Multinationality as real option facilitator
– Illusion or reality?

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Abstract

Previous literature provides multiple conflicting arguments on why multinationality should enhance or impede the firm's real options. We address this empirical question by applying a recent methodology from the finance literature to US firms over the period 1977-2013 and find that multinationality does act as a real option facilitator. Furthermore, we show that (1) full benefit from multinationality only accrues if the firm is not financially constrained, (2) benefit from multinationality is limited at very high degrees of multinationality, and (3) foreign sales has to be combined with foreign assets to achieve a degree of multinationality that facilitates real options.

INTRODUCTION

The firm-specific advantage of operating across borders lies in the managerial discretion to exercise valuable options in response to the realization of uncertain events and thus coordinate flexibly multinational activities within a network (Kogut and Kulatilaka, 1994). However, coordination costs surrounding international operations can mitigate the benefits of operational flexibility (Tong and Reuer, 2007). Rangan (1998) finds that multinational firms shift production in response to changes in exchange rates but that even in the face of large exchange rate changes, such operational responses are relatively modest. Furthermore, surveys indicate that global organizations struggle to adapt to local conditions due to organizational rigidities (Dewhurst, Harris, and Heywood, 2012). Thus, whether multinational firms operate flexibly or not is an empirical question (Allen and Pantzalis, 1996).

We show empirically that multinationality does enhance real options. We investigate non-financial firms in the U.S. over the period 1977-2013, use a battery of proxies for multinationality, and find that multinationality is consistently associated with a positive correlation between stock returns and changes in stock return volatility (an indicator of valuable real options). We furthermore show that 1) the enhancement of real options is particularly strong for firms with few financial constraints, 2) multinationality may have a non-linear impact on the value of real options, and 3) multinationality has to entail both sales and production facilities abroad in order to enhance real options. Our results are statistically significant and economically meaningful.

Trigeorgis (1993) provides examples of real options and points to the managers' ability to defer, expand, contract, abandon, or otherwise alter a project at different stages during its useful operating life. According to real option theory (e.g. Dixit and Pindyck, 1994; Trigeorgis, 1996), a manager for a firm with activities in various countries will naturally exploit the inherent flexibility of such an international network of operations. Li (2007) argues that real option theory has enriched foreign direct investment

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(FDI) theory by introducing the notion that multinational firms can strategically benefit from uncertainty because uncertainty is not only associated with downside risks but also with potential future opportunities. Several real option strategies are available to multinational firms, e.g. the ability to exploit growth options by entering a new foreign market or offering new products in an existing foreign market; abandon a foreign market; shift input sources across borders or between substitute inputs; and shift production locations or factors of production (Aabo and Simkins, 2005). The underlying real options are constituted by combinations of productive assets, human resources, and competencies that allow the multinational firm to conduct and modify business activities and move them between corporate units in different geographical locations (Andersen, 2012). Capel (1997) shows how a multinational firm can limit downside risk and increase operating cash flows by exercising switching options (choosing between productions from facilities in two different countries) *provided* that adjustment costs and lags are minor. And that is exactly a crucial reservation. If the exercise of real options is either too costly or too time consuming, the inherent flexibility in multinational structures may be more of an illusion than a reality.

Gavetti and Rivkin (2007) show that managers struggle to understand their environment well enough to search rationally for an effective strategy before their firms lose the plasticity necessary to exploit that understanding. Such delay reduces the firm's ability to adapt to disruptive changes in the external environment. Al-Obaidan and Scully (1995) and Kim and Mathur (2008) argue that the ability to adapt is further complicated as firms expand internationally due to cultural differences, staffing complications, and additional hierarchical levels. Roth, Schweiger, and Morrison (1991) note that global strategy is not only a redistribution of operations – rather, it entails a major investment and commitment on the part of the organization as complex and expensive forms of administrative mechanisms are required. Even in the case where managers are capable of making fast and optimal decisions, the adjustment costs may be prohibitively high. Thus, a firm with production facilities in two countries can only switch production from one facility to the other without incurring considerable costs *if* investment in flexibility has been done in previous periods (Capel, 1997); i.e. both facilities have the capacity to

produce similar goods, both facilities have slack capacity, and downscaling / upscaling of production at the facilities is not associated with major costs.

The opposing reflections cited above provide the rationale for the two competing hypotheses that we will test through the remainder of the paper:

Hypothesis 1. Multinationality enhances real options

Hypothesis 2. Multinationality "kills" real options

We exploit well-established insights from the finance literature (e.g. Berk and DeMarzo, 2014) to explicitly be able to pinpoint if multinationality is associated with valuable real options at the firm-specific level. A financial option gives the holder the right (but not the obligation) to buy (a call option) or sell (a put option) an underlying asset for a pre-specified price within a certain timeframe (an American option) or at a specific future point in time (a European option). Because the holder of the option is not obliged to exercise the option but can choose to leave the option unexercised, the gain/loss profile of the option is asymmetric in the sense that it has limited downside and either unlimited (in the case of a call option) or substantial (in the case of a put option) upside. The asymmetric profile makes the value of the option strictly increasing in the volatility of the underlying asset[1]. Thus, if a multinational firm holds more real options than a domestic firm, it must be the case that the value of the multinational firm increases (decreases) more than the value of the domestic firm when volatility increases (decreases).

Duffee (1995) finds a positive relation between firm stock returns and firm stock return volatility. Grullon, Lyandres, and Zhdanov (2012) hypothesize and show that this positive relation is due to firms'

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[1] As a simple example, the value of a call option that gives the holder of the option the right to buy a share at $100 will be worth more if the likely future range for the share price is $80-$130 rather than $90-$115. In the first case the potential gain can be as high as $30 ($130-$100) while in the latter case the potential gain is limited to $15 ($115-$100). In both cases, the potential "loss" is $0 (or more correctly the unspecified premium paid for obtaining the option in the first place) because the holder is not obligated to exercise the option (e.g. if the future price of the share is $90 the holder of the option will choose not to exercise the option because it is cheaper to buy the share at the spot market at $90 than exercise the option and pay $100).

real options. Grullon Lyandres, and Zhdanov argue that because firms can change their operating and investment decisions to 1) mitigate the effects of bad news (thus reducing the downside) and 2) amplify the effects of good news (thus making the best case even better), the value of a firm increases (decreases) when the volatility of underlying business processes related e.g. to demand and costs increases (decreases). Correspondingly, Grullon Lyandres, and Zhdanov find that firms with abundant investment opportunities (small firms, young firm, R&D firms, and high growth firms) and high operational flexibility (firms in non-unionized industries, firms with high earnings convexity, and firms with high sales convexity) have a stronger positive relationship between firm stock returns and changes in firm stock volatility[2] than firms with less investment opportunities and less operational flexibility.[3]

We use the methodology of Grullon, Lyandres, and Zhdanov (2012) to show empirically that multinational firms possess more real options than domestic firms. Thus, we find that the value of the multinational firm increases (decreases) more than the value of the domestic firm when volatility increases (decreases). We measure changes in firm value in terms of stock returns and changes in volatility in terms of changes in stock return volatility. Our results are robust to alternative measures of multinationality based on foreign sales, foreign assets, and foreign subsidiaries. We find that an increase in the foreign sales ratio from 0% to 25% (equivalent to the mean foreign sales ratio in our sample firms) ceteris paribus is associated with an increase of 11% in the return reaction to changes in volatility.

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[2] Two notes in this regard: First, the use of stock return volatility as a proxy for the underlying business volatility is in line with Leahy and Whited (1996) who argue that stock price returns capture the effects of any aspect of a firm's environment that investors deem important. Measuring underlying business volatility directly would face problems in terms of identifying the most important sources of uncertainty and not least measuring such uncertainty. Second, stock return volatility measures equity risk and not overall firm risk. However, a stock is an option on the firm's assets and as such its value is sensitive to the volatility of the underlying asset. This justifies the use of stock return volatility as a proxy for the volatility of the value of the firm (e.g. Bulan, 2005). We exclude firms with market value of equity less than $20 million and thereby avoid most or all stocks that are likely to behave as out-of-the money options on firm value and thus likely to have a relatively low correlation between stock value and firm value.

[3] As an example, a small firm is likely to have more investment opportunities and be more operationally flexible than a large firm. Thus, when the business environment becomes more volatile (increased stock return volatility), the value of the small firm increases more (higher stock return) than the value of the large firm because the small firm is more likely than the large firm to be able to exploit the increased volatility in terms of reducing downside and amplifying upside. Conversely, when volatility is reduced, the value of the small firm is affected negatively to a larger degree than is the case for a larger firm.

We mainly use the Fama-MacBeth (1973) cross-sectional regression to estimate the relationships. Consistent with Petersen (2009) who shows that alternative estimation methods can yield different results, we estimate the equations, in addition to the Fama-MacBeth regressions, by using the Newey-West (1987) procedure and the model with time-fixed effects that use standard errors robust to clustering at the firm level and heteroskedasticity. We determine that the results remain qualitatively the same across all estimation methods.

We also find that the effect of multinationality on the value of the firm's real options is particularly strong for firms with few financial constraints. Dividing our sample of firms into two halves shows that the impact from multinationality on the value of real options in the group of less financially constrained firms is 2.3 times the corresponding impact in the group of more financially constrained firms[4]. These results indicate that even though multinationality provides the firm with real options, the optimal exercise – and thus value - of such real options hinges on the availability of financial resources. We furthermore find indication that the effect of multinationality on real options may have non-linear characteristics. Specifically, we find that the effect from the foreign sales ratio has its maximum when the firm sells 36% more of its products abroad compared to what is expected given its size. This leaves 11% of our sample firms being "excessively" multinational, i.e. to the extent that the marginal effect from multinationality on the value of real options has turned negative. Finally, we find that firms with no physical presence abroad (e.g. in the form of production facilities) cannot enhance the utilization of their real options by simply selling to foreign markets.

Our paper adds to the current literature in two ways. First, our paper is the first to empirically link

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[4] A stock is a call option on the firm's assets. The large impact from changes in stock return volatility on stock returns for multinational firms could be argued to be a result of the option features of a stock if multinational firms are more inclined than domestic firms to represent "at-the-money" options (where the value impact from changes in volatility is the largest). However, our results for less financially constrained firms and more financially constrained firms run counter to the above reasoning.

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multinationality and the value of real options explicitly. Second, based on the quantification of this link under different settings, we are able to elaborate on the conditions under which multinationality enhances real options. Our paper is related to the literature that has advanced theoretical arguments on why or why not multinationality should enhance real options. More directly, our paper is linked to two papers that link multinationality and real options empirically. Allen and Pantzalis (1996) find that the returns to multinationality increase as firms widen the breadth of their transnational network by having subsidiaries in many foreign countries. The authors argue that the increased value for firms with extensive networks rests on the flexibility that such networks entail. However, because they link the value of the firm with the breadth of foreign subsidiaries – as opposed to our investigation of the link between returns and changes in volatility –other explanations, such as the diversification argument, cannot be excluded. Rangan (1998) finds that multinational firms shift production in response to changes in exchange rates but that even in the face of large exchange rate changes, such operational responses are relatively modest. Rangan argues that the findings lend credence to the view that multinational firms do attempt to operate flexibly, but that their ability to do so in the current period depends on strategies and actions in previous periods, i.e. to what extent the firms have imbedded flexibility (i.e., real options) into their operations. However, Rangan's study provides a partial picture of the multinationality / real options linkage as its focus is solely on the impact of changes in exchange rates, whereas our focus is on firm-specific business volatility in general (including changes in exchange rates).

Our paper is structured as follows. The next section describes the data and measures including correlation coefficients. Section 3 analyzes the relationship between multinationality and real options in three subsections: first, a univariate analysis; second, our main regression analysis including robustness test for alternative measurements of multinationality; and third, our elaborating regression analysis. The last section concludes.

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DATA AND MEASURES

Our initial sample is from the Center for Research in Securities Prices (CRSP) that includes all publicly traded firms for the period, July 1977 to June 2013. Accounting and financial data are drawn from Compustat. We exclude financials (SIC 6000-6999), utilities (SIC 4900-4999), and firms with unclear industry affiliation (i.e., with missing SIC codes). We require that firms have information on the dollar amount of foreign sales, which we use to construct our main measure of multinationality. To avoid cases where our tests results are distorted by very small firms, we exclude firms with market value of equity less than $20 million. These requirements result in a final sample that includes 699,744 firm-month observations covering the 432 month period from July 1977 to June 2013.

We present the descriptive statistics of the sample in Table 1. We winsorize all variables at the 1st and the 99th percentiles. The average firm-level excess return is 0.55% per month. We estimate firm i's volatility during month t as the standard deviation of the firm's daily returns during month t.

$$Volatility_{i,t} = \sqrt{\frac{\sum_{\tau \in t}\left(R_{i,t,\tau} - \overline{R_{i,t}}\right)^2}{n_t - 1}}, \tag{1}$$

where $R_{i,t,\tau}$ is the firm i's excess return ($r_{i,t,\tau} - r_{f,t,\tau}$) on day τ in month t and n_t is the number of days in month t. $\overline{R_{i,t}}$ is the mean excess return of the firm i in month t.[5] The mean and median standard deviation of daily firm-level stock returns are 2.98% and 2.48%, respectively, similar to those in Ang, Hodrick, Xing, and Zhang (2006). The small positive mean change in volatility (0.01%) is consistent with the rising trend in volatility found in other studies (Campbell, Lettau, Malkiel, and Xu, 2001; Cao, Simin, and Zhao, 2008; Grullon Lyandres, and Zhdanov, 2012). The standard deviation of Δ volatility is 1.46%.

*** Table 1 goes about here ***

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[5] We use the capital R for the excess return to differentiate from the raw return, r.

The average (median) firm in our sample generates 24.72% (15.97%) of sales in foreign countries. It has 10.67% (5.72%) of its assets and 44.26% (40.33%) of its employees abroad, and it has 19.54 (3.00) foreign subsidiaries in 6.88 (2.00) foreign countries[6]. The average (median) market value of assets and equity for firms in our sample are about $4.4B ($365M) and $3.5B ($277M), respectively. The average (median) book-to-market ratio is 0.61 (0.51) and about 12% (7%) of outstanding shares are traded in one month.

We present the correlation coefficients between our multinationality variables and our main size variable, the log-transformed market value of assets, in Table 2. Apart from the foreign employees ratio, all multinationality variables are positively and significantly correlated with each other and also positively and significantly correlated with our size variable. The correlation between the foreign sales ratio (our main measurement of multinationality) and the log-transformed market value of assets is 0.32. We will address the importance of this high correlation coefficient in more detail at a later stage.

*** Table 2 goes about here ***

MULTINATIONALITY AND REAL OPTIONS

Subsection 1 performs a univariate test. Subsection 2 provides our main regression analysis and robustness test. Subsection 3 elaborates.

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[6] Please note that because of data availability the number of observations for foreign assets ratio, foreign employees ratio, foreign countries, and foreign subsidiaries are considerably lower than for the other variables in Table 1. Foreign assets ratio and employees ratio cover the period July 1980 – June 2013 (180 months) and foreign countries and subsidiaries cover the period July 2006 – June 2013 (84 months).

Univariate Test

Table 3 provides a crude illustration, i.e., based on univariate statistics, of how firms with a low degree of multinationality differ from firms with a high degree of multinationality. It reports mean values of firm characteristic variables for the low- and high multinationality sub-samples, formed after sorting firms based on their foreign sales ratio relative to the total sample median each year. In the third column, mean differences across the two groups as well as the corresponding *t*-statistics for the difference tests are provided.

*** Table 3 goes about here ***

We see that firms with a low foreign sales ratio on average have significantly different characteristics from those with high foreign sales ratios. In particular, low-multinationality firms have a higher return, are more volatile, are traded more, have a higher market factor loading (i.e., beta or systematic risk) and are marginally larger than firms with a high foreign sales ratio. Also, not surprisingly, firms with a low foreign sales ratio are less multinational than firms with a high foreign sales ratio in terms of all our different measures of multinationality (foreign assets, foreign employees, foreign countries, and foreign subsidiaries).

Main Regression Analysis

Table 4 provides our main regression analysis. We basically follow the methodology of Grullon, Lyandres, and Zhadonov (2012) but improve their model by adding the variables interacted with change in volatility. Therefore, in Table 4 we estimate variations of the following Fama-MacBeth cross-sectional regression:

$$r_{i,t} - r_{f,t} = \alpha_t + \beta_t \Delta Volatility_{i,t} + \varphi_t Res(Foreign\ sales\ ratio)_{i,t}$$

$$+ v_t \Delta Volatility_{i,t} * Res(Foreign\ sales\ ratio)_{i,t} + \gamma_t est.(\eta)_{i,t} + \overline{\delta_t} x_{i,t} + \varepsilon_{i,t}, \qquad (2)$$

where *Residual foreign sales ratio* is the residual value obtained from equation (4) below. $est.(\eta)_{i,t}$ is the

estimated coefficient on the market portfolio return in the following equation:

$$r_{i,t,\tau} - r_{f,t,\tau} = \alpha_{i,t} + \eta_{i,t}(r_{m,t,\tau} - r_{f,t,\tau}) + \varepsilon_{i,t,\tau}, \qquad (3)$$

where $r_{i,t,\tau}$ is the firm i's return in day τ belonging to month t, $r_{f,t,\tau}$ is the daily risk-free rate, and $r_{m,t,\tau}$ is the

daily return on the value-weighted market portfolio. $X_{i,t}$ is a vector of firm characteristics (log-transformed

book-to-market ratio, log-transformed market value of equity, and past returns) following the asset

pricing literature (e.g. Fama and French, 1993) as well as volume. We present results based on raw

returns as many other authors do (e.g., Ang, Hodrick, Xing, and Zhang, 2006; Albuquerque, 2012). We

also use logarithmic returns instead of raw returns following Grullon et al. (2012) and Duffee (1995) and

find consistent results. These additional results are available upon request.

*** Table 4 goes about here ***

Model 1 in Table 4 excludes multinationality measures and verifies the positive relation between

firm-level volatility and firm-level returns found by Duffee (1995). The coefficient for change in

volatility is 0.9164 – similar to the result of Grullon, Lyandres, and Zhadonov (2012)[7].

Model 2 in Table 4 includes the raw foreign sales ratio and its interaction with change in

volatility. Our focus is on the interaction term. A higher foreign sales ratio does not seem to affect the

underlying positive relation between firm-level volatility and firm-level returns[8]. Thus, according to

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[7] Grullon et al. (2012) report a coefficient of 1.186 in a similar equation in their paper (last model, Table II, page 1506). Their data covers the period 7/1963 to 12/2008 and thus differs from our data period (7/1977 to 6/ 2013).
[8] Using this methodology, i.e. introducing in the base model interaction terms between change in volatility and proxies for investment opportunities, Grullon, Lyandres, and Zhadonov (2012) find that small firms, young firm,

Model 2, multinationality as a real option facilitator is an illusion.

However, before discarding multinationality as a real option facilitator, we have to recognize two important circumstances that may modify or change our initial finding. First, size and foreign sales ratio are highly positively correlated (Table 2). Second, Grullon, Lyandres and Zhadonov (2012) clearly show that size is the most significant real option "killer". Thus, the result of Model 2 may simply be the outcome of these two circumstances instead of a reflection of multinationality not being a real option facilitator. As such, it is imperative to create a "pure" measure of multinationality that nets out the significant firm size effect. Therefore, we regress foreign sales ratio on the market value of assets and take the residual value.

$$\textit{Foreign sales ratio}_{i,t} = \omega_{0,t} + \omega_{1,t} \textit{ Log-transformed market value of assets}_{i,t} + \varepsilon_{i,t}. \tag{4}$$

The residual value ($\varepsilon_{i,t}$) in the regression, named Residual foreign sales ratio, is the part of multinationality that cannot be explained by size. We will use it as the proxy for multinationality through the remainder of the paper in order to obtain a clean picture of the impact of multinationality on real options, i.e., one that is not affected by the size dimension of multinationality.

Descriptive statistics for the residual foreign sales ratio are reported in Table 1. Per construction, the mean residual foreign sales ratio is 0%. The median residual foreign sales ratio is -10%, the minimum residual foreign sales ratio is -37%, and the maximum residual foreign sales ratio is 80%. The statistics show that a majority of our sample firms sell less abroad than indicated by their size (median < mean); that, as a percentage of total sales, the least multinational firm sells 37% less abroad than what would have been expected given its size; and that the most multinational firm sells 80% more abroad than would have been expected given its size.

R&D firms, high growth firms, and firms with operational flexibility (non-unionized industries, high earnings or sales convexity) have a stronger positive relationship between firm-level volatility and firm-level returns than the "opposite" firms (e.g. large firms, old firms, etc.).

Model 3 in Table 4 includes the residual foreign sales ratio and its interaction with change in volatility. Our focus is on the interaction term. The result shows a positive and significant interaction term coefficient, implying that a higher residual foreign sales ratio seems to affect the underlying positive relation between firm-level volatility and firm-level returns. Specifically, an increase of 10 percentage points in the residual foreign sales ratio is associated with an addition of 4.4% (4.4% =10% * 0.3922 / 0.8910) in the return's sensitivity to changes in volatility. Thus, according to Model 3 multinationality as a real option facilitator is a reality.

As previously mentioned, Grullon, Lyandres, and Zhadonov (2012) find size to be a significant real option "killer". Model 4 in Table 4 shows the same result for our sample of firms and data period. Thus, Model 4 verifies that size has a significant and negative impact on the relation between changes in firm-level volatility and firm-level returns. Model 5 shows that the conclusion drawn from Model 3 – that multinationality is a real option facilitator – is robust to the inclusion of the size variable.

Our argumentation thus far – and the argumentation of Grullon, Lyandres, and Zhadonov (2012) – has focused on investment opportunities as a state variable. Thus, in Model 3 our residual foreign sales ratio is a state variable signifying to what extent the firm in question is multinational beyond what is expected given its size. Model 6 shows that also *changes* in the residual foreign sales ratio has a positive effect on returns when aligned with changes in volatility. This indicates that changes in multinationality *within* firms matter for real option facilitation. Model 7 includes both the state variable and the change variable in relation to the residual foreign sales ratio and shows that the significance as well as the magnitude of our main multinationality variable – the residual foreign sales ratio – and its interaction with changes in volatility is robust to the inclusion of the change in residual foreign sales ratio. Thus, the coefficients for the interaction term between change in volatility and the residual foreign sales ratio are 0.39 in Model 3 and 0.41 in Model 7 (both significant at the 1% level).

As stated above, we use the Fama-MacBeth (1973) cross-sectional regression to estimate the relationships in Table 4. Consistent with Petersen (2009) who shows that alternative estimation methods can yield different results, we retest the regressions of Table 4 to see whether our findings are not driven by a particular model we choose (i.e., the Fama-MacBeth procedure) and report results in Table 5. In the financial economics literature, the Newey-West procedure (1987) has been widely used as an approach to address the autocorrelation of error terms. The procedure in Newey-West (1987) was initially created to control for serial correlation of unknown form in the residuals of a single time-series data set. Many other authors (e.g., Brockman and Chung, 2001; MacKay, 2003; Bertrand, Duflo, and Mullainathan, 2004; Doidge, 2004) have modified the model to use in a panel data set by estimating only correlations between lagged residuals within the same cluster. We allow the model to handle autocorrelation up to different lags for the same firm. We find that our main findings remain intact even after controlling for autocorrelation in different lag settings. In Panel A of Table 5, we report the results with five lags. We also conduct the tests with time-fixed effects (year-month effects) controlling for standard errors robust to clustering at the firm level and heteroskedasticity in Panel B of Table 5. Both the Newey-West procedure and the model with time-fixed effects generate results consistent with ones reported in Table 4. Therefore, we present the results using the Fama-MacBeth (1973) cross-sectional regressions in the following tests.

*** Table 5 goes about here ***

Table 6 replicates Model 3 from Table 4 but with other multinationality measures. Consistently, the coefficients for the interaction terms are positive and – except for the measure based on foreign assets – statistically significant in spite of a markedly lower number of observations for these measures (due to data availability) as compared to the residual foreign sales ratio. In the remainder of the paper we will use the residual foreign sales ratio as our multinationality proxy.

*** Table 6 goes about here ***

Elaborating on the Regression Analysis

In this subsection we will elaborate on Model 3 in Table 4. We will test whether 1) multinationality is a stronger real option facilitator when firms are not financially constrained (Table 7), 2) the impact from multinationality on real options may be non-linear (Table 8), and 3) foreign sales do not facilitate real options unless these sales are combined with foreign assets (Table 9).

In Table 7 we divide our sample firms into two groups of firms depending on their financial constraints. We measure financial constraint following Kaplan and Zingales (1997). They develop indexes based on the relations of key variables such as cash flows and leverage. We construct a proxy for the degree of a firm's financial constraint following their method, in which *Financial constraint* = -1.001909*(Cash flows/capital) + 0.2826389*Tobin's q + 3.139193*(total debt/total capital) – 39.3678*(dividends/capital) – 1.314759*(cash/capital). In each month, firms are included in the less (more) financially constrained group if they exhibit a value of financial constraint that is lower (higher) than the sample's median value. Table 7 shows that multinationality 1) is a significant real options facilitator for both groups, and 2) acts as a significantly stronger facilitator when firms are less financially constrained. A comparison of the interaction terms' coefficients shows that the impact from multinationality on the value of real options in the group of less financially constrained firms is 2.3 times higher than the corresponding impact in the group of more financially constrained firms. The results indicate that while multinationality is an important real option facilitator, it is also important to have the necessary financial resources to be able to exercise such options.

*** Table 7 goes about here ***

Table 8 investigates to what extent multinationality affects real options in a non-linear fashion. A priori we may expect that as firms successively enter foreign countries, at some point the marginal

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benefits of obtaining more switching options are likely to decline (Andersen, 2012) and that the growth of

coordination and governance costs may exceed the benefits of further expansion because of the

complexity of global operations (Contractor, Kundu, and Hsu, 2003). Table 8 gives a weak indication –

significant at the 10% level – that this may be the case. We find a decreasing effect of multinationality on

real options when firms expand their multinationality above a residual foreign sales ratio of 35.51%

(=0.6068/(2*0.8544)), i.e. when the percentage of total sales generated abroad exceeds what would have

been expected based on the firms size by more than 35.51%. We observe that 77,367 (about 11%) out of

697,407 firm-months available are included in the right side of this inverse U-shaped curve. This

corresponds to approximately 11% of firms being in the range of multinationality where further

internationalization will be detrimental to the value of the firms' real options.

*** Table 8 goes about here ***

Next, we address the issue of the importance of physical assets (e.g. production facilities,

captured here by the foreign asset ratio) in providing a platform on which firms can enhance their ability

to utilize their real options associated with multinationality. We noted in Table 2 that the foreign sales

ratio is highly correlated with the alternative measures of multinationality (including the foreign assets

ratio). At the same time, we know from the literature on the flexibility aspects of multinationality that this

literature focuses on the flexibility generated by production facilities abroad. Thus, both Kogut and

Kulatilaka (1994) and Capel (1997) model the flexibility as the ability to shift production between two

manufacturing plants located in different countries. In the same vein, Tong and Reuer (2007) focus on the

flexibility created by foreign direct investments (not foreign sales). In Table 9 we investigate whether the

existence of foreign assets is a necessary precondition for our main measure of multinationality (i.e., the

residual foreign sales ratio) to have a significant and positive impact on the relation between firm-level

returns and changes in firm-level volatility. We divide our sample firms into quintiles based on their

residual foreign assets ratio. Table 9 shows that foreign sales do not significantly facilitate real options

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unless foreign assets are also present. Thus, the first two quintiles of residual foreign asset ratios have insignificant coefficients for the interaction terms while the last three quintiles have significant and positive coefficients for the interaction terms. Table 9 indicates that firms with no physical presence abroad (e.g. in the form of production facilities) do not enhance their real option utilization by simply exporting to foreign markets.

*** Table 9 goes about here ***

CONCLUSION

We empirically investigate the relationship between multinationality and real options for US non-financial firms in the period from 1977 to 2013. Generally, we find that an increase in multinationality is associated with an increase in real options. More specifically, we find that the positive relationship is especially strong for firms that are not financially constrained. Furthermore, we find a weak indication that the impact of multinationality on the utilization of real options is non-linear with an inverse U-shape. This implies a decreasing effect from multinationality on real options beyond a critical magnitude of multinationality. Finally, we find that foreign sales do not facilitate real options unless these sales are combined with the presence of foreign assets, such as production facilities overseas. Overall, our investigation shows that multinationality is an important facilitator of real options in US non-financial firms.

Our study is the first comprehensive attempt to quantify and thus verify multinationality as a real option facilitator in an empirical sense. The results are important to corporate managers and policy makers. First of all, the results are important in their overall message that multinationality is associated with a high degree of flexibility in the form of valuable growth and switching options. Secondly, our further investigation into the more detailed relationship between multinationality and real options has

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important normative implications; e.g. (1) full benefit from multinationality only accrues if the firm is not financially constrained, (2) benefit from multinationality may be limited or actually negative at very high degrees of multinationality, and (3) foreign sales has to be combined with foreign assets to achieve a degree of multinationality that facilitates real options.

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Table 1 Summary statistics

	N	Mean	Standard deviation	Minimum	25th percentile	Median	75th percentile	Maximum
Excess return	699,855	0.0055	0.1355	-0.3674	-0.0688	-0.0007	0.0725	0.4789
Volatility	699,855	0.0298	0.0186	0.0065	0.0170	0.0248	0.0370	0.1094
Δ Volatility	699,855	0.0001	0.0146	-0.0490	-0.0066	-0.0002	0.0064	0.0525
Foreign sales ratio	699,855	0.2472	0.2733	0.0000	0.0000	0.1597	0.4071	1.0000
Residual foreign sales ratio	697,407	0.0012	0.2569	-0.3656	-0.1794	-0.0914	0.1315	0.7952
Foreign assets ratio	114,005	0.1067	0.1320	0.0000	0.0168	0.0572	0.1455	0.6907
Foreign employees ratio	34,125	0.4426	0.3041	0.0000	0.1887	0.4033	0.6472	1.0000
Foreign countries	122,016	6.8818	11.0096	0.0000	0.0000	2.0000	8.0000	51.0000
Foreign subsidiaries	122,016	19.5352	40.3090	0.0000	0.0000	3.0000	17.0000	209
Market value of assets	697,407	4379	20469	20.0027	103	365	1659	884356
Financial constraint	633,908	0.5551	1.3321	-5.4355	-0.0858	0.6030	1.3551	5.1013
Market factor loading	699,855	0.8492	1.0670	-2.2271	0.2283	0.8029	1.4201	4.2231
B/M	699,855	0.6144	0.4505	0.0395	0.3030	0.5068	0.7994	2.6323
Market value of equity	699,855	3463	16110	20.0004	76.0375	277	1274	626550
Past return	699,855	0.0705	0.4176	-0.9912	-0.1505	0.0308	0.2249	27.8265
Volume	699,855	0.1223	0.1477	0.0021	0.0317	0.0704	0.1517	0.8519

Notes: This table reports the descriptive statistics. Excess return = monthly return minus risk free rate. Volatility = the standard deviation of the firm's daily returns during month t. Δ Volatility = month-to-month change in firm-level volatility. Foreign sales (assets, employees) ratio = foreign sales (assets, employees) divided by total sales (assets, employees).). Residual foreign sales ratio = the residual value of regression of foreign sales ratio on the log-transformed market value of assets. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Foreign countries = the number of foreign countries where the firm's subsidiaries are located. Foreign subsidiaries = the number of foreign subsidiaries. Financial constraint = the measure of firm's financial constraint as in Kaplan and Zingles (1997). Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t. B/M = book-to-market ratio of equity. Past return = 6-month lagged return for months t-7 to t-2. Volume = monthly trading volume divided by the number of shares outstanding.

Table 2 Correlation coefficients

	Foreign sales ratio	Foreign assets ratio	Foreign employees ratio	Foreign countries	Foreign subsidiaries
Foreign assets ratio	0.3428***				
	[0.000]				
Foreign employees ratio	0.6443***	0.4194***			
	[0.000]	[0.000]			
Foreign countries	0.1132***	0.1200***	-0.0324***		
	[0.000]	[0.000]	[0.000]		
Foreign subsidiaries	0.0943***	0.1698***	-0.0054	0.8834***	
	[0.000]	[0.000]	[0.453]	[0.000]	
Log-transformed market value of assets	0.3210***	0.2121***	0.0038	0.4221***	0.4411***
	[0.000]	[0.000]	[0.147]	[0.000]	[0.000]

Notes: This table reports the pairwise correlation coefficients. Foreign sales (assets, employees) ratio = foreign sales (assets, employees) divided by total sales (assets, employees). Foreign countries = the number of foreign countries where the firm's subsidiaries are located. Foreign subsidiaries = the number of foreign subsidiaries. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. *** indicates significance at the 1% level.

Table 3 Univariate tests

	(1) Firms with low foreign sales ratio	(2) Firms with high foreign sales ratio	(1) – (2)	t-statistic
Excess return	0.0067	0.0052	0.0016***	(3.91)
Volatility	0.0313	0.0294	0.0019***	(35.54)
Δ Volatility	0.0000	0.0001	-0.0001	(-1.36)
Foreign sales ratio	0.1365	0.2815	-0.1450***	(-289)
Residual foreign sales ratio	-0.1184	0.0383	-0.1567***	(-319)
Foreign assets ratio	0.0683	0.1424	-0.0741***	(-101)
Foreign employees ratio	0.2681	0.5763	-0.3083***	(-112)
Foreign countries	4.9422	8.8287	-3.8866***	(-62.59)
Foreign subsidiaries	13.7736	25.3185	-11.5449***	(-50.50)
Market value of assets	4492	4344	148***	(2.77)
Financial constraint	0.6241	0.5332	0.0910***	(23.39)
Market factor loading	0.9326	0.8233	0.1093***	(38.92)
B/M	0.6231	0.6118	0.0113***	(8.56)
Market value of equity	3580	3426	153***	(3.49)
Past return	0.0804	0.0674	0.0130***	(9.98)
Volume	0.1531	0.1128	0.0403***	(90.35)

Notes: This table compares the mean values of the variables for the sub-samples classified by foreign sales ratio. Excess return = monthly return minus risk free rate. Volatility = the standard deviation of the firm's daily returns during month t. Δ Volatility = month-to-month change in firm-level volatility. Foreign sales (assets, employees) ratio = foreign sales (assets, employees) divided by total sales (assets, employees). Residual foreign sales ratio = the residual value of regression of foreign sales ratio on the log-transformed market value of assets. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Foreign countries = the number of foreign countries where the firm's subsidiaries are located. Foreign subsidiaries = the number of foreign subsidiaries. Financial constraint = the measure of firm's financial constraint as in Kaplan and Zingles (1997). Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t. B/M = book-to-market ratio of equity. Past return = 6-month lagged return for months t-7 to t-2. Volume = monthly trading volume divided by the number of shares outstanding. *** indicates significance at the 1% level.

Table 4 Returns, contemporaneous changes in volatility, and foreign sales ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Volatility	0.9164***	0.9162***	0.8910***	1.8595***	1.8418***	0.8779***	0.8465***
	(17.11)	(15.61)	(16.48)	(17.11)	(17.01)	(16.28)	(15.67)
Foreign sales ratio		-0.0021*					
		(-1.73)					
Δ Volatility * Foreign sales ratio		-0.0833					
		(-0.88)					
Residual foreign sales ratio			-0.0016		-0.0015		-0.0013
			(-1.34)		(-1.23)		(-0.95)
Δ Volatility * Residual foreign sales ratio			0.3922***		0.3214***		0.4085***
			(4.40)		(3.47)		(4.15)
Δ Residual foreign sales ratio						-0.0022	-0.0015
						(-0.68)	(-0.47)
Δ Volatility * Δ Residual foreign sales ratio						1.6375***	1.1197***
						(3.72)	(3.19)
Log-transformed total assets				0.0003	0.0003		
				(0.82)	(0.79)		
Δ Volatility * Log-transformed total assets				-0.1799***	-0.1780***		
				(-10.56)	(-10.46)		
Market factor loading	0.0010	0.0010	0.0010	0.0012	0.0013	0.0011	0.0011
	(1.24)	(1.25)	(1.30)	(1.57)	(1.63)	(1.30)	(1.33)
Log-transformed B/M	0.0124***	0.0126***	0.0126***	0.0115***	0.0117***	0.0116***	0.0117***
	(7.06)	(7.21)	(7.15)	(6.56)	(6.71)	(6.44)	(6.48)
Log-transformed market value of equity	0.0003	0.0004	0.0003			0.0002	0.0002
	(0.80)	(1.02)	(0.77)			(0.40)	(0.45)
Past return	0.0081***	0.0080***	0.0080***	0.0083***	0.0081***	0.0090***	0.0091***
	(4.28)	(4.23)	(4.22)	(4.36)	(4.33)	(4.58)	(4.50)
Volume	0.0996***	0.0996***	0.0999***	0.0993***	0.0992***	0.0909***	0.0904***
	(10.63)	(10.68)	(10.65)	(10.76)	(10.78)	(9.26)	(9.36)
Constant	-0.0123	-0.0135	-0.0120	-0.0078**	-0.0077**	-0.0086	-0.0089
	(-1.40)	(-1.54)	(-1.38)	(-2.47)	(-2.47)	(-0.97)	(-1.01)
N of observations	699,855	699,855	697,407	699,855	697,407	633,701	633,701
N of months	432	432	432	432	432	420	420
Average R-squared	0.0907	0.0947	0.0948	0.0940	0.0980	0.0913	0.0956

Notes: This table reports the Fama-MacBeth regression results. Excess return = monthly return minus risk free rate. Δ Volatility = month-to-month change in firm-level volatility, where volatility is the standard deviation of the firm's daily returns during month t. Foreign sales ratio = foreign sales divided by total sales. Residual foreign sales ratio = the residual value of regression of foreign sales ratio on the log-transformed market value of assets. Δ Residual foreign sales ratio = year-to-year change in residual foreign sales ratio. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Log-transformed total assets = the log of one plus the book value of total assets. Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t. Log-transformed B/M = the log of one plus book-to-market ratio of equity. Log-transformed market value of equity = the log of one plus market value of equity. Past return = 6-month lagged return for months t-7 to t-2. Volume = monthly trading volume divided by the number of shares outstanding. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5 The Newey-West procedure and time-fixed-effect model

				Panel A: Newey-West procedure			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Volatility	0.1403***	0.2424***	0.1329***	1.7369***	1.7325***	0.1264***	0.1212***
	(8.10)	(10.64)	(7.65)	(32.19)	(32.10)	(6.87)	(6.59)
Foreign sales ratio		-0.0029***					
		(-4.13)					
Δ Volatility * Foreign sales ratio		-0.4227***					
		(-6.70)					
Residual foreign sales ratio			-0.0026***		-0.0027***		-0.0029***
			(-3.74)		(-3.89)		(-3.89)
Δ Volatility * Residual foreign sales ratio			0.2567***		0.2876***		0.1577**
			(3.89)		(4.39)		(2.18)
Δ Residual foreign sales ratio						0.0043**	0.0062***
						(1.99)	(2.84)
Δ Volatility * Δ Residual foreign sales ratio						0.9156***	0.8015***
						(4.87)	(4.12)
Log-transformed total assets				0.0004***	0.0003***		
				(4.33)	(4.16)		
Δ Volatility * Log-transformed total assets				-0.3115***	-0.3124***		
				(-32.50)	(-32.57)		
Controlling variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N of observations	699,855	699,855	697,407	699,855	697,407	633,701	633,701
F-statistic	325.93***	256.44***	247.24***	521.03***	407.43***	206.70***	166.09***

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Panel B: Time-fixed effects				
Δ Volatility	0.6576***	0.6976***	0.6525***	1.4336***	1.4274***	0.6467***	0.6429***
	(32.58)	(27.21)	(32.08)	(25.32)	(25.13)	(30.39)	(30.07)
Foreign sales ratio		-0.0011					
		(-1.60)					
Δ Volatility * Foreign sales ratio		-0.1676**					
		(-2.56)					
Residual foreign sales ratio			-0.0008		-0.0007		-0.0010
			(-1.18)		(-1.02)		(-1.34)
Δ Volatility * Residual foreign sales ratio			0.2255***		0.2280***		0.1416*
			(3.38)		(3.47)		(1.95)
Δ Residual foreign sales ratio						0.0021	0.0027
						(1.06)	(1.36)
Δ Volatility * Δ Residual foreign sales ratio						0.7679***	0.6659***
						(4.57)	(3.82)
Log-transformed total assets				0.0005***	0.0005***		
				(5.91)	(5.68)		
Δ Volatility * Log-transformed total assets				-0.1546***	-0.1545***		
				(-15.36)	(-15.28)		
Controlling variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N of observations	699,855	699,855	697,407	699,855	697,407	633,701	633,701
R-squared	0.1859	0.1860	0.1861	0.1861	0.1869	0.1853	0.1853

Notes: This table reports the results of Newey-West procedure (Panel A) and time-fixed-effect model (Panel B). Excess return = monthly return minus risk free rate. Δ Volatility = month-to-month change in firm-level volatility, where volatility is the standard deviation of the firm's daily returns during month t. Foreign sales ratio = foreign sales divided by total sales. Residual foreign sales ratio = the residual value of regression of foreign sales ratio on the log-transformed market value of assets. Δ Residual foreign sales ratio = year-to-year change in residual foreign sales ratio. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Log-transformed total assets = the log of one plus the book value of total assets. Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t. Log-transformed B/M = the log of one plus book-to-market ratio of equity. Log-transformed market value of equity = the log of one plus market value of equity. Past return = 6-month lagged return for months t-7 to t-2. Volume = monthly trading volume divided by the number of shares outstanding. In Panel B, we use standard errors robust to at the firm level and heteroskedasticity. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6 Returns, contemporaneous changes in volatility, and other multinationality measures

Dependent variable = excess return	(1)	(2)	(3)	(4)
Δ Volatility	0.4985***	0.7306***	0.6975***	0.6936***
	(5.34)	(7.47)	(6.88)	(6.88)
Residual foreign assets ratio	0.0119**			
	(2.39)			
Δ Volatility * Residual foreign assets ratio	0.5568			
	(1.32)			
Residual foreign employees ratio		0.0025		
		(0.53)		
Δ Volatility * Residual foreign employees ratio		0.8200***		
		(3.13)		
Residual foreign countries			0.0001*	
			(1.91)	
Δ Volatility * Residual foreign countries			0.0259**	
			(2.46)	
Residual foreign subsidiaries				0.00002
				(1.57)
Δ Volatility * Residual foreign subsidiaries				0.0100***
				(3.46)
Market factor loading	-0.0018	-0.0005	0.0009	0.0009
	(-0.91)	(-0.15)	(0.39)	(0.37)
Log-transformed B/M	0.0067	0.0042	0.0040	0.0040
	(1.62)	(0.35)	(1.13)	(1.13)
Log-transformed market value of equity	-0.0008	-0.0016	0.0007	0.0008
	(-0.74)	(-1.22)	(1.13)	(1.22)
Past return	-0.0003	0.0035	-0.0015	-0.0013
	(-0.08)	(0.42)	(-0.31)	(-0.28)
Volume	0.0193**	0.0553***	0.0151**	0.0148**
	(2.18)	(3.08)	(2.36)	(2.32)
Constant	0.0180	0.0321	-0.0151	-0.0161
	(0.76)	(1.02)	(-0.96)	(-1.01)
N of observations	113,466	33,958	121,343	121,343
N of months	179	174	84	84
Average R-squared	0.1090	0.1528	0.0693	0.0691

Notes: This table reports the Fama-MacBeth regression results. Excess return = monthly return minus risk free rate. Δ Volatility = month-to-month change in firm-level volatility, where volatility is the standard deviation of the firm's daily returns during month t. Residual foreign assets (employees) ratio = the residual value of regression of foreign assets (employees) ratio on the log-transformed market value of assets. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Foreign assets (employees) ratio = foreign assets (employees) divided by total assets (employees). Residual foreign countries (subsidiaries) = the residual value from the regression of the number of foreign countries (subsidiaries) on the log-transformed market value of assets. Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t. Log-transformed B/M = the log of one plus book-to-market ratio of equity. Log-transformed market value of equity = the log of one plus market value of equity. Past return = 6-month lagged return for months t-7 to t-2. Volume = monthly trading volume divided by the number of shares outstanding. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 7 Returns, contemporaneous changes in volatility, and foreign sales ratio: Impact of financial constraints

Dependent variable = excess return	Less financially constrained	More financially constrained
	(1)	(2)
Δ Volatility	0.7857***	0.9960***
	(12.41)	(17.17)
Residual foreign sales ratio	-0.0006	-0.0008
	(-0.41)	(-0.50)
Δ Volatility * Residual foreign sales ratio	0.7127***	0.3191***
	(4.40)	(2.60)
Market factor loading	0.0006	0.0013
	(0.69)	(1.54)
Log-transformed B/M	0.0212***	0.0051**
	(10.56)	(2.54)
Log-transformed market value of equity	0.0010**	-0.0005
	(2.54)	(-1.31)
Past return	0.0032	0.0082***
	(1.57)	(3.63)
Volume	0.0609***	0.1259***
	(4.77)	(11.65)
Constant	-0.0277***	0.0074
	(-3.14)	(0.80)
Test: $v_{Less\ constrained} - v_{More\ constrained} = 0$	0.3935*	
[p-value]	[0.0530]	
N of observations	327,144	306,764
N of months	432	432
Average R-squared	0.1016	0.1132

Notes: This table reports the Fama-MacBeth regression results. Financial constraint = the measure of firm's financial constraint as in Kaplan and Zingles (1997). In each month, firms are included in the less (more) constrained group if the value of financial constraint is lower (higher) than the median value. Excess return = monthly return minus risk free rate. Δ Volatility = month-to-month change in firm-level volatility, where volatility is the standard deviation of the firm's daily returns during month t. Residual foreign sales ratio = the residual value of regression of foreign sales ratio on the log-transformed market value of assets. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Foreign sales ratio = foreign sales divided by total sales. Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t. Log-transformed B/M = the log of one plus book-to-market ratio of equity. Log-transformed market value of equity = the log of one plus market value of equity. Past return = 6-month lagged return for months t-7 to t-2. Volume = monthly trading volume divided by the number of shares outstanding. *** and ** indicate significance at the 1% and 5% levels, respectively.

Table 8 Non-linear relationship

Dependent variable = excess return	(1)	(2)
Δ Volatility	0.9186***	0.9201***
	(17.19)	(15.81)
Residual foreign sales ratio	0.0011	0.0008
	(0.76)	(0.51)
Residual foreign sales ratio^2	-0.0101***	-0.0078**
	(-3.01)	(-2.32)
Δ Volatility * Residual foreign sales ratio		0.6068***
		(4.00)
Δ Volatility * Residual foreign sales ratio^2		-0.8544*
		(-1.69)
Market factor loading	0.0010	0.0010
	(1.26)	(1.28)
Log-transformed B/M	0.0126***	0.0128***
	(7.20)	(7.24)
Log-transformed market value of equity	0.0003	0.0003
	(0.83)	(0.86)
Past return	0.0080***	0.0080***
	(4.21)	(4.20)
Volume	0.0999***	0.0997***
	(10.68)	(10.73)
Constant	-0.0119	-0.0122
	(-1.37)	(-1.41)
N of observations	697,407	697,407
N of months	432	432
Average R-squared	0.0946	0.0984

Notes: This table reports the Fama-MacBeth regression results. Excess return = monthly return minus risk free rate. Δ Volatility = month-to-month change in firm-level volatility, where volatility is the standard deviation of the firm's daily returns during month t. Residual foreign sales ratio = the residual value of regression of foreign sales ratio on the log-transformed market value of assets. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Foreign sales ratio = foreign sales divided by total sales. Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t. Log-transformed B/M = the log of one plus book-to-market ratio of equity. Log-transformed market value of equity = the log of one plus market value of equity. Past return = 6-month lagged return for months t-7 to t-2. Volume = monthly trading volume divided by the number of shares outstanding. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 9 Foreign assets as a necessary condition

Dependent variable = excess return	Residual foreign assets ratio				
	Quintile 1 (Low)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (High)
	(1)	(2)	(3)	(4)	(5)
Δ Volatility	-0.0019	0.0165	0.6069***	0.5106***	0.3768*
	(-0.01)	(0.03)	(4.73)	(2.97)	(1.89)
Residual foreign sales ratio	0.0037	0.0488	-0.0195	-0.0105	-0.0049
	(0.52)	(1.16)	(-0.46)	(-1.21)	(-0.46)
Δ Volatility * Residual foreign sales ratio	-0.1435	0.0084	0.7727*	0.8838***	0.9640**
	(-0.37)	(0.02)	(1.73)	(2.79)	(2.08)
Controlling variables	Yes	Yes	Yes	Yes	Yes
N of observations	22,473	22,536	22,777	22,899	22,781
N of months	174	174	174	174	174
Average R-squared	0.2031	0.1605	0.1756	0.1761	0.1862

Notes: This table reports the Fama-MacBeth regression results of the sub-samples classified by the residual value of foreign assets ratio. Residual foreign assets ratio = the residual value of regression of foreign assets ratio on the log-transformed market value of assets. Log-transformed market value of assets = the log of one plus the sum of market value of equity and total debt, where market value of equity is share price time the number of shares outstanding at the end of previous month. Excess return = monthly return minus risk free rate. Δ Volatility = month-to-month change in firm-level volatility, where volatility is the standard deviation of the firm's daily returns during month t. Residual foreign sales ratio = the residual value of regression of foreign sales ratio on the log-transformed market value of assets. Foreign sales (assets) ratio = foreign sales (assets) divided by total sales (assets). Controlling variables are: Market factor loading = the estimated coefficient from the daily regression of firm-level excess return on market risk premium in the month t; Log-transformed B/M = the log of one plus book-to-market ratio of equity; Log-transformed market value of equity = the log of one plus market value of equity; Past return = 6-month lagged return for months t-7 to t-2; and Volume = monthly trading volume divided by the number of shares outstanding. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.