0.15*	−0.47**
	(0.11)	(0.09)	(0.23)	(0.11)	(0.09)	(0.23)	(0.11)	(0.09)	(0.24)	(0.11)	(0.09)	(0.23)
Organizational slack	13.80***	6.49***	17.32***	13.72***	6.43***	17.25***	13.74***	6.34***	17.31***	13.68***	6.30***	17.25***
	(0.47)	(0.60)	(0.66)	(0.47)	(0.60)	(0.66)	(0.47)	(0.61)	(0.66)	(0.47)	(0.61)	(0.66)
Tobin's q	−0.51***	−0.83***	−0.33**	−0.49***	−0.82***	−0.30**	−0.49***	−0.84***	−0.31**	−0.48***	−0.83***	−0.29**
	(0.09)	(0.11)	(0.15)	(0.09)	(0.11)	(0.15)	(0.09)	(0.11)	(0.15)	(0.09)	(0.11)	(0.15)
Product diversity	−0.04	−0.09	0.13	−0.10	−0.11	0.00	−0.05	−0.09	0.12	−0.10	−0.11*	0.01
	(0.07)	(0.06)	(0.14)	(0.07)	(0.07)	(0.15)	(0.07)	(0.06)	(0.14)	(0.07)	(0.07)	(0.15)
International experience	−0.03***	−0.04***	−0.02	−0.03***	−0.04***	−0.02	−0.03***	−0.04***	−0.02	−0.03***	−0.04***	−0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
GDP growth	−0.54	−5.49***	1.87	−1.32	−5.80***	1.03	−0.74	−5.45***	1.64	−1.35	−5.72***	0.96
	(0.82)	(1.32)	(1.19)	(0.84)	(1.33)	(1.22)	(0.82)	(1.32)	(1.20)	(0.84)	(1.33)	(1.22)
Multinationality	−0.11***	−0.04	−0.15***	−0.09***	−0.03	−0.13**	−0.11***	−0.04	−0.16***	−0.09***	−0.03	−0.13**
	(0.03)	(0.03)	(0.06)	(0.03)	(0.03)	(0.06)	(0.03)	(0.03)	(0.06)	(0.03)	(0.03)	(0.06)
Equity share	−0.05	−0.24	−0.70**	−0.91***	−0.40	−2.28***	−0.15	−0.28	−0.78***	−0.85***	−0.41	−2.16***
	(0.21)	(0.34)	(0.30)	(0.31)	(0.35)	(0.59)	(0.21)	(0.34)	(0.30)	(0.31)	(0.35)	(0.59)
Equity share × multinationality	—	—	—	−0.37***	−0.22	−0.61***	—	—	—	−0.30***	−0.18*	−0.54***
	—	—	—	(0.10)	(0.11)	(0.19)	—	—	—	(0.10)	(0.11)	(0.20)
Expatriate ratio	0.03	−0.76	−0.40	0.03	−0.81	−0.36	−1.29**	−0.96	−2.52**	−1.07*	−0.99	−1.83
	(0.49)	(0.67)	(0.67)	(0.48)	(0.67)	(0.67)	(0.60)	(0.68)	(1.21)	(0.60)	(0.68)	(1.24)
Expatriate ratio × multinationality	—	—	—	—	—	—	−0.87***	−0.66***	−1.06**	−0.72***	−0.60**	−0.72
	—	—	—	—	—	—	(0.23)	(0.24)	(0.50)	(0.23)	(0.24)	(0.52)
Constant	−3.60***	0.33	−5.70***	−3.41***	0.39	−5.41***	−3.57***	0.35	−5.71***	−3.41***	0.41	−5.44***
	(0.53)	(0.54)	(0.74)	(0.53)	(0.54)	(0.74)	(0.53)	(0.54)	(0.74)	(0.53)	(0.54)	(0.74)
N	10,799	5,399	5,400	10,799	5,399	5,400	10,799	5,399	5,400	10,799	5,399	5,400
Log likelihood	−20,233.16	−9,044.46	−10,933.71	−20,226.07	−9,042.30	−10,928.8	−20,225.83	−9,040.68	−10,931.51	−20,221.15	−9,039.22	−10,927.82
Log likelihood ratio test (χ^2)												
Expanded model vs. basic model	—	—	—	14.17***	4.32*	9.81***	14.65***	7.56**	4.41*	24.00***	10.49**	11.77***

[a] Both industry and year fixed effects are included; both are jointly significant at $p < 0.01$ (two-tailed test).
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$ (two-tailed test).

options, because correlations within a firm's option portfolio (subadditivity) can reduce the value of the portfolio as a whole. We apply this novel perspective to the context of multinational firms' international operations that confer a portfolio of switching options, and our empirical study also extends prior analytical modeling research in this area (e.g., Kogut and Kulatilaka, 1994; de Meza and van der Ploeg, 1987). Our study's focus on the impact of subadditivity in option portfolios on firms' downside risk complements prior work on the impact of subadditivity on firms' investment and divestment decisions (e.g., Belderbos and Zou, 2009; McGrath and Nerkar, 2004; Vassolo *et al.*, 2004) by showing that subadditivity can shape firm outcomes as well as strategic choices. Our finding of a negative moderating impact of subadditivity on the relationship between multinationality and downside risk highlights the value of considering the role of option portfolio characteristics in real options research. We believe that our portfolio focus and contingent approach can provide a useful step toward better understanding real options theory's applications to multinational firms.

Second, our study responds to recent calls for real options research to give greater attention to some of the organizational aspects of real options analysis when applying the theory to strategic management (e.g., Bowman and Moskowitz, 2001; Coff and Laverty, 2007; Kogut and Kulatilaka, 2004). We show that multinational firms' equity stakes and expatriate assignment policy in their foreign affiliates strengthen the negative impact of multinationality on downside risk and that these organizational policies are more salient for firms operating in host countries with relatively low labor cost correlations. According to our knowledge, we provide one of the first studies to *integrate* firms' organizational characteristics with their environmental conditions in the empirical literature on real options. A key implication of our finding on the moderating effect of firms' ownership level is that smaller equity shares that increase the value of growth options, as emphasized in prior research (e.g., Chi and McGuire, 1996; Li and Li, 2010; Tong *et al.*, 2008), need to be balanced against their reduced value in implementing switching options and lowering downside risk. This also points to the importance of using variables that can directly address switching and growth options in order to further advance real options research.

Finally, our study has useful implications for several streams of international strategy research. For example, our study is related to a large body of work on the relationship between multinationality and performance (e.g., Hitt, Hoskisson, and Kim, 1997; Lu and Beamish, 2004; Mitchell, Shaver, and Yeung, 1992; Qian *et al.*, 2010). Despite its significance and contributions, Hennart (2007) suggests that this body of work has often neglected the role of host country environments and similarly has paid insufficient attention to the importance of organizational factors. Though we focus on downside risk, our study addresses some of these limitations by analyzing the role of host countries' labor cost correlations, the role of organizational factors, as well as the interactive effects between the two. Our sensitivity tests incorporating the nonlinear effect of multinationality on downside risk also suggest that future research on the declining marginal impact of increased multinational scope on firm performance will benefit from explicitly considering the configuration of host country characteristics.

As another example, our study's finding on the impact of expatriate assignment on downside risk also has implications for the literature on human resource management in multinational firms. Specifically, that literature has examined many of the advantages that expatriates can offer at the individual affiliate level and has suggested that these advantages should be traded off against the high expatriation cost for the firm (Wang *et al.*, 2009). Our study suggests that it may be important to assign expatriates to affiliates in order to implement system-wide flexibility and achieve the multinational firm's global objective of positive performance outcomes and risk reduction. At a more general level, our findings on the important roles that host country conditions and organizational factors play have useful implications for multinational firms' configuration of international value chains, subsidiary location choices, and global investment strategies (Belderbos and Sleuwaegen, 2005; Kouvelis *et al.*, 2001).

We would like to note several areas for future research, which can help to address some of the paper's limitations. Our study joins recent research to apply real options theory to multinational firms based in other countries than the U.S., yet the findings we report might be specific to Japan. For instance, Japanese firms have made substantial investments in the emerging economies

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in Asia that tend to be more heterogeneous in their economic environments, while U.S. firms' overseas investments have historically concentrated in developed countries such as Europe that are relatively more homogeneous. However, we believe that the theory we draw from is general and should be applicable to multinational firms based in other countries. Future work might find it valuable to compare the roles of option portfolios and organizational policies in affecting firms' downside risk across different countries. Relatedly, future research can investigate other sources of subadditivity than labor or input cost, as well as subadditivity in product markets and other environmental factors. Research can also examine how subadditivity affects multinational firms' strategic choices and performance outcomes in other cross-border investment contexts such as foreign market entry and exit.

In our study, we rely on measures such as equity share and expatriate assignment as proxies for firms' abilities to control and coordinate activities among dispersed affiliates. Researchers might consider how specific organizational processes, such as particular control systems, delegation and autonomy, compensation policies, and incentive schemes (e.g., Alessandri *et al.*, 2012; Kogut and Kulatilaka, 1994), might also shape the firms' abilities to exploit the switching opportunities to coordinate multinational activities and achieve flexibility. Issues such as these might be more productively investigated through surveys or field interviews, which can examine in finer-grained terms some of the specific mechanisms through which firms can implement the embedded switching options as well as the opportunities and challenges they might encounter during the implementation process. As multinational firms' activities are increasingly located and coordinated across countries of heterogeneous environmental conditions nowadays, we believe that more research on the roles of real option portfolio and organization will prove particularly useful in enhancing the value of real options theory for understanding multinational investments and the associated economic outcomes.

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SUPPORTING INFORMATION

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Appendix A