EXPANSION OF FOREIGN SUBSIDIARIES BY MULTINATIONAL CORPORATIONS

Arkadiy V. Sakhartov
Gies College of Business
University of Illinois at Urbana-Champaign
493 Wohlers Hall, 1206 S. Sixth Street
Champaign, IL, 61820
arkadiys@illinois.edu

Jeffrey J. Reuer
Leeds School of Business
University of Colorado Boulder
402M Koelbel Building, 995 Regent Drive
Boulder, CO80309
jeffrey.reuer@colorado.edu

Abstract

A multinational corporation facing high uncertainty in foreign markets can expand its foreign subsidiaries through a switching option—by redeploying resources from other locations, or through a growth option—by scaling up these subsidiaries on a stand-alone basis. Although the two real options represent natural alternatives, the choice of one versus the other has not been investigated. This study develops a formal model that casts the two real options as a portfolio available to the multinational corporation. Multiple results of the model bring up three novel insights. First, contrary to the prevalent applications of real options theory, neither the strongest advantage of the to-be-expanded foreign subsidiary over other subsidiaries in the firm suffices to justify expansion of that subsidiary through the switching option, nor does the strongest performance of that subsidiary in absolute terms justify its expansion through the growth option. Second, although the cost of implementing each option suppresses its use, this known effect critically depends on other determinants of each of the two options. Finally, while uncertainty monotonically raises the odds that the multinational corporation expands its foreign subsidiary through the switching option, this known effect of uncertainty holds for the growth option only when the growth cost is high. Otherwise, with low growth costs, the use of the growth option declines in uncertainty. The results of the model provide necessary groundwork for better empirical identification of alternative expansion options in future international strategy research. They can also be used by executives to guide their foreign expansion decisions.

Keywords: multinational corporation, foreign expansion, resource redeployment, switching option, growth option.

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Foreign subsidiaries of multinational corporations (MNCs) are often located in highly uncertain and dynamically changing host countries. With shifts in local product markets, in local labor markets, in exchange rates for the local currency, and in the local institutional environment, executives in MNCs must make decisions about the potential expansion of foreign subsidiaries (Kogut, 1983, 1989; Trigeorgis, 1996). Those evolving conditions and associated expansion choices can have an important impact on the future performance of a foreign subsidiary and of an MNC overall. The developing real options perspective on such decisions emphasizes that MNCs can access upside opportunities and limit downside losses by dynamically altering commitments to foreign subsidiaries with the arrival of new information on host country environments.

Existing research has raised two distinct ways in which MNCs can expand in host countries. First, an MNC might exercise a *switching option* by withdrawing some resources (*e.g.*, capital, physical assets, labor, and input procurement) from a domestic subsidiary and redeploying them to a foreign subsidiary (Kogut & Kulatilaka, 1994; Huchzermeier & Cohen, 1996).[1] This view portrays the MNC as a dynamic network whose flexibility is determined by the dispersion of assets across countries with unique external environments (Belderbos & Zou, 2007; Sundaram & Black, 1992), in contrast to the perspective that the MNC internalizes technology transfers or controls other exchanges in intermediate goods to reduce transaction costs (Buckley & Casson, 1998). Second, the MNC might instead scale up a foreign subsidiary by buying necessary resources from local factor markets in the host country (Chi & McGuire, 1996). Here, the MNC exercises a within-country *growth option* and scales up on an independent or standalone basis, instead of withdrawing key resources from their uses in other locations, as above (Chang & Rosenzweig, 2001; Chi & Seth, 2009).[2]

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Although the two ways for an MNC to expand its foreign subsidiaries were sometimes recognized within a portfolio of alternative options (Kogut, 1989; Trigeorgis, 1996), more often they were studied separately from each other. A rare exception was the study of Chung et al. (2010) that investigated foreign subsidiary expansion/contraction and appealed to both growth and switching options. Given that Chung et al. (2010) did not separate the two options from each other in conceptual predictions or empirical operationalizations, it is interesting and valuable to investigate how each of those options is used for the expansion of a foreign subsidiary in the presence of another option. Chi et al. (2019) attributed the limited understanding of the interplay between the two options to the conceptual complexity of portfolios of growth and switching options and to the difficulty of modeling such portfolios. Indeed, existing research on the expansion of foreign subsidiaries has often relied on conceptual framing, formal valuation models, and empirical analysis to study antecedents and consequences of each option while implicitly assuming away another option. For instance, the literature on multinationality and the switching options it confers has built on early conceptual models (Kogut, 1983; Kogut & Kulatilaka, 1994; Trigeorgis, 1996) to test empirically whether multinationality confers useful operational flexibility and performance or risk advantages (Allen & Pantzalis, 1996; Belderbos, Tong, & Wu, 2014; Reuer & Leiblein, 2000; Tong & Reuer, 2007). That research also began to isolate the conditions under which the option to switch operations across countries is created (Fisch & Zschoche, 2012) and exercised (Lee & Song, 2012; Rangan, 1998). Just as these studies focused on the switching option and ignored the growth option within the host country, another stream of research focused specifically on the option to expand through staged investment (Kogut, 1991; Folta, 1998; Chi, 2000; Folta & Miller, 2002; Cuypers & Martin, 2010; Tong & Li, 2013; Smit, Pennings, & van Bekkum, 2017). However, it is equally evident that the option to

grow a subsidiary through staged investment should be selected from a portfolio that also includes the option to switch resources to that subsidiary.

Another feature of research on the two options to expand foreign subsidiaries is that, despite the inherent complexity of these options, their best possible use has not been scrutinized theoretically and has been relegated instead to exploratory studies. Notably, both options are known to be complicated by the multiplicity of their determinants, such as uncertainty and the costs of exercising them (Chi et al., 2019). Moreover, both options entail hysteresis, wherein the current superior performance of a subsidiary may not justify its expansion (Kogut & Kulatilaka, 1994). With these complications, extant work on the two options can be classified into three groups. The first group consists of empirical studies that characterized implications of the expansion options for an MNC's performance (Allen & Pantzalis, 1996; Belderbos et al., 2014; Reuer & Leiblein, 2000; Tong & Reuer, 2007), or that investigated the creation of the expansion options *via* establishing a joint venture or *via* acquiring a foreign firm (Cuypers & Martin, 2010; Fisch & Zschoche, 2012; Folta, 1998; Tong & Li, 2013). While studies in this group implied that MNCs would improve performance by exercising the expansion options, none of these studies captured such exercising behavior and its performance consequences. The second group includes formal models that assessed the value of the expansion options (Chi, 2000, Huchzermeier & Cohen, 1996; Kogut & Kulatilaka, 1994). Like studies in the first group, these formal valuation models were agnostic about the actual exercising of the expansion options. Finally, the third group involves a few empirical studies that registered the use of the growth option (Folta & Miller, 2002; Kogut, 1991) or of the switching option (Belderbos & Zou, 2007; Lee & Song, 2012; Rangan, 1998). Such exploratory work has cast doubt on whether MNCs fully use the

expansion options (Rangan, 1998) or has emphasized that the understanding of that use is very limited (Belderbos & Zou, 2007; Lee & Song, 2012).

This study uses a formal model to restore the portfolio approach to enable a comparative analysis of the expansion of MNCs' foreign subsidiaries, whereby an MNC selects an expansion option that fits best with the specific conditions in which its foreign subsidiary operates, instead of using a single option as a default. Such research could inform executives whether they should, or should not, engage in switching operations across countries or in scaling up a foreign subsidiary in a particular situation. This approach to formalize the simultaneous presence of the two expansion options responds to the calls to study interactions between various real options (Anand, Oriani, & Vassolo, 2007; Folta & O'Brien, 2004; Vassolo, Anand, & Folta, 2004), including a recent call to formally model the specific interaction between the switching option and the growth option in the portfolio held by an MNC (Chi et al., 2019). Although the formal model in this study is based on the methods used in previous formal valuation models (Chi, 2000, Huchzermeier & Cohen, 1996; Kogut & Kulatilaka, 1994), the model extends this work by deriving the best possible use of the expansion options over time. One advantage of using such a model for this investigation is that the model reliably identifies the casual relationships in the context with two real options that are complex individually as well as are interacting with each other, instead of relegating such identification to exploratory studies.

The model deploys the following determinants of the two expansion options raised in previous research (a) the current returns in an MNC's subsidiaries, (b) the cost of exercising the switching option, (c) the cost of exercising the growth option, (d) uncertainty of future returns in an MNC's subsidiaries, and (e) correlation of those returns. Some results, such as the reduction of the use of the switching option by the switching cost, the enhancement of the use of the

switching option by uncertainty, or the reduction of the use of the growth option by the growth cost, are intuitive and validate the model. These results also correspond to received findings in previous option valuation models. Other results go beyond these implications and alter intuition in important ways as well as interpretations not based on the formal logic. There are overall 16 formal results of the model that are classified as unique to this study. While all of the unique results are discussed in detail below, three groups of such results are particularly worth highlighting, *vis-à-vis* the priors for them contained in the extant literature.

First, it was believed that the MNC is more likely to expand its foreign subsidiary *via* the switching option when that subsidiary more strongly outperformed another subsidiary in the firm, and *via* the growth option when that subsidiary performed better in absolute terms. The model indicates that this simple intuition for the effects of performance on the foreign expansion does not capture the conditions sufficient for the foreign expansion. Namely, in many cases, the MNC does not use the switching option to expand its foreign subsidiary even when that subsidiary most strongly outperforms another subsidiary in the firm. Likewise, in many cases, the MNC does not use the growth option to expand its foreign subsidiary even when that subsidiary performs at its best possible level in absolute terms. The simple intuition for the conditions that are sufficient for the foreign expansion breaks down because the true effect of performance on the use of each option is confounded by three factors: (i) the optimal time for the use of the option may not have come yet, and even the strongest performance of the foreign subsidiary, in absolute terms or relative to another subsidiary, cannot induce expansion; (ii) the optimal time for the use of the option under the conditions of the strongest performance of the foreign subsidiary may have already passed, and such performance does not lead to further expansion; and (iii) another expansion option may currently be more profitable, so ignoring that

other expansion option cannot explain why the considered option is not used despite the seemingly ideal performance conditions for its use when it is considered in isolation.

Second, it is indeed intuitive that the switching cost negatively affects the use of the switching option to expand an MNC's subsidiary, and that the growth cost has a strong negative effect on the use of the growth option to expand an MNC's subsidiary. The model indicates that this simple intuition is right but incomplete because it is based on (i) the separate accounts of the two options, and (ii) on the neglect of the interactions between the cost of implementing an expansion option and other determinants of that option. When the richness of the context of the expansion of an MNC's foreign subsidiary is restored by jointly considering both expansion options, the model demonstrates that both negative effects may be substantially smaller than they were assumed. In particular, the effect of the switching cost on the use of the switching option is smaller than it would be if the growth option were absent or prohibitively expensive. Likewise, the effect of the growth cost on the use of the growth option is smaller than it would be if the switching option were absent or prohibitively expensive. Furthermore, the effect of the switching cost on the use of the switching option is negatively moderated by correlation of returns between an MNC's subsidiaries and is positively moderated by uncertainty; whereas the effect of the growth cost on the use of the growth option is positively moderated by uncertainty.

Third, uncertainty was considered a key facilitator for the use of the expansion options. Again, this popular idea was based on neglecting the interactions between uncertainty and other determinants of the expansion options. While the model confirms that uncertainty monotonically raises the use of the switching option to expand an MNC's foreign subsidiary, that positive effect strongly interacts with the switching cost such that the switching cost positively moderates the effect of uncertainty. In fact, low switching costs may even make that effect trivial. For the

growth option, the interaction between uncertainty and the cost of implementing that option is so strong that it can even flip the positive effect of uncertainty on the use of the option to ultimately become a negative effect. Notably, the odds that the firm will use the growth option decline in uncertainty if the growth cost is low and rise in uncertainty only if the cost is high.

By addressing Chi et al.'s (2019) call for models that incorporate both the switching and the growth options at the same time, this study aims to improve the ability of empirical research to characterize how MNCs expand their foreign subsidiaries. For example, the attention to the possibility for MNCs to expand their foreign subsidiaries through the growth option can explain why the switching option was not fully used by MNCs despite strong advantages of their foreign subsidiaries over other subsidiaries in those MNCs (Rangan, 1998). Likewise, the consideration of determinants of the expansion options other than performance of the MNCs' subsidiaries (*i.e.*, of the costs of implementing these options and of uncertainty) warrants more comprehensive empirical investigation and can explain empirical findings that appeared counterintuitive otherwise. Furthermore, given the important role that uncertainty played in verbal accounts of the use of the expansion options and in exploratory models of such expansion, the elaboration of the non-monotonic effect of uncertainty on the expansion of foreign subsidiaries by MNCs lays the groundwork for more accurate specification of future empirical models. Finally, the results that are derived with the formal model introduced below can also serve as a starting point for the development of heuristics, or rules of thumb, for executives of MNCs who manage alternative expansion modes for their foreign subsidiaries.

MODEL

The model involves a firm that has a foreign subsidiary in addition to its domestic business. Specifically, at the initial time $t = 0$, the firm uses half (*i.e.*, proportion $m_{i0} = 0.5$) of

its resources in its foreign business i; the firm uses another half (*i.e.*, proportion $(1-m_{i0})=0.5$) of the resources in its domestic business j. At any time before the end of the lifecycle of its resources $t=T$, the firm can double its participation in the foreign business i by using one of two real options. First, the firm can use the switching option: it can switch all resources that were initially used in its domestic business j to the foreign business i. Second, the firm can use the growth option: it can buy additional resources for the foreign business i. The model consists of three parts: (1) a specification of returns in the firm's two businesses, (2) a specification of the two real options for expanding the foreign business, and (3) a description of how the firm uses those options. These three parts are described in turn below.

Returns in the Firm's Businesses

Returns in the firm's businesses are uncertain. In particular, the margin C_{it} in the foreign business and the margin C_{jt} in the domestic business follow geometric Brownian motions:

$$C_{it}=C_{i0}e^{\left[\left(\mu_i-\frac{\sigma_i^2}{2}\right)t+\sigma_i W_{it}\right]} \qquad (1)$$

$$C_{jt}=C_{j0}e^{\left[\left(\mu_j-\frac{\sigma_j^2}{2}\right)t+\sigma_j W_{jt}\right]} \qquad (2)$$

$$dW_{it}\,dW_{jt}=\rho\,dt\,. \qquad (3)$$

In Equations 1–3, C_{i0} and C_{j0} are margins in businesses i and j at the initial time $t=0$; μ_i and μ_j are drifts for the margins; σ_i and σ_j are volatilities of the margins that capture uncertainty; and W_{it} and W_{jt} are Brownian motions with correlation ρ. This specification, which is prevalent in modeling real options, makes a reasonable assumption that the uncertain margins become more difficult to predict the farther the margins are projected into the future.[3]

Real Options for Expanding the Foreign Business

Switching option. The first option with which the firm can expand its foreign business is to switch its resources to that business. If resources are switched to the foreign business i, the net margin that is earned with the resources that are withdrawn from the domestic business j is lower than the regular margin C_{it} in the foreign business i, by the marginal switching cost s. Like in Sakhartov and Folta (2015), the full switching cost S_t^x, in this case, is a product of (a) the marginal switching cost s of a unit of resources; (b) the amount $(1-m_{i0})$ of resources that are switched to i; and (c) the current realization C_{it}^x of the uncertain margin C_{it} in the recipient business. Formally,

$$S_t^x = s(1-m_{i0})C_{it}^x. \qquad (4)$$

Equation 4 leads to the following statement of the expected net present value V_t^{xS} of the firm that uses the switching option to expand its foreign subsidiary:

$$V_t^{xS} = \begin{cases} -S_t^x + C_{it}^x + e^{-r\partial t}E^{P^i}\left[V_{t+\partial t}^{xS} \mid \left(M_t^* = 2, x\right)\right] & \text{if } M_{t-\partial t} = 1 \\ C_{it}^x + e^{-r\partial t}E^{P^i}\left[V_{t+\partial t}^{xS} \mid \left(M_t^* = 2, x\right)\right] & \text{if } M_{t-\partial t} = 2 \end{cases}. \qquad (5)$$

In Equation 5, $E^{P^i}\left[V_{t+\partial t}^{xS} \mid \left(M_t^* = 2, x\right)\right]$ is the expectation with respect to the probability distribution P^i for C_{it}, r is a risk-free interest rate, and $V_{t+\partial t}^{xS}$ is the net present value in the immediate next time $(t+\partial t)$. Expectation $E^{P^i}[\cdot]$ is conditioned on the current or the past choice to use the switching option $(M_t^* = 2)$. This expectation is assessed when margin C_{it} is in state x. While the first line in Equation 5 corresponds to the situation where resources were not switched before time t (*i.e.*, $M_{t-\partial t} = 1$); the second line is for the situation where resources were switched to i before time t (*i.e.*, $M_{t-\partial t} = 2$) and, thus, no switching cost is incurred at time t.

Growth option. The second way in which the firm can expand its foreign business is to use the growth option and to buy additional resources for that business. If the firm does so, it pays the price G_t that is equal to the discounted net present value that similar firms would accumulate, on average, in deploying the amount m_{i0} of resources in the foreign business i from time $\tau = t$ to time $\tau = T$. The price is increased by the premium $\gamma \geq 0$, which the firm pays to buy the additional resources on the factor market. This premium characterizes the incurred growth cost. Formally,

$$G_t = (1+\gamma) m_{i0} \sum_{\tau=t}^{T} e^{-r(\tau-t)} \hat{C}_{i\tau} , \qquad (6)$$

where $\hat{C}_{i\tau}$ is the average margin that is earned by firms that operate in business i at time τ. In addition to the interpretation that the growth cost represents a transaction cost in the imperfect foreign factor market, the growth cost can be explained by referring to a few classical interpretations of 'barriers to entry' (Bain, 2013). In the context of this study, the growth cost may be thought of as an extra expense that is incurred by the MNC to overcome such barriers as it scales up further. One factor that may make such barriers particularly critical in the context of foreign expansion is the 'liability of foreignness' (Zaheer, 1995). Even though the firm has already invested in the country, it can still encounter such a liability as it expands in the country. Also, if for competitive reasons the foreign expansion should be executed quickly, the MNC incurs 'time-compression diseconomies' (Jiang, Beamish, & Makino, 2014), which represent an additional ramification of the growth cost.

With this specification of the growth cost, the expected net present value V_t^{xyG} of the firm when it uses the growth option to expand its foreign business can be expressed as follows:

$$V_t^{xyG} = \begin{cases} -G_t + 2m_{i0}C_{it}^x + (1-m_{i0})C_{jt}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xyG} \mid \left(M_t^* = 3, x, y\right)\right] & \text{if } M_{t-\partial t} = 1 \\ 2m_{i0}C_{it}^x + (1-m_{i0})C_{jt}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xyG} \mid \left(M_t^* = 3, x, y\right)\right] & \text{if } M_{t-\partial t} = 3 \end{cases}. \quad (7)$$

Here, $V_{t+\partial t}^{xyG}$ is the net present value at time $(t+\partial t)$. Expectation $E^{P^{ij}}\left[V_{t+\partial t}^{xyG} \mid M_t^* = \left(3, x, y\right)\right]$ is taken with respect to the joint probability distribution P^{ij} for C_{it} and C_{jt}. This expectation is conditioned on the current or the past choice to use the growth option $(M_t^* = 3)$ and is estimated when margins C_{it} and C_{jt} are in states x and y. Whereas the first line in Equation 7 considers the case where the growth option is exercised exactly at time t (*i.e.*, $M_{t-\partial t} = 1$), the second line is relevant when the growth option was exercised before time t (*i.e.*, $M_{t-\partial t} = 3$).

Use of Alternative Expansion Options

The two indicated ways in which the firm can expand its foreign business are options, rather than obligations. They are exercised only if doing so makes the firm better off. A natural alternative available to the firm at any time is to continue holding the amount m_{i0} of resources in the foreign business i and the amount $(1-m_{i0})$ of resources in the domestic business j. When current realizations for C_{it} and C_{jt} are C_{it}^x and C_{jt}^y respectively, the expected net present value V_t^{xy0} for the firm that keeps its initial resource allocation can be expressed as follows:

$$V_t^{xy0} = m_{i0}C_{it}^x + (1-m_{i0})C_{it}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xy} \mid \left(M_t^* = 1, x, y\right)\right]. \quad (8)$$

In Equation 8, $V_{t+\partial t}^{xy0}$ is the net present value of the firm in the immediate next time $(t+\partial t)$. Expectation $E^{P^{ij}}\left[V_{t+\partial t}^{xy} \mid \left(M_t^* = 1, x, y\right)\right]$ is taken with respect to the joint probability distribution P^{ij} for C_{it} and C_{jt}. This expectation is conditioned on the current choice to keep the original

resource allocation (*i.e.*, $M_t^* = 1$). The expectation is estimated when C_{it} and C_{jt} are in their respective states x and y.

Based on Equations 5, 7, and 8, the firm's net present value V_t^{xy} can be stated as follows:

$$V_t^{xy} = \begin{cases} \max\limits_{M_t} \begin{cases} m_{i0}C_{it}^x + (1-m_{i0})C_{it}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xy} \mid \left(M_t^* = 1, x, y\right)\right] & \text{if } M_{t-\partial t} = 1, \\ -S_t^x + C_{it}^x + e^{-r\partial t}E^{P^i}\left[V_{t+\partial t}^{xS} \mid \left(M_t^* = 2, x\right)\right] & \text{if } M_{t-\partial t} = 1, \\ -G_t + 2m_{i0}C_{it}^x + (1-m_{i0})C_{jt}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xyG} \mid \left(M_t^* = 3, x, y\right)\right] & \text{if } M_{t-\partial t} = 1 \end{cases} \\ C_{it}^x + e^{-r\partial t}E^{P^i}\left[V_{t+\partial t}^{xS} \mid \left(M_t^* = 2, x\right)\right] \quad \text{if } M_{t-\partial t} = 2 \\ 2m_{i0}C_{it}^x + (1-m_{i0})C_{jt}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xyG} \mid \left(M_t^* = 3, x, y\right)\right] \quad \text{if } M_{t-\partial t} = 3 \end{cases}. \quad (9)$$

Whereas, the firm's respective current choice $M_t^* \in \{1, 2, 3\}$ is expressed in the following way:

$$\left(M_t^* \middle| M_{t-\partial t}\right) = \begin{cases} \arg\max\limits_{M_t} \begin{cases} m_{i0}C_{it}^x + (1-m_{i0})C_{it}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xy} \mid \left(M_t^* = 1, x, y\right)\right] & \text{if } M_{t-\partial t} = 1, \\ -S_t^x + C_{it}^x + e^{-r\partial t}E^{P^i}\left[V_{t+\partial t}^{xS} \mid \left(M_t^* = 2, x\right)\right] & \text{if } M_{t-\partial t} = 1, \\ -G_t + 2m_{i0}C_{it}^x + (1-m_{i0})C_{jt}^y + e^{-r\partial t}E^{P^{ij}}\left[V_{t+\partial t}^{xyG} \mid \left(M_t^* = 3, x, y\right)\right] & \text{if } M_{t-\partial t} = 1 \end{cases} \\ 2 \quad \text{if } M_{t-\partial t} = 2 \\ 3 \quad \text{if } M_{t-\partial t} = 3 \end{cases}. \quad (10)$$

Equations 9 and 10 are variants of the same Bellman equation (Bellman, 1957) that represents the firm's choice to expand its foreign business as dynamically optimal. The dynamic optimality demands that the firm choose the best time to exercise an option. This setting makes the firm compare: (a) the value of continuing to hold both expansion options if none of them has been exercised yet (*i.e.*, the first lines in Equations 9 and 10), (b) the value of exercising the switching option if none of the two expansion options has been exercised yet (*i.e.*, the second lines in Equations 9 and 10), and (c) the value of exercising the growth option if none of the two expansion options has been exercised yet (*i.e.*, the third lines in Equations 9 and 10). If the firm already exercised the switching option or the growth option in the past, the firm stays in the corresponding new mode as reflected in the last two lines in Equations 9 and 10. To capture the

possibility that one of the option was exercised in the past, Equation 10 states the optimal decision $\left(M_t^* \middle| M_{t-\partial t}\right)$ at time t as conditional on what the firm did in the past.

Equations 9 and 10 split the problem of the expansion of the firm's foreign business into a sequence of sub-problems that are amenable to a numerical solution. The choice to expand the foreign business is expressed in a recursive form that relies on backward induction to derive optimal conditional choices $\left(M_t^* \middle| M_{t-\partial t}\right)$ at all times t and with all values of C_{it}^x, and C_{jt}^y. The solution involves the discretization of the continuous-time distribution P^{ij} specified with Equations 1–3. Like Sakhartov and Folta (2015), the present model uses the popular and efficient discretization developed by Boyle, Evnine, and Gibbs (1989) that approximates geometric Brownian motions with a binomial lattice. This approach preserves the mean and the variance of the original distribution if the time step ∂t on the lattice is short. On the lattice, the next-period margins $C_{it+\partial t}$ and $C_{jt+\partial t}$ take four states: $C_{it+\partial t}^u$ and $C_{jt+\partial t}^u$ with probability q^{uu}, $C_{it+\partial t}^u$ and $C_{jt+\partial t}^d$ with probability q^{ud}; $C_{it+\partial t}^d$ and $C_{jt+\partial t}^u$ with probability q^{du}; or $C_{it+\partial t}^d$ and $C_{jt+\partial t}^d$ with probability q^{dd}.[4] Accordingly, expected values in the first three lines in Equations 9 and 10 can be estimated as $E\left[V_{t+\partial t}^{xy0}\right] = q^{uu}V_{t+\partial t}^{uu0} + q^{ud}V_{t+\partial t}^{ud0} + q^{du}V_{t+\partial t}^{du0} + q^{dd}V_{t+\partial t}^{dd0}$, $E\left[V_{t+\partial t}^{xS}\right] = (q^{uu} + q^{ud})V_{t+\partial t}^{uS} + (q^{du} + q^{dd})V_{t+\partial t}^{dS}$, and $E\left[V_{t+\partial t}^{xyG}\right] = q^{uu}V_{t+\partial t}^{uuG} + q^{ud}V_{t+\partial t}^{udG} + q^{du}V_{t+\partial t}^{duG} + q^{dd}V_{t+\partial t}^{ddG}$.

The backward induction procedure starts at the penultimate time $t = T - \partial t$ with the terminal conditions $V_T^{xy0} = 0$, $V_T^{xS} = 0$, and $V_T^{xyG} = 0$ suggesting that the resources will have fully exhausted their ability to generate returns by that time. The algorithm proceeds recursively backward in time with a step ∂t until it reaches time $t = 0$. At this point in the estimation, the model returns the net present value of the firm V_0^{xy}, but the firm's choices are still characterized

as conditional $\left(M_t^* \middle| M_{t-\partial t}\right)$. Because the firm is known to have initially split its resources equally between its domestic and foreign businesses ($M_0 = 1$), the model can now change the direction for going through the lattice and follows recursively forward in time until it reaches time $t = T$. In each step going forward in time and for each combination of margins C_{it}^x, and C_{jt}^y, the model derives unconditional choice M_t^* based on the known immediate previous choice $M_{t-\partial t}$ and on the optimal conditional decision $\left(M_t^* \middle| M_{t-\partial t}\right)$ recovered with the backward induction. Finally, the three-dimensional matrix (t, x, and y) that is generated for M_t^* enables the following analyses.

RESULTS

Results of the model are split into the following six groups. The first group specifies the use of the two expansion options in terms of current returns in the firm's markets. The second group focuses on how the switching cost and uncertainty determine the use of the two options. The third group considers how the growth cost and uncertainty affect the use of the expansion options. The fourth group presents how the switching cost and the growth cost shape the use of the two options. The fifth group elaborates upon how correlation of margins in the firm's markets affect the use of the expansion options. The last group validates the robustness of the main findings and illustrates additional ramifications of the model through supplemental analysis. If the variation of a parameter is not required in a considered result, the following values are used: $s = 10$, $\gamma = 0.15$, $C_{i0} = C_{j0} = 0.08$, $\sigma = \sigma_i = \sigma_j = 0.2$, $\rho = 0$, $T = 1$, $N = 200$, and $r = 0.08$. If the variation of a parameter is needed for the demonstrated result, the range for the parameter is reported with that result.

Implications of Current Returns for the Use of the Expansion Options

Figure 1 dissects the bivariate binomial lattice at four points in time. The lattice has the shape of a rectangular pyramid with the apex at time $t = 0$ where margins in the foreign and the domestic businesses of the firm are known to be C_{i0} and C_{j0} respectively, and with the base at time $t = T$ where uncertain margins can take numerous realizations C_{iT}^{x} and C_{jT}^{y} from the probability distribution specified with Equations 1–3. The expansion of the pyramid from the apex to the base reflects the property of the geometric Brownian motion that the margins become more uncertain the farther they are projected into the future. The resulting four sectional views are parallel to the base because time does not vary within each section. The scale of the axes in the five panels in Figure 1 expands substantially going from Panel A, through Panels B and C, to Panel D due to the increasing ranges for possible margins going farther into the future. In each of Panels A, B, C, and D, the two sectional views in the form of rectangles represent 'snapshots' for the odds of using the switching option (*i.e.*, the left-hand side) and of using the growth option (*i.e.*, the right-hand side) over the entire space for realizations C_{it}^{x} and C_{jt}^{y} possible at time t.

Insert Figure 1 about here

Panel A of Figure 1 illustrates the start of the use of the switching option to expand the foreign business. That use begins in the top left corner of the plot where the margin in the foreign market C_{i9} has its highest possible realization $C_{i9}^{\max}$ and the margin in the domestic market C_{j9} has its lowest realization $C_{j9}^{\min}$ in the considered time. Although the co-occurrence of $C_{i9}^{\max}$ and $C_{j9}^{\min}$ is rather unlikely, if the firm happens to be in that state, it will switch resources from the domestic market to the foreign market because the difference $\left(C_{i9}^{\max} - C_{j9}^{\min}\right)$ represents a very

high opportunity cost to remaining in the considerably underperforming domestic business. An important fact is that, while the scenario with the strongest advantage $\left(C_{it}^{\max} - C_{jt}^{\min}\right)$ of the foreign market over the domestic market occurred in the top left corners of the 'snapshots' for all preceding time steps, step 9 is the first time when this condition favorable for the exercise of the switching option entails such exercise. This fact reflects a rational delay, or inertia, in the use of the switching option that, despite the strongest advantage of the destination over the origin, is fully aligned with dynamic optimality (*cf.* Equation 10). Hence, predicting the use of that option demands the joint analysis of performance and time. In other words, the strong advantage of the destination market for switching resources in the MNC over the original market is necessary but not sufficient for the exercising of such switching. Although, in the context of Panel A, this first manifestation of non-sufficiency of performance is linked to the rational delay in the use of the option, two additional explanations for the non-sufficiency of performance are developed below.

Panel B shows the start of the use of the growth option. The use of the growth option begins in the top right corner where the margin in the foreign market C_{i19} has its highest possible realization $C_{i19}^{\max}$ in the respective time, thus making the foreign market most attractive for the expansion through the growth option. Meanwhile, although the same scenario with the highest return $C_{it}^{\max}$ in the foreign market happened in the top right corners of the 'snapshots' for all preceding time steps, step 19 is the first time when this condition favorable for the growth option plays out. This fact indicates a delay, or inertia, in the use of the growth option despite the strongest attractiveness of the foreign market. Accordingly, predicting the use of the growth option also requires the joint analysis of performance and time. In other words, the high return in the foreign market is necessary but not sufficient for the exercising of the growth option. Like the delay in the use of the switching option despite the strongest advantage of the destination

over the origin, the delay in the use of the growth option despite the highest returns in the to-be-expanded foreign subsidiary reflects the first manifestation of non-sufficiency of performance.

The second manifestation of non-sufficiency of the highest return in the foreign market for predicting the use of the growth option is that such use critically depends on returns in the domestic market. That use occurs only if the margin in the domestic market is close to its highest value $C_{j19}^{\max}$ because, with lower returns in the domestic market, the firm can use the switching option. Thus, the second source of the non-sufficiency of the highest return in the to-be-grown subsidiary for predicting the use of the growth option is that this highest return may activate the switching option instead of the growth option. Multiple states that invite such switching form a straight line with a slope greater than 45 degrees, on which the condition $C_{i19}^{x} > C_{j19}^{y}$ justifies the switching from j to i. Below that line, the use of the switching is unprofitable. Why does the dark-blue area to the north-west of that line show no use of the switching even when $C_{i19}^{x} > C_{j19}^{y}$, specifically in the top left corner where the difference $\left(C_{i19}^{\max} - C_{j19}^{\min}\right)$ asumes the highest value? Also, why does that area show no use of the growth option even with $C_{i19}^{\max}$? This lack of use of the expansion options reveals the third manifestation of non-sufficiency of performance: the combinations of the two margins in the considered area are formed by evolving from their states $C_{i9}^{\max}$ and $C_{j9}^{\min}$ with which the switching was already used earlier, as shown in Panel A.

Panel C of Figure 1 indicates the evolution of the use of the two options. The line for the switching option continues to expand along with the extension of possible states for returns over time and maintains the same slope of greater than 45 degrees so that $C_{i100}^{x} > C_{j100}^{y}$. In turn, states that lead to the use of the growth option combine into a horizontal line in the respective plot in Panel C. That horizontal line is longer than in Panel B and is distant from the top margin of the

plot. Why does the dark-blue rectangular area to the top of the horizontal line reveal no use of the growth option if higher values of C^{x}_{i100} in that area make the growth option more attractive? This happens because the high values of C^{x}_{i100} in that rectangular area have evolved from their state $C^{\max}_{i19}$ with which the growth option was already exercised, as shown in Panel B. It can also be seen that the position of the left end of the horizontal line for the use of the growth option coincides with the position of the right end of the sloped line for the use of the switching option. This result indicates how the choice between the options maps onto the margin in the domestic business: with lower values of that margin, the firm prefers to use the switching option; whereas, with higher values of that margin, the firm chooses the growth option.

Panel D of Figure 1 reports further evolution in the use of the two options. Like in Panel C, the location of the left end of the horizontal line for the use of the growth option matches the location of the right end of the line with the slope of more than 45 degrees for the use of the switching option. Furthermore, the horizontal line for the use of the growth option becomes even more distant from the top margin of the plot than in Panel B, thus getting closer to the middle of the plot in the vertical dimension. That middle represents the natural threshold for the attractiveness of the growth option because it captures the basis for the price that the firm would have to pay in buying additional resources for the growth. Below that line, that form of expanding the foreign business is unprofitable for the firm.

Figure 2 extends Panel D of Figure 1 with two additional ‘snapshots’ where one of the two options is disallowed by the model. These two plots demonstrate the conditions, in terms of returns in the two businesses that are intrinsic to each of the two options and not artefacts of the presence of another option; these plots are also instrumental for understanding what interrupts the line for each option in plots where both options are present. Thus, in the absence of the

growth option, the line for the switching option proceeds uninterrupted to the top margin of the respective plot while maintaining the slope of greater than 45 degrees so that $C^{x}_{i151} > C^{y}_{j151}$. The area below that line represents combinations of the two margins with which the expansion in the foreign business through the switching option is unprofitable. In the area above that line, the firm also refrains from exercising the switching option in the considered time, but for a very different reason. As discussed with Panel B of Figure 1, the area above the line represents cases where the switching option was already exercised in the past more profitably, *i.e.*, based on the principle of dynamic optimality (Bellman, 1957). In turn, when the switching option is absent, the horizontal line for the growth option proceeds uninterrupted to the left margin of the plot, *i.e.*, down to the lowest possible value for the margin in the domestic business. The area below that line involves values of the margin in the foreign business with which the use of the growth option is unprofitable. In the area above that line, the firm also avoids using the switching option in the considered time, but for a very different reason. As explained with Panel C of Figure 1, the area above the horizontal line involves cases where the growth option was already used in the past more-profitably, *i.e.*, based on the principle of dynamic optimality.

Insert Figure 2 about here

It is worth ending this section by highlighting the unique insights that go beyond previous knowledge or simple intuition. It is well-understood that the MNC uses the switching option to expand its foreign subsidiary when the to-be-expanded subsidiary most strongly outperforms another subsidiary in the firm, and that the MNC uses the growth option to expand its foreign subsidiary when the to-be-grown subsidiary performs at its best possible level in absolute terms. Figure 1 indicates that this understanding is true only in the very limiting and unlikely case

where an observer of such foreign expansion accidently picks the right time for the observation (*i.e.*, time step 9 for the switching option and time step 19 for the growth option). Otherwise, the effect of performance on the use of each option is confounded by three factors: (i) the optimal time for the use of the option may not have come yet; (ii) the optimal time for the use of the option may have already passed; and (iii) another expansion option may be more profitable. The unique insights provided by Figure 1 can be summarized with the following rules of thumb for the use of the switching option and of the growth option: (a) there is a delay in the optimal use of the switching option, even when the to-be-expanded subsidiary most strongly outperforms another subsidiary in the firm; (b) there is a delay in the optimal use of the growth option, even when the to-be-expanded subsidiary performs at its best possible level in absolute terms; (c) only right after the optimal delay, the firm expands its foreign operations *via* the switching option if and only if the foreign market most strongly outperforms the domestic market; (d) only right after the optimal delay, the firm expands its foreign operations *via* the growth option if and only if the foreign market has the highest possible performance; (e) as the firm's resources age further, the exercise of the switching option demands that the foreign business outperform the domestic business by a margin and that *the foreign business do not perform too well in absolute terms*; (f) as the firm's resources age further, the exercise of the growth option demands that the foreign business outperform the average for its performance by a margin and that *the domestic business do not perform too poorly in absolute terms*. As Figure 2 shoes, the absence of another option relaxes the confounding item "iii" and the italicized parts of conditions "e" and "f" above.

Implications of the Switching Cost and Uncertainty for the Use of the Expansion Options

Figure 3 demonstrates how the switching cost s and uncertainty σ jointly affect the cumulative odds that the firm will have expanded its foreign operations by the middle of the

lifecycle of its resources (*i.e.*, by time step 100 out of 200). Specifically, Figure 3 predicts the following three outcomes: (a) the probability of using the switching option when the growth option is also allowed (*i.e.*, Panel A), (b) the probability of using the growth option when the switching option is also allowed (*i.e.*, Panel B), and (c) the probability of using the switching option when the growth option is disallowed (*i.e.*, three plots in Panel C).

Insert Figure 3 about here

Panel A of Figure 3 changes its tone from red to dark blue in the direction from the top left corner to the bottom right corner. This pattern demonstrates that, when both expansion options are available, the probability that the firm will use the switching option declines in the switching cost and increases in uncertainty. The negative effect of the switching cost is intuitive: the net payoff to the exercising of the switching option is reduced by the total switching cost S_t^x (*i.e.*, Equation 5), which in turn depends directly on the marginal switching cost s (*i.e.*, Equation 4). The positive effect of uncertainty on the probability of switching is less intuitive. An explanation that needs to be ruled out is that the positive effect of uncertainty on the probability of switching is an artifact of the presence of the growth option that, in turn, is influenced by uncertainty. This explanation is indeed rejected in the filled contour map in Panel C, where the growth option is disallowed and thus cannot interfere with the effect of uncertainty on the use of the switching option. In fact, the isolines in the filled contour maps in Panels A and C of Figure 3 indicate that, when the growth option is absent in Panel C, the positive effect of uncertainty on the odds of switching is stronger than it is when the growth option is allowed in Panel A.

To further scrutinize how uncertainty and the switching cost affect the foreign expansion solely *via* the switching option, two additional plots are created based on the left-side figure in

Panel C. In particular, the middle plot in Panel C dissects the three-dimensional contour map in that panel at the bottom margin (*i.e.*, the blue line with low uncertainty, $\sigma = 0.1$) and at the top margin (*i.e.*, the red line with high uncertainty, $\sigma = 1.1$). As expected, slopes of both lines are negative; but they differ from each other. With low uncertainty, the change in the switching cost from zero to 50 entails the drop of 0.45 in the odds that the MNC uses the switching option; with high uncertainty, the respective drop is only 0.07. This difference reveals that the negative effect of the switching cost on the probability that the MNC expands its foreign subsidiary through the switching option is strongly positively moderated by uncertainty. This interaction was implied in Kogut and Kulatilaka (1994) and is better understood based on the right-side plot in Panel C.

The right-side plot in Panel C dissects the three-dimensional contour map in that panel at the left margin (*i.e.*, the blue line with the low switching cost, $s = 0$) and at the right margin (*i.e.*, the red line with the high switching cost, $s = 50$). Slopes of both lines in the right-side plot in Panel C are positive, thus confirming the observation in the contour map that the use of the switching option increases in uncertainty. What makes the use of the switching option grow in uncertainty? This monotonic positive effect stems from the condition necessary for the use of the switching option: the foreign business should outperform the domestic business by, at least, the switching cost. Because uncertainty expands the bounds for the vacillation of returns in both the foreign and the domestic businesses and enhances the vacillation of those returns between their upper and lower bounds, high uncertainty enables the arrival of that necessary condition. In other words, with higher uncertainty and thus with broader and more intense vacillation of returns in the two businesses, it is more likely that returns in the foreign business happen to be above returns in the domestic business at least once over the lifecycle of the MNC's resources. By

contrast, when uncertainty is lower, returns in the two businesses vacillate less intensely, and the return in the MNC's foreign market is less likely to exceed the return in the domestic market.

In addition to diagnosing the direct effect of uncertainty, the left-side plot in Panel C reconfirms the interaction between uncertainty and the switching cost and is useful in explaining this interaction. The positive slopes for the blue and red lines markedly differ from each other. With the low switching cost, the rise in uncertainty from 0.1 to 1.1 increases the odds that the MNC uses the switching option by only 0.0044; with the high switching cost, the respective rise is 0.38. The difference shows that the effect of uncertainty on the use of the switching option is positively moderated by the switching cost. This moderation is explained as follows. When the switching cost is trivial, even a tiny advantage in the foreign market over the domestic market induces the switching from the later to the former, and scenarios where the switching option is used abound. In that case, the switching is very likely in general and the blue line has a consistently high altitude over the base of the panel; uncertainty can increase that inherently high propensity to switch only by a thin margin. Conversely, the high switching cost makes the MNC more inert in using the switching option; the firm switches only when the advantage in the foreign market exceeds this high switching cost. With low uncertainty at the left margin of the panel, the bands for the vacillation of the margins in the two markets are narrow and such scenarios favorable to the switching are unlikely. By contrast, high uncertainty extends the bands for the two margins, thus spurring the scenarios that are favorable to the switching. As a result, the right end of the red line rises far above the left end, thus demonstrating that uncertainty matters much more when the switching cost is high than when the switching cost is low.

With regard to the effects of the switching cost and uncertainty on the use of the growth option, Panel B of Figure 3 changes its tone from dark blue in the top left corner to red in the

bottom right corner. This change reveals that, when both expansion options are present, the odds of using the growth option increase in the switching cost and decline in uncertainty. The positive effect of the switching cost on the use of the growth option holds because higher costs make the use of the switching option less profitable (*i.e.*, Equations 4 and 5), thus making the firm prefer the expansion of its foreign operations through the growth option. Explaining the negative effect of uncertainty on the use of the growth option needs to rule out the chance that this effect derives from the presence of the switching option that, in turn, is affected by uncertainty. This issue is addressed in the next section where the switching option is disallowed in some analyses.

To conclude this section, the insights that are diagnosed with Figure 3 and that go beyond simple intuition can be summarized as follows: (a) the use of the switching option increases in uncertainty, (b) the positive effect of uncertainty on the use of the switching option is positively moderated by the switching cost, (c) the use of the growth option increases in the switching cost, and (d) the use of the growth option declines in uncertainty (this idea is revisited below). As the central plot in Panel C of Figure 3 indicates, item "b" above can also be restated as a positive moderation of the negative effect of the switching cost on the use of the switching option.

Implications of the Growth Cost and Uncertainty for the Use of the Expansion Options

Figure 4 explores how the growth cost γ and uncertainty σ jointly affect the cumulative odds that the firm will have expanded its foreign operations by the middle of the lifecycle of its resources (*i.e.*, by time step 100 out of 200). In particular, Figure 4 considers the following three outcomes: (a) the probability of using the growth option when the switching option is also present (*i.e.*, Panel A), (b) the probability of using the switching option when the growth option is also allowed (*i.e.*, Panel B), and (c) the probability of using the growth option when the switching option is absent (*i.e.*, three plots in Panel C).

Insert Figure 4 about here

Panel A of Figure 4 demonstrates that, when both expansion options are available, the odds that the firm will use the growth option decline in the growth cost. Like with switching, the negative effect of the cost of exercising the option is intuitive: the net payoff to the exercising of the growth option is reduced by the price G_t that the firm pays for the expansion (*i.e.*, Equation 7) and that, in turn, includes the premium γ (*i.e.*, Equation 6). By contrast, uncertainty has a complex effect on the use of the growth option. Specifically, with low growth costs, uncertainty reduces the use of the growth option; whereas, with high growth costs, uncertainty propels the exercise of the growth option. This complex effect contrasts with the positive effect of uncertainty on the odds of switching. An explanation that needs to be ruled out is that this complex effect derives from the presence of the switching option. This explanation is ruled out in Panel C, where the switching option is absent but the complex effect of uncertainty on the use of the growth option remains.

To scrutinize how uncertainty and the growth cost affect the foreign expansion solely *via* the growth option, two more plots are developed based on the left-side figure in Panel C. The middle plot in Panel C dissects the contour map in that panel at the bottom margin (*i.e.*, the blue line with low uncertainty, $\sigma = 0.1$) and at the top margin (*i.e.*, the red line with high uncertainty, $\sigma = 1.1$). Although the slopes of both lines are negative, they are very differently so. With low uncertainty, the rise in the growth cost from zero to 0.15 entails the drop of 0.46 in the odds of using the growth option; with high uncertainty, the respective drop is only 0.08. This difference reveals that the negative effect of the growth cost on the probability that the MNC expands its foreign subsidiary through the growth option is positively moderated by uncertainty. Although

this moderation is akin to the interaction between uncertainty and the switching cost in Figure 3, its unique ramifications are further considered in the right-side plot of Panel C in Figure 4.

The right-side plot in Panel C dissects the contour map in that panel at the left margin (*i.e.*, the blue line with the low growth cost, $\gamma = 0$) and at the right margin (*i.e.*, the red line with the high growth cost, $\gamma = 50$). Whereas the slope of the red line is positive, the slope of the blue line is negative. Notably, with the high growth cost, the rise in uncertainty from 0.1 to 1.1 leads to the increase of 0.24 in the use of the growth option; with the low growth cost, the odds of such use drop by 0.15. This change in the sign of the effect or slope suggests that the interaction between uncertainty and the growth cost, which was observed in the middle plot in Panel C, is so strong that it reverses the ultimate effect of uncertainty on foreign expansion when the growth cost is low. What makes uncertainty stimulate the use of the growth option when the growth cost is high (like with the switching option) and suppress the use of the growth option when the growth cost is low (in contrast to the switching option)? This complex effect derives from the exercise condition unique to the growth option: the foreign business should outperform its own average by, at least, the growth cost. When the growth cost is high, the foreign business should outperform its own average by a lot to justify the use of the growth option. This condition places the threshold for the exercising the growth option above most of possible paths for returns in the foreign business, especially when such paths are contained in amplitude by low uncertainty. In this case, a high amplitude of the vacillation of returns in the foreign business due to high uncertainty is required for the threshold to be hit and the option to be exercised. In other words, high uncertainty enables the use of the growth option despite high growth costs. When the growth cost is trivial, the threshold value of returns in the foreign business reflects the mean for such returns. Lower uncertainty makes it easier for returns in the foreign business to hit that

threshold because lower uncertainty contains the vacillation of those returns in the closer proximity to their mean. By contrast, with high uncertainty, many possible paths for future returns diverge from the mean by a lot; and, if this divergence is below the mean, such paths never hit the threshold for the exercising of the growth option.[5] Thus, when the growth option is unencumbered by high costs, uncertainty reduces the odds that the option will ever be exercised, explaining why the right end of the blue line gets below the left end in right side plot in Panel C.

With regard to the effects of the growth cost and of uncertainty on the use of the switching option, Panel B of Figure 5 changes its color from red in the top right corner to dark blue in the bottom left corner. This change reveals that, when both expansion options are present, the odds that the firm will use the switching option increase in the growth cost and continue to increase in uncertainty. The positive effect of the growth cost on the use of the switching option occurs because higher growth costs make the use of the growth option less profitable (*i.e.*, Equations 6 and 7), thus making the firm choose the expansion of its foreign operations through the switching option. The positive effect of uncertainty was explained in the previous section.

To sum up the analysis of the implications of the growth cost and uncertainty, the insights that are revealed in Figure 4 and that go beyond simple intuition can be summarized as follows: (a) the odds that the firm will use the growth option decline in uncertainty when the growth cost is low and increases in uncertainty when the growth cost is high, and (b) the odds that the firm will use the switching option increase in the growth cost. As the central plot in Panel C of Figure 4 indicates, item “a” above can also be reformulated as a positive moderation of the negative effect of the growth cost on the use of the growth option.

Implications of the Interaction between the Switching Cost and the Growth Cost for the Use of the Expansion Options

Figure 5 analyzes how the switching cost s and the growth cost γ affect the cumulative odds that the firm will have expanded its foreign subsidiary by the middle of the lifecycle of its resources (*i.e.*, by time step 100 out of 200). Figure 5 predicts the following two outcomes: (a) the probability of using the switching option when both options are allowed (*i.e.*, Panel A) and (b) the probability of using the growth option when both options are allowed (*i.e.*, Panel B).

Insert Figure 5 about here

In Panel A of Figure 5, the blue line represents the low growth cost (*i.e.*, $\gamma = 0$); whereas the red line depicts the high growth cost (*i.e.*, $\gamma = 0.15$). The panel reveals that the two lines diverge from each other at the left margin of the panel. Notably, with the low growth cost, a change in the switching cost from zero to 50 entails the drop of only 0.33 in the odds that the MNC uses the switching option to expand its foreign subsidiary. By contrast, with the high growth cost, the respective drop is 0.43. This difference demonstrates that the effect of the switching cost on the probability that the MNC expands its foreign subsidiary through the switching option is positively moderated by the growth cost. The previously undiagnosed moderation takes place for the following reason. When the use of the growth option is very costly, the MNC does not consider that option as an attractive alternative for expanding its foreign subsidiary and decides whether to undertake that expansion solely *via* the switching option. Accordingly, the odds that the firm will use the switching option depend strongly on the switching cost. Conversely, when the growth cost is low, the use of the switching option by the MNC is contested by the attractiveness of the inexpensive growth option. As a result, the use of

the switching option becomes less sensitive to the switching cost simply because the switching option is less intensely used by the MNC when the growth option is more attractive.

In Panel B of Figure 5, the blue line represents the low switching cost (*i.e.*, $s = 0$); whereas the red line depicts the high switching cost (*i.e.*, $s = 50$). The panel reveals that the two lines differ in their slopes. Notably, with the low switching cost, a change in the growth cost from zero to 0.15 leads to the drop of only 0.19 in the odds that the MNC uses the growth option to expand its foreign subsidiary. Alternatively, with the high switching cost, the respective drop is 0.35. This difference indicates that the effect of the growth cost on the probability that the MNC expands its foreign subsidiary through the growth option is positively moderated by the switching cost. The previously ignored moderation can be intuitively explained in the following way. When the use of the switching option is prohibitively high, the MNC does not count on that option as an attractive alternative for foreign expansion and decides whether to conduct that expansion exclusively through the growth option. Therefore, the odds that the firm will use the growth option depend strongly on the switching cost. By contrast, when the switching cost is low, the use of the growth option by the MNC is contested by the attractiveness of the costless switching. Hence, the use of the growth option becomes less sensitive to the growth cost because that option is less intensely used by the MNC when another option is more profitable.

Finally, the unique results illustrated in Figure 5 can be stated as the following two propositions: (a) the negative effect of the switching cost on the use of the switching option is positively moderated by the growth cost, and (b) the effect of the growth cost on the use of the growth option is positively moderated by the switching cost.

Implications of Correlation for the Use of the Expansion Options

Figure 6 displays how the switching cost s and correlation ρ of margins in the domestic and the foreign markets affect the cumulative odds that the firm will have expanded its foreign operations by the middle of the lifecycle of its resources (*i.e.*, by time step 100 out of 200). Figure 3 predicts the following three outcomes: (a) the probability of using the switching option when the growth option is also allowed (*i.e.*, Panel A), (b) the probability of using the growth option when the switching option is also allowed (*i.e.*, Panel B), and (c) the probability of using the switching option when the growth option is disallowed (*i.e.*, two plots in Panel C).

Insert Figure 6 about here

Panel A of Figure 6 changes its tone from red to dark blue in the direction from the bottom left corner to the top right corner. This pattern demonstrates that, when both expansion options are available, the odds of using the switching option decline both in the switching cost and in correlation. The negative effect of correlation on the probability of switching was known in previous research. This effect takes place because more positive correlation makes future returns in the two markets more strongly converge to each other, thus making less likely the scenarios where the foreign market outperforms the domestic market that invites the switching of resources from the later to the former. This negative effect of correlation is not caused by the growth option: the contour map in Panel C disallows the growth option and continues to show the negative effect of correlation on the use of the switching option.

To further investigate whether correlation and the switching cost interact in determining the odds of switching, the additional plot in Panel C dissects the contour map in that panel at the bottom margin (*i.e.*, the blue line with negative correlation, $\rho = -0.9$) and at the top margin (*i.e.*,

the red line with positive correlation, $\rho = 0.9$). The two negatively sloped lines differ from each other. Namely, with negative correlation, the change in the switching cost from zero to 50 entails the drop of 0.42 in the odds that the MNC uses the switching option; with high uncertainty, the respective drop is only 0.37. This difference reveals that the negative effect of the switching cost on the use of the switching option is negatively moderated by correlation. This moderation is explained as follows. When correlation is strongly negative, returns in the two markets are countercyclical, and scenarios that that put returns in the foreign business above returns in the domestic busines and that invite the switching abound. In that case, the net impact of such switching on the MNC, as well as the use of it by the MNC, very strongly depends on the switching cost. Conversely, when correlation is strongly positive, returns in the two markets converge to each other, and scenarios that are good for switching are rare. As a result, the impact of the switching cost is muted because the switching is inherently unattractive in most scenarios.

With regard to the effects of the switching cost and correlation on the use of the growth option, Panel B of Figure 3 changes its tone from dark blue in the bottom left corner to red in the top right corner. This change reveals that, when both expansion options are present, the odds of using the growth option increase both in the switching cost and in correlation. These positive effects take place because both parameters make the use of the switching option less profitable, thus making the firm prefer the expansion of its foreign operations through the growth option.

Figure 7 presents how the growth cost γ and correlation ρ determine the cumulative odds that the firm will have expanded its foreign subsidiary by the middle of the lifecycle of its resources (*i.e.*, by time step 100 out of 200). Figure 7 considers the following three outcomes: (a) the probability of using the growth option when both options are allowed (*i.e.*, Panel A), (b) the

probability of using the switching option when both options are allowed (*i.e.*, Panel B), and (c) the probability of using the growth option when the switching option is absent (*i.e.*, Panel C).

Insert Figure 7 about here

Panel A of Figure 7 alters its tone from red to dark blue in the direction from the top left corner to the bottom right corner. This direction indicates that, when both expansion options are present, the odds of using the growth option decline in the growth cost and rise in correlation. Both direct effects were already discussed above. As Panel C where the switching option is disallowed shows, the effect of correlation in Panel A stems uniquely from the switching option. With regard to the effects of the growth cost and correlation on the use of the switching option, Panel B of Figure 7 confirms the effects that were already discussed above: the use of the that option increases in the growth cost and declines in correlation. Finally, the new results illustrated in Figures 6 and 7 can be stated as the following two propositions: (a) the negative effect of the switching cost on the use of the switching option is negatively moderated by the correlation in subsidiaries' returns and (b) the use of the growth option increases in this correlation.

Additional Results

The following extensions to the main model were developed separately from each other to validate the robustness of the main results and to discover additional ramifications of the model for the expansion of the MNC's foreign subsidiaries. First, because the MNC may have more than two subsidiaries in various countries, uncertainty that the firm can exploit to expand its foreign subsidiary through the switching option may be thought of as involving more than two random variables. In that case, the main model with only two primitives may underrepresent the richness of choices for switching. To address this possibility, an additional foreign market was

added to the main model to allow the expansion of the focal foreign subsidiary by switching resources not only from the domestic subsidiary but also from the additional foreign subsidiary. All the results reported for the switching option with the left-side plot in Panel C of Figure 3 remain intact. The only additional insight is that, when there are more subsidiaries from which the MNC can switch resources to the considered foreign subsidiary, each of the effects following from the left-side plot in Panel C of Figure 3 gets stronger. Second, the even initial distribution of the firm's resources between the domestic and the foreign subsidiaries was relaxed and many alternatives to such distribution were tried. The change in the initial distribution of resources does not alter either of the 16 results uniquely derived in this study. Third, the assumption that the firm can only use *either* the switching option *or* the growth option in a particular state of the nature was relaxed. In particular, the MNC was allowed to undertake part of the foreign expansion with one option and to undertake another part of the foreign expansion with another option. In response to this additional freedom for the ways in which the firm might expand its foreign subsidiary, the firm in the model never used the combination of the options but instead always preferred to optimally use the option that was most appropriate for the conditions diagnosed in Figure 1. Fourth, the assumption that the firm can only use an expansion option in full was relaxed. Specifically, the MNC was allowed to undertake the partial exercising of the switching option and the partial exercising of the growth option. In response to this additional discretion, the firm in the model never used the partial exercising of either of the two options. Fifth, the set of options available to the MNC was extended by including the option to abandon the foreign subsidiary by selling it in the host factor market. This extension has not tangibly changed either the odds of expansion or the relationships reported. Finally, the set of options available to the MNC was extended by including the option to contract the foreign subsidiary by

switching resources from it to the domestic subsidiary. Although this extension has slightly reduced the odds of using the expansion options, it has not disturbed any of the reported relationships. Thus, these six additional analyses indicate that the findings and interpretations offered earlier are very robust to a variety of extensions, including additional options and sources of flexibility that the MNC might have in managing its expansion.[6]

DISCUSSION

MNCs confront high uncertainty in host countries where they locate subsidiaries. Strong fluctuations in product and labor markets, in currency exchange rates, and in the economic and institutional contexts of these countries open up opportunities for MNCs to expand their foreign subsidiaries and secure performance advantages. Notably, an MNC can switch capital, physical assets, labor, and input procurement to a foreign subsidiary from other countries (Kogut & Kulatilaka, 1994; Huchzermeier & Cohen, 1996); or it can scale up a foreign subsidiary by buying resources necessary for the expansion from local factor markets in the host country (Chang & Rosenzweig, 2001; Chi & McGuire, 1996; Chi & Seth, 2009). The two ways for the expansion clearly represent a portfolio of alternative options open to an MNC (Chi et al., 2019). However, these two options have often been studied separately from each other. It is clear that the choice an executive faces is not merely whether to scale up by exercising a growth option or not, nor is it simply whether to redeploy various resources and exercise a switching option or not.

Rather, executives have a menu of alternatives: they can choose between alternative modes of foreign expansion in a host country based on the multiple options the firm possesses. For empirical research, this implies that models that examine the use of switching options risk the conflation of what appears to be “do nothing” with the use of growth options, just as models examining the use of growth options risk inadvertently treating the use of switching options as

"do nothing." For practice and research, it is therefore important to appreciate the multiple options executives have when expanding foreign businesses and their interactions (Trigeorgis, 1996). The comparative analytical approach this study develops for switching and growth options in general, and for alternative foreign expansion modes in particular, has been broadly and usefully applied in strategy and international business studies using other theories such as transaction cost analysis to consider related choices including initial entry modes into countries, decisions to cooperate or compete, or technology commercialization paths (Caves, 2007). In broad terms, the analyses and findings in this paper demonstrate the importance of such a comparative approach in the study of real options possessed by MNCs. Such a comparative analytical approach can be usefully employed in future research using formal models as well as in empirical research on various applications of real options in strategy and management.

The specific contributions of this study are derived from the development of a formal model that casts the two expansion options as a portfolio available to the MNC. This approach responds to the calls for research that investigates interactions between various real options, including the recent specific call for research that formally models the interplay between the switching option and the growth option in the portfolio held by an MNC (Chi et al., 2019). The model derives several unique insights that have the potential to inform future research as well as practice. First, neither the strongest advantage of the to-be-expanded foreign subsidiary over other subsidiaries in the MNC suffices to justify the switching of the MNC's resources to the considered subsidiary, nor does the strongest performance of that subsidiary in absolute terms justify its expansion through the growth option. Each of these options is exercised in the specific time that reflects what is optimal for the MNC in the long run. Besides, findings of the model underscore the important point that the presence of an alternative expansion option seriously

confounds the use of the focal option based on the performance criteria appropriate for its exercise without such an alternative. The model in this study presents results that account for both confounding factors to obtain insights on optimal option exercise behavior when the MNC holds multiple options for the expansion of a foreign subsidiary at the same time. Second, although the cost of implementing each expansion option indeed suppresses the use of that option by the MNC, this effect strongly depends on other determinants of that option, and on the determinants of another expansion option. This study formally derives multiple interactions, with which the intuitive negative effect of the cost of implementing an expansion option on the use of that option can decline, and even become trivial. Finally, while uncertainty monotonically raises the odds that the MNC expands its foreign subsidiary through the use of the switching option, such uncertainty can increase the use of the growth option only when the growth cost is high. Otherwise, with low growth costs, the use of the growth option declines in uncertainty. These findings indicate the ways in which the two options substitute for each other, have common drivers with unique implications, and have a complex interplay that necessitate their combined consideration in research and practice.

The least intuitive of these results is the contrast between the two options in how uncertainty affects the expansion of the foreign subsidiary. This contrast derives from the difference in the exercise rules between the two options. Notably, the condition necessary for exercising of the switching option is that the foreign business outperforms the domestic business by, at least, the switching cost. With this condition, the threshold value for returns in the foreign business, with which the switching option is exercised, is stochastic: it depends on the realization of another uncertain variable, the return in the domestic business. Because uncertainty increases the amplitude of the vacillation of returns not only in the foreign business but also in the

domestic business, it facilitates the arrival of the condition that is necessary for exercising of the switching option. In particular, when uncertainty is very high, there is little chance that the intensely vacillating returns in the foreign business never hit the markedly vacillating threshold level of returns in the domestic business. Thus, uncertainty unconditionally raises the odds that the switching option will be exercised over the lifecycle of the firm's resources.

By contrast, the condition necessary for the exercising of the growth option is that the foreign business outperforms its own average by, at least, the growth cost. Accordingly, the threshold for returns in the foreign business, with which the growth option is exercised, is not stochastic. When the growth cost is trivial, this threshold reflects the mean value of returns in the foreign business; lower uncertainty keeps returns in that business very close to the threshold thus making it very easy for those returns to hit it. Alternatively, with high uncertainty, many possible paths for future returns diverge from the mean by a lot; and, if this divergence is below the mean, such paths never hit the threshold for the exercising of the growth option. Thus, when the growth option is unencumbered by high costs, uncertainty reduces the odds that the option will ever be exercised. In turn, when the growth cost is high, the foreign business should outperform its own average by this high cost to justify the use of the growth option. This condition places the threshold for the exercising the growth option above most of possible paths for returns in the foreign business, especially when such paths are contained in amplitude by low uncertainty. In this case, a high amplitude of the vacillation of returns in the foreign business due to high uncertainty is required for the threshold to be hit and the option to be exercised.

By considering both expansion options, these results can improve the ability of empirical research to investigate as well as interpret the expansion of foreign subsidiaries by MNCs. As one example, with these results, it is no longer surprising that an MNC sometimes avoids the use

of the option to switch its resources to a foreign subsidiary that substantially outperforms other units in that MNCs (Rangan, 1998). Such refraining from the use of the switching option can occur because the MNC expands its foreign subsidiary through the growth option instead of using the switching option. Alternatively, the avoidance of the use of the option to switch the MNC's resources to the outperforming foreign subsidiary can be explained with determinants of the expansion options other than performance of that subsidiary, such as the costs of implementing these options and uncertainty. Likewise, given the number of empirical studies that examine growth options in isolation, it would be valuable for future research on growth options in international or other investment contexts to consider the potential substitutability of any switching options that the firm might possess. Absent such considerations, it is possible for interpretations to be biased when exercise of switching options is implicitly treated as "do nothing" or attributed to an intent to hold open a switching option. This theoretical account of the substitution between the two expansion options and of the fuller treatment of their determinants lays the groundwork for more comprehensive specifications of these options in future empirical models that explore strategies of MNCs. Ultimately, the theoretical insights that are developed in this study can also have some normative implications: these insights can provide the foundation for heuristics to be used by executives who manage expansion of foreign subsidiaries in MNCs. More broadly, these insights encourage a comparative analytical approach to options in general, and foreign expansion modes in particular.

Extensions to this research might proceed in a number of valuable directions. To begin with, the alternative modes of expansion of foreign subsidiaries in MNCs can also have implications for firm boundaries and transaction costs (Trigeorgis & Reuer, 2017). It would be interesting to assess the degree to which transaction cost considerations influence the conditions

under which the two foreign expansion modes are selected, particularly given that various uncertainties and external disturbances in host countries might have a bearing on boundary of the firm choices as well as optimal resource allocation choices per real options theory. It might also be that other factors not considered here, such as financial constraints and the operation of internal capital markets come into play, or institutional considerations in factor markets in host countries. It would also be valuable in future research to examine how firms' initial motives to enter countries, such as market seeking or resource seeking (Yu, Lee, & Han, 2015), might have implications for how they expand foreign subsidiaries. Like previous research on the use of real options by MNCs and on the performance implications of such options, this study has taken the existence of the MNC and the options it possesses as given (Belderbos & Zou, 2007; Belderbos et al., 2014; Chung et al., 2010; Dasu & Li, 1997; Kogut & Kulatilaka, 1994; Lee & Makhija, 2009; Lee & Song, 2013; Rangan, 1989; Reuer & Leiblein, 2000; Shin & Lee, 2019; Song, Lee, & Makhija, 2015; Song, Makhija, & Lee, 2014; Tong & Reuer, 2007). For instance, the degree to which a multinational firm seeks to satisfy a local market, such as by following a multidomestic strategy, may inhibit the exercise of switching options. More generally, conditions prevailing upon market entry (*e.g*., motives, entry modes, localization needs and policies, *etc*.) can have implications for subsequent growth, and real options research might also investigate the potential impact of factors surrounding the decisions to purchase and exercise options. The model might also be elaborated upon to consider the implications of firms' local or more centralized capabilities to seize upon the switching and growth options studied here. Given that the application context in this study is the multinational firm and its foreign subsidiaries, it would be interesting to delve into particular types of uncertainties that matter for foreign subsidiary expansion through the exercise of switching and growth options, whether local inputs and labor

markets, exchange rates, *etc*. Moreover, the model might also be adapted to consider other applications for which portfolios of switching and growth options matter, including the management of product-market diversification and technology development. Research in directions such as these would help future scholarship address option portfolios and interactions using the comparative approach developed here for firm decision-making, and such study could also generate valuable heuristics for managers facing alternative modes of growth.

In conclusion, although the simultaneous consideration of both expansion options at once has been rare, analogues of each option, in isolation, can be found in research other than real options. Some of that other research investigated the expansion by a firm in general, while other research was concerned specifically with MNCs. For instance, the switching option corresponds to a strategic change with which a firm moves from one set of consumers to other consumers. Outside the context of MNCs, this change was exemplified with how U.S. radio broadcasting stations move across content formats (Greve, 1998). In the context of MNCs, Rangan (1998) observed only "relatively modest" use of switching between MNCs' subsidiaries even in the presence of large performance differences between them, and he tried to explain that pattern based on approaches less rational than real options. Meanwhile, the inertia in switching that Rangan (1998) cast as contradicting real options and as necessitating less rational explanations is consistent with the formalism of real options. Likewise, the growth option corresponds to the sequential expansion of commitment to a particular course of action. Outside the context of MNCs, the behavioral theory of the firm (Cyert & March, 1963) was used to explain the growth of firms' preexisting businesses by the means of either corporate acquisitions (Iyer & Miller, 2008) or internal development (Audia & Greve, 2006). The behavioral theory was also applied to the context of MNCs and was named the "behavioral paradigm" that explains how MNCs

gradually expand their foreign operations (Andersen, Ahmad, & Chan, 2014; Blomstermo, Sharma, & Sallis, 2006; Johanson & Wiedersheim-Paul, 1975; Sharma & Erramilli, 2004). Given the prominence of these alternative theoretical interpretations, nearly a whole issue of this journal was once dedicated to whether and how real options provide unique insights relative to alternative theories (*i.e*., Vol. 29, No. 1 of the *Academy of Management Review*, 2004). Even if the dependent variable of foreign expansion by either of the two options and the independent variables of that option's determinants are shared by several theories, the real options approach is a unique quantitative tool that enables one to describe a firm's choices that maximize that firm's value in the presence of uncertainty. Meanwhile, this study embraces the call of Sakhartov & Folta (2013) for a "comparative testing" of alternative theories of organizational change. By developing a set of very specific predictions on how MNCs expand their foreign subsidiaries based on real options, this study facilitates such comparative testing of alternative theories.

FOOTNOTES

1. Trigeorgis (1996) classified switching options into an option to switch inputs and an option to switch outputs. With the option to switch inputs, the MNC extends its foreign subsidiary by contracting its domestic subsidiary because the foreign country provides it with labor or other inputs at a cost lower than in the home country. With the option to switch outputs, the MNC redeploys capital, human, and physical resources from its domestic subsidiary to the foreign subsidiary because the foreign country lets the firm sell its output at a price higher than in the home country. The difference in input costs or in output prices between the foreign subsidiary and the domestic subsidiary can derive from the currency exchange rates (Kogut & Kulatilaka, 1994) or may reflect local equilibria, for input costs or for output prices, that vary by country (Belderbos & Zou, 2007; Song, 2017). In addition to considering MNCs that already have a network of subsidiaries, across which their resources can be switched, some studies in international business research focused on the initial entry into a foreign market given the presence of a switching option. The present study embraces the former approach and is agnostic with regard to the latter. Also, although the expansion of one subsidiary in an MNC through the use of the switching option was mentioned explicitly only in some studies (Belderbos & Zou, 2007; Lee & Song, 2012; Rangan, 1998), such expansion is an inevitable consequence of switching when resources are withdrawn from one subsidiary and added to another.

2. Sometimes, a foreign subsidiary can grow “bigger” in terms of the possessed assets, without increasing the scale in terms of the finished goods sold in its market. For example, the subsidiary can integrate the manufacturing of its intermediate inputs (*i.e.*, vertically integrate backward) to mitigate the opportunistic behavior of suppliers of such inputs. Such an increase of the foreign subsidiary in size, which aims to increase the efficiency of the subsidiary, falls outside the scope

of using the growth option, which instead focuses on the increase in the scale of the production of the finished product. This study focuses on the latter and is agnostic with regard to the former. The integration of the two foci is a simulating and challenging task for future formal modeling in international business research.

3. The margin C_{it} in the foreign subsidiary reflects the intrinsic inducement for expanding that subsidiary, by any means. In turn, the difference between the margins C_{it} and C_{jt} captures the inducement for expanding the foreign subsidiary at the expense of the domestic subsidiary. The specification of two random variables, C_{it} and C_{jt}, allows this model to more fully capture uncertainty inherent in the context that is faced by an MNC. Most generally, uncertainty represents the lack of certainty about the future. In the context of an MNC, future returns that the MNC will receive in its domestic and foreign subsidiaries are unknown. As was illustrated in Mascarenhas (1982), such uncertainty faced by the MNC can derive from the political situation in the host country, from the exchange rate for the host currency, from the state of the host markets for inputs, from the state of the host market for outputs, and from the state of development of infrastructure and technology in the host country. Thus, the specification of of such considerations for each of the countries in which an MNC operates extends the approach of Kogut & Kulatulaka (1994), with which the currrency exchange rate was the only possible source of uncertainty. The current, more complete specification of uncertainty follows previous empirical operationalizations (Belderbos & Zou, 2007; Song, 2017) and formal models (De Meza & Van der Ploeg, 1987; Li & Rugman, 2007) in international strategy research. Furthermore, the specification with two primitives has been prevalent in the modeling of the switching option in general (Sakhartov & Folta, 2015; Triantis & Hodder, 1990; Trigeorgis, 1996).

Alternatively, uncertainty that the MNC can exploit to expand its foreign subsidiary through the switching option may be thought of as involving more than two random variables. Thus, an MNC may have three or even more subsidiaries in various countries. In that case, a model with only two primitives may underrtepresent the richness of choices for switching. The conventional modeling of the switching option with only two markets is pragmatic: adding more sources of randomness makes the model intractable even numerically and is unlikely to add new insights. In testing the robustness of the results in this study, the folowing extension was tried. The MNC was modeled to operate in three markets (*i.e.*, the domestic market, the focal foreign market, and the additional foreign market), and the number of time discretization steps was reduced from $N = 200$ (*i.e.*, used in the reported results) to $N = 50$ to make the computation feasible. All the results reported for the switching option with the left-side plot in Panel C of Figure 3 remain intact. The only additional insight is that, when there are more subsidiaries from which an MNC can switch resources to the considered foreign subsidiary, each of the effects following from the left-side plot in Panel C of Figure 3 gets only stronger in magnitude.

4. The formulas for calculating $C^{u}_{it+\partial t}$, $C^{u}_{jt+\partial t}$, $C^{d}_{it+\partial t}$, $C^{d}_{jt+\partial t}$, q^{uu}, q^{ud}, q^{du}, and q^{dd} are given in Sakhartov & Folta (2015).

5. Given that it is very easy for a random variable with multiple draws taken over time to get above its own mean at least once anyway, the most critical question in this case becomes how many paths never hit the threshold rather than how many do. With strong divergence of paths for returns in the foreign market (*i.e.*, sequences of draws for the respective random variable) from the mean provided by high uncertainty, relatively more paths go deeper down and never get the growth option into the money. The fact that a path may also strongly diverge upward due to higher uncertainty does not seem to be as consequential because a single occasion of the path

crossing the mean suffices for the option exercise anyway; so, the path going further up does not change the instance of exercising the option on that path after it first hits the threshold.

6. A detailed description of all the robustness tests is available from the authors upon request.

REFERENCES

Allen, L., & Pantzalis, C. 1996. Valuation of the operating flexibility of multinational corporations. ***Journal of International Business Studies***, 27(4): 633–653.

Anand, J., Oriani, R., & Vassolo, R. 2007. Managing a portfolio of real options. ***Advances in Strategic Management***, 24: 275–303.

Andersen, P., Ahmad, S. Z., & Chan, W. M. 2014. Revisiting the theories of internationalization and foreign market entry mode: a critical review. ***International Journal of Business and Commerce***, 4(01): 37–86.

Audia, P. G., & Greve, H. R. 2006. Less likely to fail: Low performance, firm size, and factory expansion in the shipbuilding industry. ***Management Science***, 52(1): 83–94.

Bain, J. S. 2013. ***Barriers to new competition: their character and consequences in manufacturing industries***. Harvard University Press.

Belderbos, R., Tong, T., & Wu, W. 2014. Multinationality and downside risk: the roles of option portfolio and organization. ***Strategic Management Journal***, 35(1): 88–106.

Belderbos, R., & Zou, J. 2007. On the growth of foreign affiliates: multinational plant networks, joint ventures, and flexibility. ***Journal of International Business Studies***, 38(7): 1095–1112.

Bellman, R. 1957. ***Dynamic Programming***. Princeton University Press: Princeton, NJ.

Blomstermo, A., Sharma, D. D., & Sallis, J. 2006. Choice of foreign market entry mode in service firms. ***International Marketing Review***, 23(2): 211–229.

Boyle, P. P., Evnine, J., & Gibbs, S. 1989. Numerical evaluation of multivariate contingent claims. **The *Review of Financial Studies***, 2(2): 241–250.

Buckley, P. J., & Casson, M. C. 1998. Models of the multinational enterprise. ***Journal of International Business Studies***, 29(1): 21–44.

Caves, R. 2007. ***Multinational Enterprise and Economic Analysis*** *(3rd Edition)*. Cambridge University Press: Cambridge, UK.

Chang, S. J., & Rosenzweig, P. M. 2001. The choice of entry mode in sequential foreign direct investment. ***Strategic Management Journal***, 22(8): 747–776.

Chi, T. 2000. Option to acquire or divest a joint venture. ***Strategic Management Journal***, 21(6): 665–687.

Chi, T., & McGuire, D. J. 1996. Collaborative ventures and value of learning: integrating the transaction cost and strategic option perspectives on the choice of market entry modes. ***Journal of International Business Studies***, 27(2): 285–307.

Chi, T., & Seth, A. 2009. A dynamic model of the choice of mode for exploiting complementary capabilities. ***Journal of International Business Studies***, 40(3): 365–387.

Chi, T., Li, J., Trigeorgis, L., & Tsekrekos, A. E. 2019. Real options theory in international business. ***Journal of International Business Studies***, 50(4): 525-553.

Chung, C. C., Lee, S. H., Beamish, P. W., & Isobe, T. 2010. Subsidiary expansion/contraction during times of economic crisis. ***Journal of International Business Studies***, 41(3): 500–516.

Cuypers, I. R. P., & Martin, X. 2010. What makes and what does not make a real option? A study of equity shares in international joint ventures. ***Journal of International Business Studies***, 41(1): 47–69.

Cyert, R. M., & March, J. G. 1963. ***A Behavioral Theory of the Firm***. Englewood Cliffs, NJ.

Dasu, S., & Li, L. 1997. Optimal operating policies in the presence of exchange rate variability. ***Management Science***, 43(5): 705–722.

De Meza, D., & Van der Ploeg, F. 1987. Production flexibility as a motive for multinationality. ***The Journal of Industrial Economics***, 35(3): 343–351.

Fisch, J. H., & Zschoche, M. 2012. The role of operational flexibility in the expansion of international production networks. ***Strategic Management Journal***, 33(13): 1540–1556.

Folta, T. B. 1998. Governance and uncertainty: the trade-off between administrative control and commitment. ***Strategic Management Journal***, 19(11): 1007–1029.

Folta, T. B., & Miller, K. D. 2002. Real options in equity partnerships. ***Strategic Management Journal***, 23(1): 77–88.

Folta, T. B., & O'Brien, J. P. 2004. Entry in the presence of dueling options. ***Strategic Management Journal***, 25(2): 121–138.

Greve, H. R. 1998. Performance, aspirations, and risky organizational change. ***Administrative Science Quarterly***, 43(1): 58–86.

Huchzermeier, A., & Cohen, M. A. 1996. Valuing operational flexibility under exchange rate risk, ***Operations Research***, 44(1): 100–113.

Iyer, D. N., & Miller, K. D. 2008. Performance feedback, slack, and the timing of acquisitions. ***Academy of Management Journal***, 51(4): 808–822.

Jiang, R. J., Beamish, P. W., & Makino, S. 2014. Time compression diseconomies in foreign expansion. ***Journal of World Business***, 49(1): 114–121.

Johanson, J., & Wiedersheim-Paul, F. 1975. The internationalization of the firm: Four Swedish cases. ***Journal of Management Studies***, 12(3): 305–322.

Kogut, B. 1983. Foreign direct investment as a sequential process. In Kindelberger, C. P., Audretsch, D. (Eds.). ***The Multinational Corporations in the 1980s***. MIT Press: Cambridge.

Kogut, B. 1989. A note on global strategies. ***Strategic Management Journal***, 10(4): 383-389.

Kogut, B. 1991. Joint-ventures and the option to expand and acquire. ***Management Science***, 37(1): 19–33.

Kogut, B., & Kulatilaka, N. 1994. Operating flexibility, global manufacturing, and the option value of a multinational network. ***Management Science***, 40(1): 123–139.

Kogut, B., & Kulatilaka, N. 2004. Real options pricing and organizations: The contingent risks of extended theoretical domains. ***Academy of Management Review***, 29(1): 102–110.

Lee, S. H., & Makhija, M. 2009. Flexibility in internationalization: is it valuable during an economic crisis? ***Strategic Management Journal***, 30(5): 537–555.

Lee, S. H., & Song, S. 2012. Host country uncertainty, intra-MNC production shifts, and subsidiary performance. ***Strategic Management Journal***, 33(11): 1331–1340.

Li, J., & Rugman, A. M. 2007. Real options and the theory of foreign direct investment. ***International Business Review***, 16(6): 687–712.

Mascarenhas, B. 1982. Coping with uncertainty in international business. ***Journal of International Business Studies***, 13(2): 87–98.

Rangan, S. 1998. Do multinationals operate flexibly? Theory and evidence. ***Journal of International Business Studies***, 29(2): 217–237.

Reuer, J. J., & Leiblein, M. J. 2000. Downside risk implications of multinationality and international joint ventures. ***Academy of Management Journal***, 43(2): 203–214.

Sakhartov, A. V., & Folta, T. B. 2013. Rationalizing organizational change: A need for comparative testing. ***Organization Science***, 24(4): 1140–1156.

Sakhartov, A. V., & Folta, T. B. 2015. Getting beyond relatedness as a driver of corporate value. ***Strategic Management Journal***, 36(13): 1939–1959.

Sharma, V. M., & Erramilli, M. K. 2004. Resource-based explanation of entry mode choice. ***Journal of Marketing Theory and Practice***, 12(1): 1–18.

Shin, H., & Lee, S. H. 2019. Economic crisis, intra-MNC production shifts and MNC performance from a network perspective. ***Asia Pacific Journal of Management***, 36(1): 185–217.

Smit, H., Pennings, E., & van Bekkum, S. 2017. Real options and institutions. ***Journal of International Business Studies***, 48(5): 620-644.

Song, S. 2017. Host market uncertainty, subsidiary characteristics, and growth option exercise. ***Long Range Planning***, 50(1): 63–73.

Song, S., Lee, S. H., & Makhija, M. 2015. Operational hedging in foreign direct investments under volatile and divergent exchange rates across countries. ***Journal of World Business***, 50(3): 548–557.

Song, S., Makhija, M., & Lee, S. H. 2014. Within-country growth options versus across-country switching options in foreign direct investment. ***Global Strategy Journal***, 4(2): 127–142.

Sundaram, A. K., & Black, J. S. 1992. The environment and internal organization of multinational enterprises. ***Academy of Management Review***, 17(4): 729–757.

Tong, T. W., & Li, S. 2013. The assignment of call option rights between partners in international joint ventures. ***Strategic Management Journal***, 34(10): 1232–1243.

Tong, T. W., & Reuer, J. J. 2007. Real options in multinational corporations: organizational challenges and risk implications. ***Journal of International Business Studies***, 38(2): 215–230.

Triantis, A. J., & Hodder, J. E. 1990. Valuing flexibility as a complex option. ***Journal of Finance***, 45(2):549–565.

Trigeorgis, L. 1996. ***Real Options: Managerial Flexibility and Strategy in Resource Allocation***. MIT Press: Boston, MA.

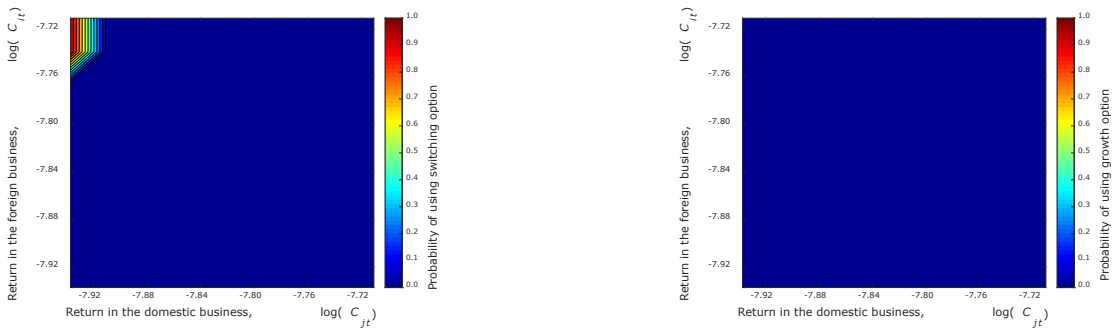
Trigeorgis, L., & Reuer, J. J. 2017. Real options theory in strategic management. ***Strategic Management Journal***, 38(1): 42–63.

Vassolo, R. S., Anand J., & Folta, T. B. 2004. Non-additivity in portfolios of exploration activities: a real options-based analysis of equity alliances in biotechnology. ***Strategic Management Journal***, 25(11): 1045–1061.

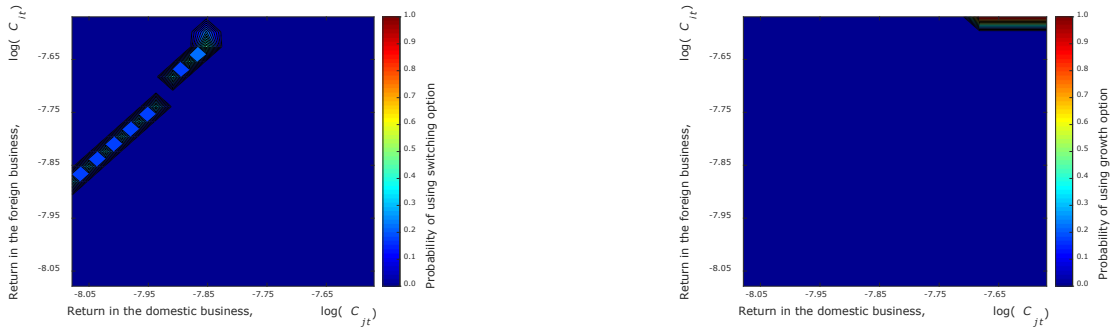
Yu, J., Lee, S. H., & Han, K. 2015. FDI motives, market governance, and ownership choice of MNEs: A study of Malaysia and Thailand from an incomplete contracting perspective. ***Asia Pacific Journal of Management***, 32(2): 335–362.

Zaheer, S. 1995. Overcoming the liability of foreignness. ***Academy of Management Journal***, 38(2): 341–363.

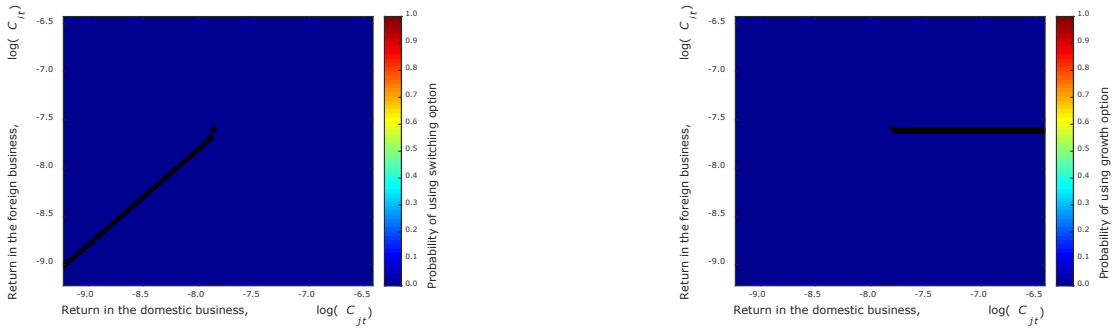
FIGURE 1
Use of the Switching Option and of the Growth Option under Different Realizations of Uncertain Returns in the Domestic and the Foreign Businesses (Both Options Are Present)



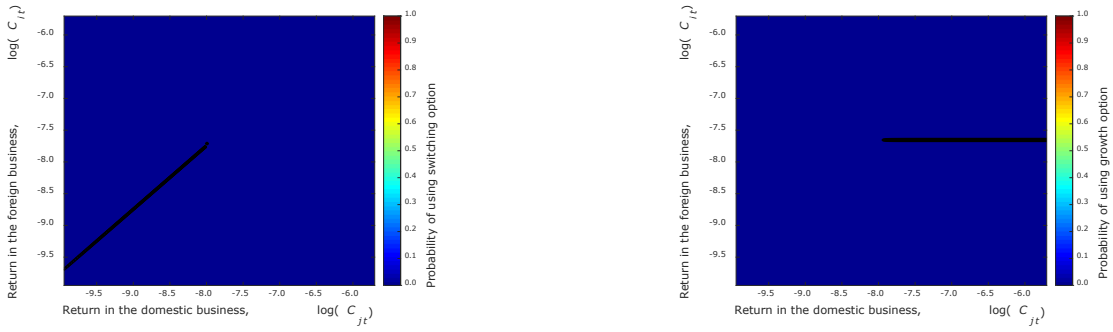
A. Time step 9 out of 200



B. Time step 19 out of 200

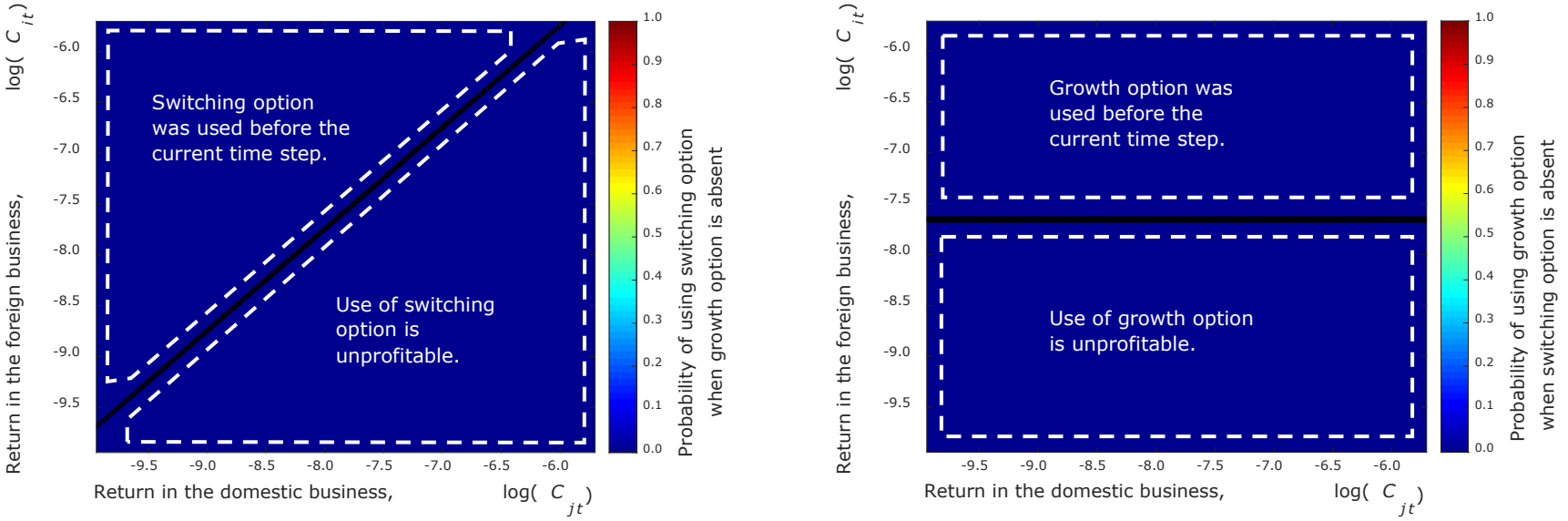


C. Time step 100 out of 200



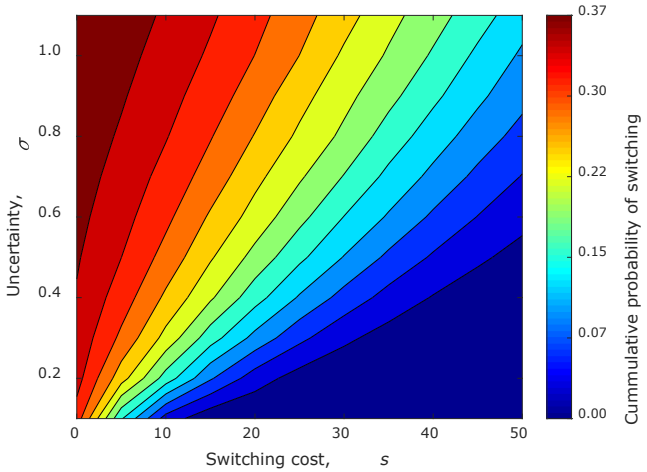
D. Time step 151 out of 200

FIGURE 2
Use of the Switching Option and of the Growth Option under Different Realizations of Uncertain Returns in the Domestic and the Foreign Businesses (Only One Option Is Present)

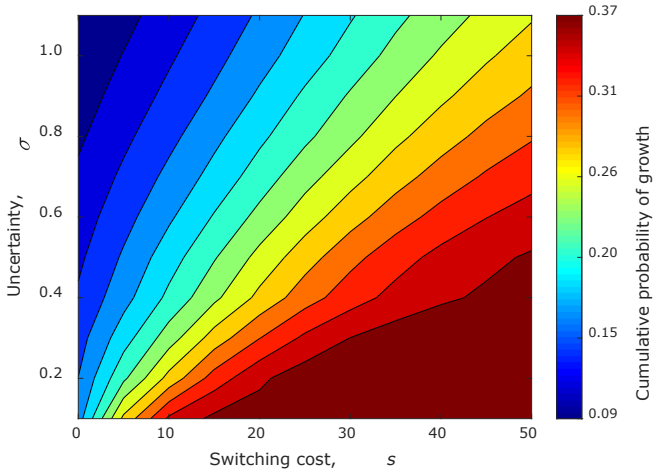


Time step 151 out of 200

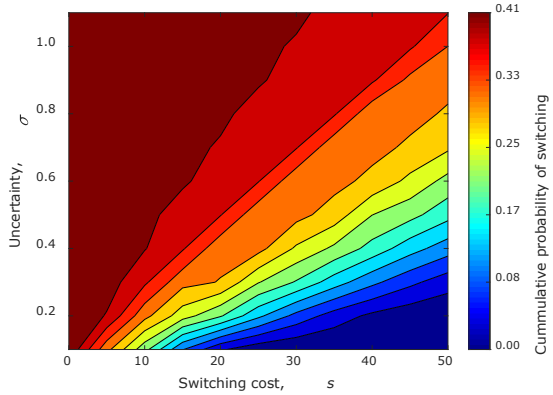
FIGURE 3
Implications of the Switching Cost and of Uncertainty for the Use of the Two Expansion Options

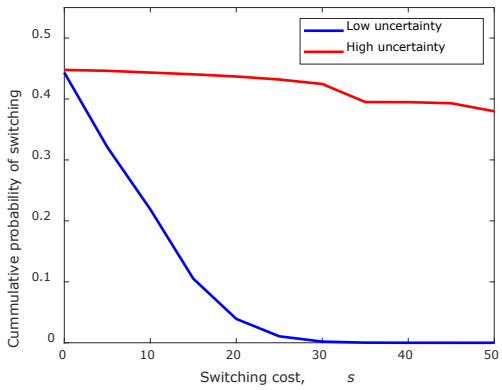


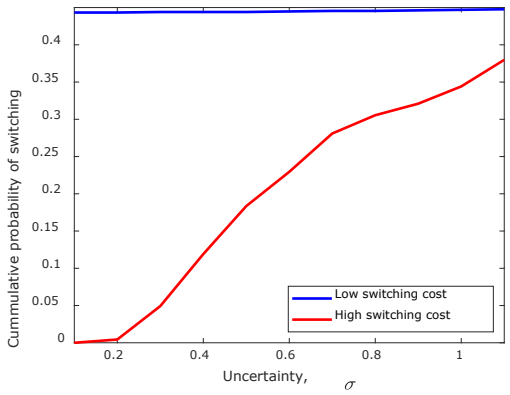
A. Use of the switching option when both options are present



B. Use of the growth option when both options are present

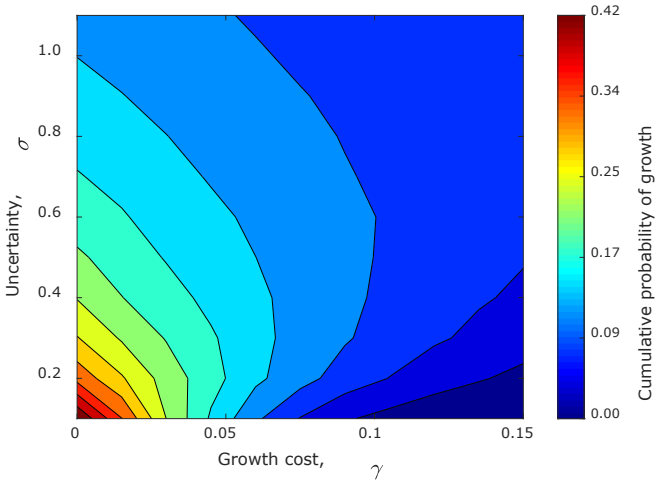




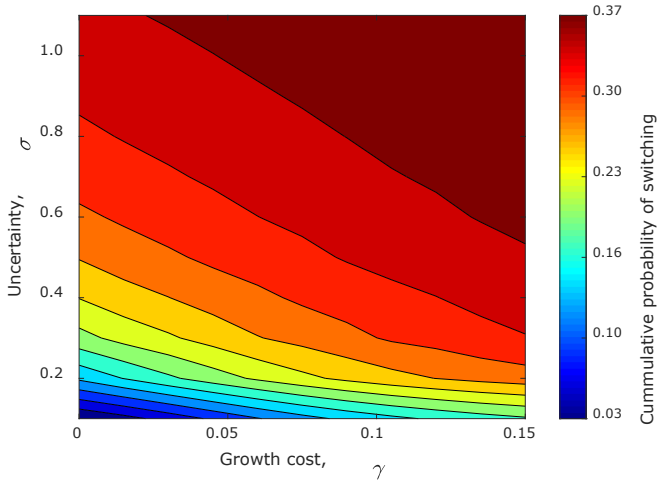


C. Use of the switching option when the growth option is absent

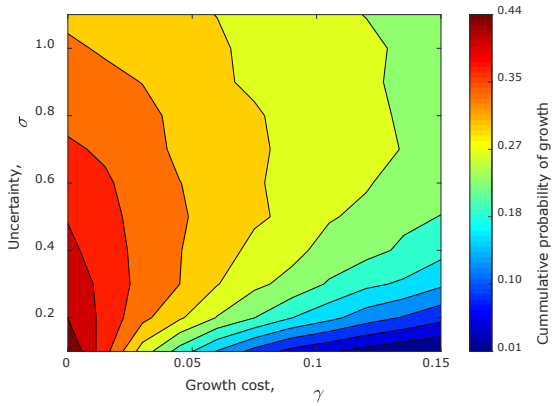
FIGURE 4
Implications of the Growth Cost and of Uncertainty for the Use of the Two Expansion Options

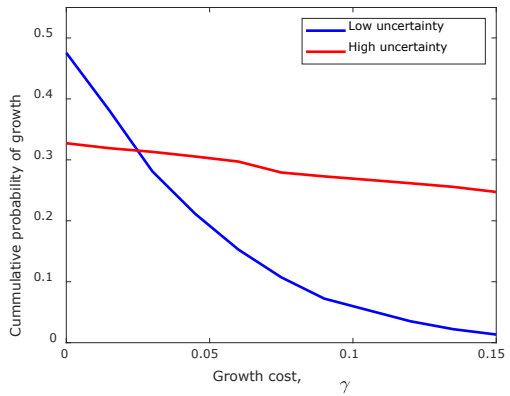


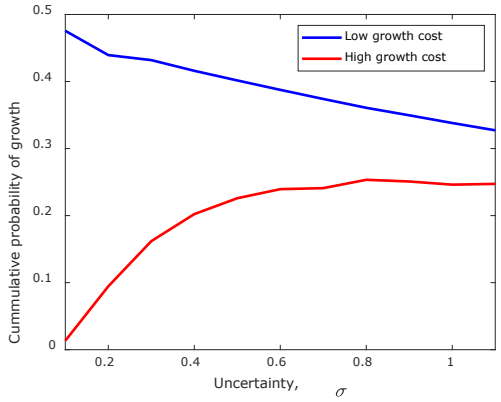
A. Use of the growth option when both options are present



B. Use of the switching option when both options are present

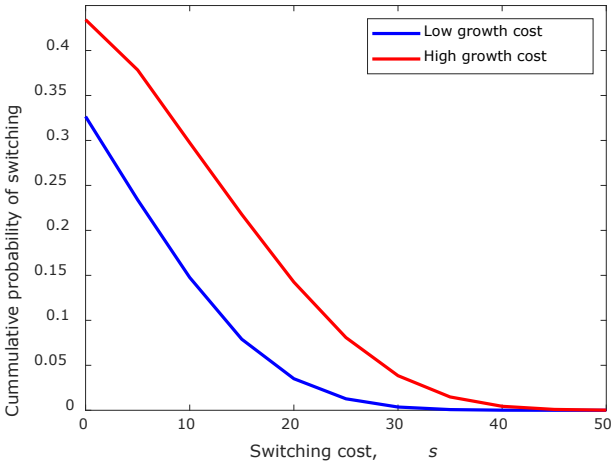




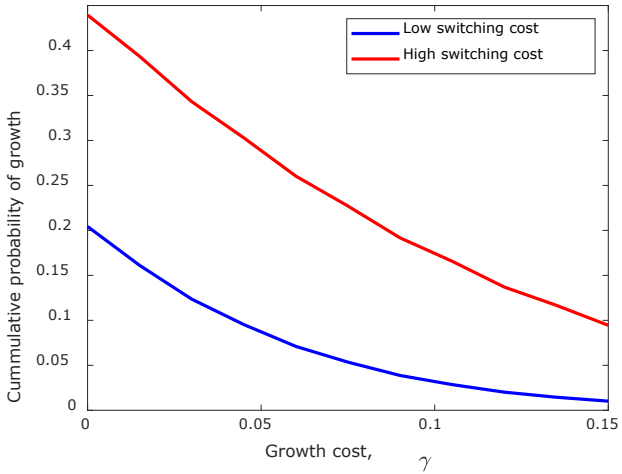


C. Use of the growth option when the switching option is absent

FIGURE 5
Implications of the Interaction between the Growth Cost and the Switching Cost for the Use of the Two Expansion Options

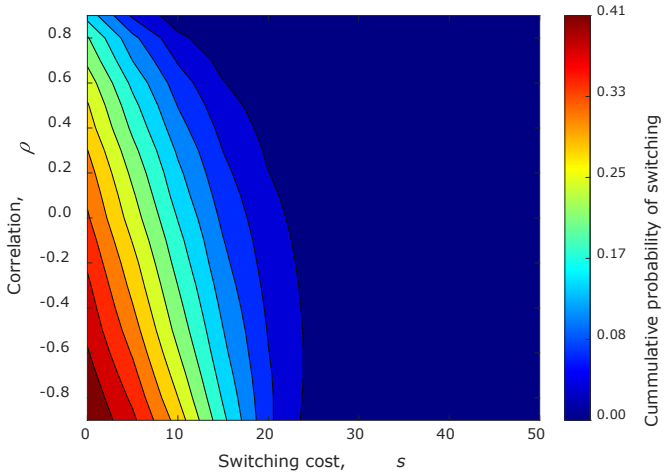


A. Use of the switching option when both options are present

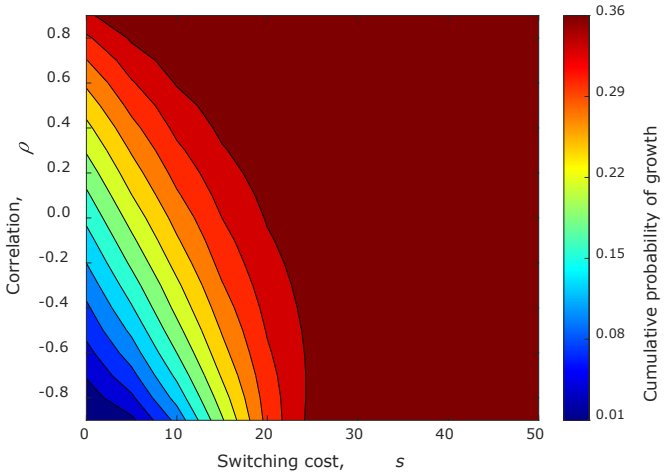


B. Use of the growth option when both options are present

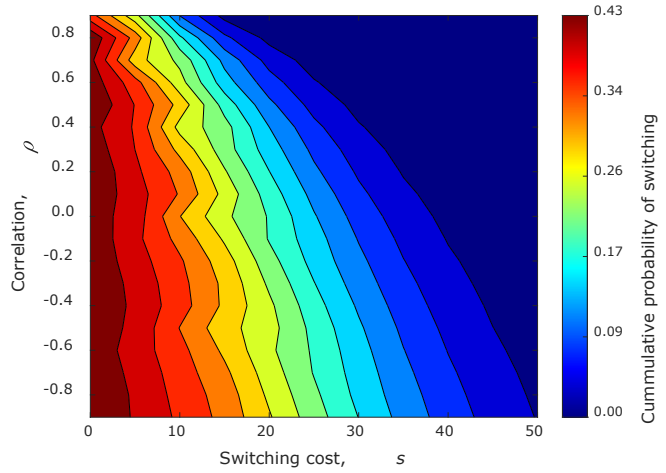
FIGURE 6
Implications of the Switching Cost and of Correlation for the Use of the Two Expansion Options

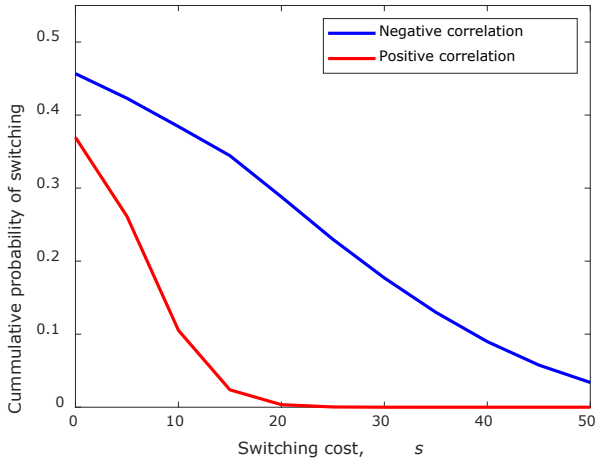


A. Use of the switching option when both options are present



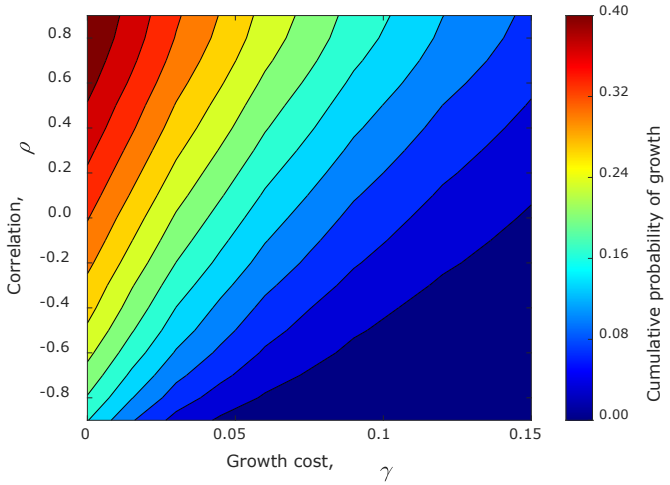
B. Use of the growth option when both options are present



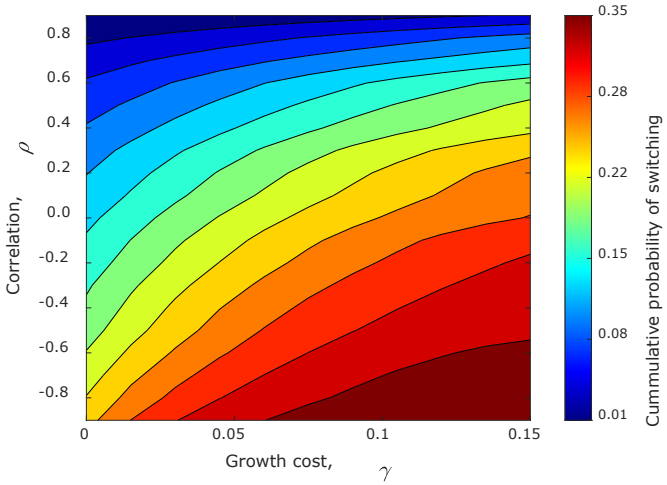


C. Use of the switching option when the growth option is absent

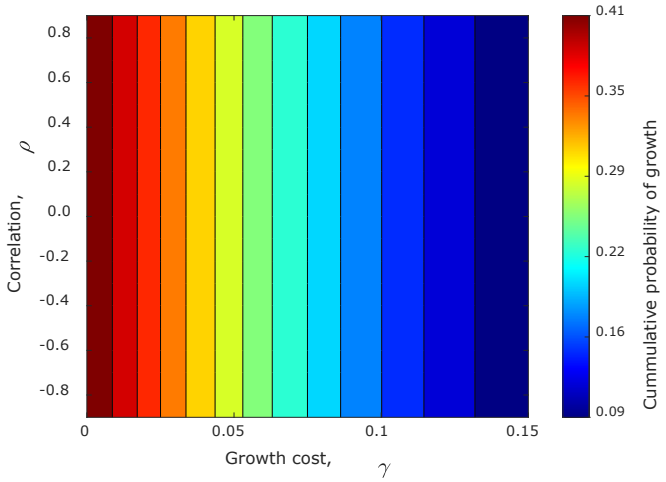
FIGURE 7
Implications of the Growth Cost and of Correlation for the Use of the Two Expansion Options



A. Use of the growth option when both options are present



B. Use of the switching option when both options are present



C. Use of the growth option when the switching option is absent