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Financial derivatives use and multifaceted exposures

Evidence from East Asian non-financial firms

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Abstract

Purpose – The purpose of this paper is to assess the effect of financial derivatives use on different exposures by comparing domestic firms, domestic multinational corporations (MNCs) and affiliates of foreign MNCs using a unique hand-collected data set of derivatives activities from 881 non-financial firms in eight East Asian countries over the period of 2003-2013.

Design/methodology/approach – In this paper, the authors apply a two-stage approach. In the first stage, exposures to country risks, exchange rate and interest rate risks are estimated by using the market model. In the second stage, potential effects of firms' derivatives use on multifaceted exposures are investigated by carrying out pooled regression model, and panel data regressions with random effect specifications.

Findings – The authors provide novel evidence that financial hedging of domestic firms and domestic MNCs reduces exposure to home country risks by 10.91 and 14.42 percent per 1 percent increase in notional derivative holdings, respectively, while affiliates of foreign MNCs fail to mitigate exposure to host country risks. The use of foreign currency and interest rate derivatives by domestic firms and domestic MNCs is effective in alleviating such firms' exposures to varied degrees, while foreign affiliates' use of derivatives can only lower interest rate exposures.

Originality/value – The primary theoretical contribution of this study is applying the market model to estimate exposures to home and host country risks. Regarding empirical contributions, the authors provide strong evidence that the use of financial derivatives by domestic firms and domestic MNCs significantly contributes to a decline in exposure to home country risks, and evidence the outperformance of domestic MNCs *vis-à-vis* domestic firms and foreign affiliates.

Keywords MNCs, Exposure, Hedging, Derivatives use

Paper type Research paper

1. Introduction

In recent decades, the strong development of financial derivatives as the most cost-effective instrument to manage market risks has aroused substantial interest among researchers to empirically investigate firms' hedging behaviors. However, while the determinants of derivatives use have been relatively thoroughly investigated in both theoretical and empirical respects, the impact of financial derivatives use on firms' exposures has only recently become a subject of empirical analysis, and the research remains occasional.

Specifically, most previous studies focus on exchange rate exposure and provide unclear-cut evidence on the relationship with derivatives use (e.g. Allayannis and Ofek, 2001; Choi and Jiang, 2009; Yip and Nguyen, 2012). In fact, empirical research in the East Asia context is very rare, although firms in East Asian countries have been increasingly using derivatives to

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manage risks in recent decades[1]. The question of whether the use of derivatives among non-financial firms in these countries reduces exposures is therefore of great interest.

Building on the gaps in the existing literature, we explore the unique link between derivatives use and exposures to country risks, exchange rate risks and interest rate risks by comparing domestic firms, domestic multinational corporations (MNCs) and affiliates of foreign MNCs (hereafter foreign affiliates) with a new hand-collected data set of the derivatives use of 881 non-financial firms from 8 East Asian countries for the period from 2003-2013. We make the following contributions.

First, while we have long learned over recent decades about exchange rate exposures and, sometimes, interest rate exposures, to the best of our knowledge, the research linking derivatives use with exposure to country risks is still scarce in the current literature. This is surprising, as country risks have implications for taxation, spending, monetary and trade policy and industry regulation, ultimately directly influencing firms' performance. Relatedly, country risks may have impacts on firm fundamentals, such as investment opportunities, cash flows or risk-adjusted discount factors, leading to the possibility that firms may use derivatives to hedge exposures to country risks. Our study therefore aims to measure exposure to home (host) country risks and investigate the relationship between derivatives use and that type of exposure.

Second, most recent studies on exposures and derivatives use rule out domestic firms by explicitly focusing on MNCs simply because MNCs engage more in overseas operations and trade (see Bartov and Bodnar, 1994; Faff and Marshall, 2005). However, a purely domestic firm is still exposed to market risks, even exchange rate risks if its competitor engages in international business (Pantzalis *et al.*, 2001; Choi and Jiang, 2009). Thus, whether MNCs are more exposed than domestic firms and other firms is not well understood. Relatedly, although the benefits of hedging from reducing exposures are well established, little has been done to investigate whether derivative activities of MNCs are associated with more significant reduced levels of exposures than other firms.

In this study, we propose that different firms have diverse objectives in managing risks and different views on the importance of various types of exposures and that those different hedging strategies determine how derivatives use influences the level of exposure that firms face. Our study fully examines the link between derivatives use and exposures on the comparison of three types of firms (domestic firms, domestic MNCs and foreign affiliates). Further, although there are numerous studies on that crisis, little has been done to analyze its impacts on derivatives use. Our study covers the 2003-2013 period, which provides a natural experiment of financial risks and risk management and allows us to investigate that dynamic relationship when firms face exogenous shocks caused by the global financial crisis of 2007-2008.

Third, although exposure to interest rate risks is a potentially considerable issue in corporate risk management not only for financial institutions but also for other firms, little attention is paid to interest rate exposure of non-financial firms. As a matter of fact, a large body of previous studies focuses on the link between derivatives usage and exchange rate exposure (e.g. Pantzalis *et al.*, 2001; Zhou and Wang, 2013; Hutson and Laing, 2014), while a majority of studies on interest rate exposures has neglected the effects of derivative use (e.g. Bartram, 2002). Thus, in this study, we present a comprehensive analysis of the link between derivatives use and interest rate exposure for a large sample of cross-country non-financial firms.

We summarize the main findings of our study as follows. We provide a novel evidence that the use of financial derivatives by domestic firms and domestic MNCs significantly contributes to a reduction in the exposure to home country risks by 10.91 and 14.42 percent per 1 percent increase in notional derivative holdings, respectively. We also find the outperformance of domestic MNCs in mitigating exposures compared to domestic firms and

foreign affiliates. Domestic MNCs using foreign currency and interest rate derivatives experience declines in exposures to exchange rate risks (12.47 percent) and interest rate risks (15.45 percent) for each 1 percent increase in notional derivative holdings. Meanwhile, a 1 percent increase in foreign currency and interest rate notional holdings of domestic firms contributes to a 10.21 percent decrease in exchange rate exposure and a 12.67 percent decrease in interest rate exposure. Notably, derivatives use of foreign affiliates is not effective in alleviating exposure to host country risks and exchange rate risks, but is associated with 1.51 percent lower interest rate exposure.

The remainder of this study proceeds as follows. Section 2 provides a review of current literature and develops the hypotheses. Sections 3 and 4 describe the sample, variables and research method. Empirical results are discussed in the Section 5. Section 6 draws conclusions.

2. Theoretical framework and hypotheses

2.1 The use of derivatives and exposures

The increasing fluctuation of exchange rates and interest rates creates an additional source of uncertainty and risk and ultimately affects the profitability and value of the firm. Hedging theory and risk management theories imply that if financial derivative contracts are value-enhancing instruments, then an increase in the use of derivatives in accordance with exposures to market risks should reduce individual exposure[2]. Thus, greater efforts in the use of derivatives may result in smaller exposures if hedging activities are effective.

Economic theory implies that all firms, from purely domestic firms to MNCs, are subject to exposures to exchange rate risks, as their cash flows are directly or indirectly affected by movements in exchange rates (Heckman, 1985; Levi, 1994; Shapiro, 1975). Direct exposure refers to the transaction exposure of expected future cash flows in foreign currencies, while indirect exposure derives from the effect of changes in exchange rates on the competitiveness of the firm (i.e. from competitors and suppliers). Dumas (1978) and Hodder (1982) define exchange rate exposure as a regression coefficient of the value of a firm on exchange rates across states of nature.

However, the extant literature finds a puzzling relationship between exchange rate exposure and the use of financial derivatives. Many studies find that derivatives use is related to a significant reduction in exposure, with effects ranging from as low as 2.387 percent to as high as 54 percent (e.g. Adam and Fernando, 2006; Nguyen and Faff, 2010; Bartram *et al.*, 2010). Following Jorion (1990), Allayannis and Ofek (2001) apply the market model and find a negative relationship between a firm's exchange rate exposure and its ratio of foreign currency derivatives intensity. In line with early studies, a recent study by Zhou and Wang (2013) determines that the use of foreign currency derivatives is effective in reducing firms' risk exposure to various degrees. However, Li and Marinc (2014) find that derivatives use by bank holding companies in the USA is associated with higher exchange rate exposure. Meanwhile, the arguments that firms use derivatives to hedge their exchange rate exposure and that such usage efficiently reduces firm's exposures are questioned by other empirical studies, which are unable to find any significant link (e.g. Choi and Jiang, 2009). Building on the insights into theoretical arguments and empirical evidence, we propose the following hypothesis:

H1a. The use of foreign currency derivatives reduces exchange rate exposure.

As for interest rate exposure, the discounted cash flow model of firm valuation predicts that an increase in interest rate exposure reduces the present value of future cash flow, as interest rate movements influence the investment behavior of a firm through cost of capital (Bartram, 2005) and impact firms' financial assets and liabilities and ultimately share prices (Solnik, 1984). Given the theoretical expectation, it is interesting to examine a relationship between derivatives use and exposure to interest rate risks. However, that relationship has

gained little attention in the existing literature. Nguyen and Faff (2010) provide mixed results. They report that among moderate derivative users with an extent of usage of less than 40 percent, the use of interest rate derivatives results in a risk reduction of approximately 2.387 percent, while in the case of extensive derivative users, derivative use seems to increase firm risk. By contrast, Guay (1999) finds a decline in interest rate exposure by 22 percent after the period of initiating interest rate derivative positions. Relatedly, Gay *et al.* (2011), and Brewer *et al.* (2014) find a negative association between interest rate derivatives use and interest rate exposure.

We therefore propose that there is a negative relationship between the use of derivatives and interest rate exposure:

H1b. The use of interest rate derivatives reduces exposure to interest rate risk.

2.2 Exposures to country risks and the use of derivatives

Shapiro (1999) defines country risk as a general level of political and economic uncertainty in a country that influences the value of investments in that country. Butler (2008) and Madura (2010) demonstrate that country risk underlines the risk related to an unexpected change in a country's environment and can be partitioned into political risk and financial risk[3]. Allien and Carletti (2013) further indicate that the interaction of institutions and markets determine the country risk that drives firms' activities (Cantwell *et al.*, 2010). Relatedly, Pástor and Veronesi (2012, 2013) state that policy-related uncertainty cannot be diversified away as uncertainty is made up of a large fraction of risk premiums. Hence, it depresses asset prices by raising the discount rate when the new policy is announced. Additionally, Butler (2008) shows that "many political risks can be mitigated through political risk insurance" and "insurance contracts, such as insurance against political risk, are forms of put options," which is one type of derivative contract. Thus, it is reasonable to anticipate that derivatives use may influence exposure to country risks, which can be defined as the sensitivity of corporate stock returns to changes in a country's environment.

Although the literature on political and economic uncertainty has been investigated extensively, both economic theories and prior literature have largely been silent on the link between derivatives use and country risk. Bartram *et al.* (2009) state that firms located in countries with greater economic, financial and political risks are more likely to use derivatives. On the other hand, firms based in less risky countries may have lower expected financial distress costs and less need for risk management. Recently, Azad *et al.* (2012) and Kim *et al.* (2017) find evidence that a higher degree of economic, financial and political risks encourages firms to use derivatives more intensively.

Taking both the literature on the association between derivatives use and exposures and theoretical and empirical studies on country risks together yields the following hypothesis:

H2. There is a negative relationship between the use of financial derivatives and exposure to country risks.

2.3 Derivatives use and exposures for different firms

In the preceding sections, we hypothesized a negative relationship between the use of financial derivatives and exposures. However, the use of financial derivatives does not have the same impact on exposures for different firm types. Institutional literature provides evidence that firms are not equally influenced by market and country risks. That heterogeneity derives from firms' differential resources, capabilities and stock of experience in the same and/or similar environment (Holburn and Zelner, 2010; Cuervo-Cazurra, 2011).

In particular, this difference can be attributed to firm-specific advantages (FSAs)[4]. Following the internationalization theory (Buckley and Casson, 1976; Dunning, 1977),

international business (IB) scholars have found that MNCs would be able to exploit cost differentials on a global scale due to operations cross-borders (e.g. Allen and Pantzalis, 1996; Chung *et al.*, 2010; Lo, 2016; Malhotra *et al.*, 2016). MNCs, by virtue of their global scope and strategy and their ability to span both internal and external business networks across national boundaries (Scott-Kennel and Giroud, 2015) can have further advantages in hedging exposures to specific market or country risks. Financial researchers also note one of the keys to success of MNCs is their advantages in accessing international capital markets and abilities to exploit market imperfections through internal capital markets or their networks of international subsidiaries (Park *et al.*, 2013). These advantages enable MNCs to overcome challenges, such as exchange rate fluctuations, transfer of capital limits set up by home/host countries' regulations and potential double taxation. Thus, MNCs can achieve superior performance of hedging against market risks on their FSAs.

Compared with domestic firms, MNCs have far greater opportunities than domestic firms to utilize a combination of organizational and external resources to spread market risks and enhance performance, by means of multinationality, as suggested by the OLI paradigm (Dunning and Lundan, 2008). Earlier financial studies (e.g. Hughes *et al.*, 1975; Fatemi, 1984; Michel and Shaked, 1986) also indicate that internationalization is risk-reducing and the MNCs have lower systematic risk, idiosyncratic risk and total risk *vis-à-vis* domestic firms. Likewise, Allayannis and Ofek (2001), Choi and Jiang (2009) find that MNCs may possess a superior capability to reduce exposures to market risks, such as exchange rate risks, by using financial derivatives. Dunning and Rugman (1985) further indicate that MNCs have a greater degree of freedom than domestic firms restricted to one country. While domestic firms must rely on limited financial instruments to hedge their exposures, MNCs have superior ability to engage in additional hedging tools (Pantzalis *et al.*, 2001).

Furthermore, the IB literature emphasizes the importance of country-specific advantages (CSAs) such as economies of scale and access to natural resources for the operation of domestic MNCs and shows that MNCs are better at exploiting CSAs than their domestic counterparts (Bhaumik *et al.*, 2016). These advantages increase MNCs' competitive advantage over domestic firms and may contribute to a reduction in MNCs' exposure to country and market risks. Along this line, Choi and Jiang (2009) state that MNCs face smaller and less significant exchange rate exposures than non-MNCs.

In terms of foreign affiliates, recent IB and international finance studies suggest that foreign affiliates tend to be at a disadvantage, as they often suffer from liability of foreignness, in which they are likely to bear higher cost of capital, lower liquidity and less analyst coverage *vis-à-vis* local firms (Blass and Yafeh, 2001; Bell *et al.*, 2012) and suffer from higher risks of having foreign operations (Van den Waeyenberg and Hens, 2012; Lo, 2016). Foreignness is usually associated with issues such as foreign affiliates' lack of knowledge about local cultures and networks connecting them with important actors in host country's economy and their weak link to local institutional settings (Zaheer, 2002; Bell *et al.*, 2012). Thus, it is reasonable to suggest that foreignness adds more difficulties in implementing derivative activities for MNC affiliates than domestic firms and domestic MNCs.

Furthermore, foreignness can be determined largely by institutional distance between home and host countries, that is, differences in economic development, business practices, political systems, and regulatory, normative and cultural-cognitive institutions between two countries (Salomon and Wu, 2012; Conti *et al.*, 2016). Liability of foreignness can, in turn, increase foreign affiliates' cost of doing business in the host country (Riaz *et al.*, 2015; Conti *et al.*, 2016; Zaheer, 1995, 2015). In particular, the inconsistencies in the decision and law making by a particular host country's regulatory institutions and governments increase variations in the immediate task environments of foreign affiliates (Khanna and Palepu, 1997), which may undermine the implementation of derivative contracts. Additionally, by

virtue of facing conflicting conformity pressures arising from regulations in the home country and policies of the parent company (Kostova and Zaheer, 1999; Kostova *et al.*, 2008), foreign affiliates bear additional costs of hedging exchange rate exposure[5].

On the other hand, foreign affiliates could benefit from access to a broad range of resources, such as knowledge, networks and know-how, due to the diversity of the MNC. However, coordination, governance and administrative costs may reduce these benefits or even make costs outweigh benefits (Khanna and Palepu, 2000), which potentially increases hedging costs and dampens the effectiveness of derivative activities. Furthermore, Andersson *et al.* (2002) show that external embeddedness is not always in the best interest of the entire MNC, as it may decrease subsidiaries' incentive to contribute to the performance of MNCs (Oehmichen and Puck, 2016). As such, it may reduce the effect of foreign affiliates' derivative activities on hedging exposure to host country risks.

Overall, based on the extant research in the realm of domestic MNCs, domestic firms and foreign affiliates and on the arguments developed above, we hypothesize the following:

H3. Derivatives use by domestic MNCs results in a greater decrease in their exposures compared to both domestic firms and foreign affiliates.

3. Sample and descriptive statistics

Our sample consists of 9,691 firm-yearly observations; it is a balanced panel data set of 881 non-financial firms across 34 different industries in 8 countries in East Asia, namely, China, Hong Kong, Japan, Singapore, Malaysia, Thailand, Philippines and Indonesia over the period from 2003-2013. We exclude financial firms because they are likely to have different incentives for using derivatives than non-financial firms. All data on derivatives contracts were hand-collected. We strived to verify the data accuracy by searching through a subset of firms' annual reports, Morningstar[6] – an independent investment research database – and the stock exchanges of each country.

Our study uses a new hand-collected data set of derivatives use and provides greater statistical power. This sample was chosen for the following reasons. First, although the literature on derivatives use has been growing, most empirical studies focus on the derivatives usage of US non-financial firms (e.g. Treanor *et al.*, 2014; Hutson and Laing, 2014; Talbot *et al.*, 2013; Wei and Starks, 2013; Gay *et al.*, 2011; Lee and Jang, 2010; Huffman *et al.*, 2010; Choi and Jiang, 2009; Verschoor and Muller, 2007). Therefore, research on the hedging behavior of East Asian firms is still relatively scarce, even though they have become the world's key derivatives users[7]. Second, our sampled firms are located in countries with great variance in terms of their economic, political and social environments. Such variation and country heterogeneity allow us to focus on the differences in exposures to home and host country risks that our sample firms face, and to explore the link between derivatives use and those exposures. Third, many prior studies investigated derivatives use and exposures over one or two years, our sample covers the period from 2003-2013, and spans beyond the global financial crisis of 2007-2008, which provides us with the unique natural experiment of derivatives use and financial risks, allowing us to provide new insights into firms' hedging activities during that turbulent period. Lastly, in the sample, 389 domestic firms, 427 domestic MNCs and 65 foreign affiliates are identified. In particular, we have 4,279 firm-year observations for domestic firms, 4,697 firm-year observations for domestic MNCs and 715 firm-year observations for foreign affiliates. This rich data set gives us a unique opportunity to examine the effects of derivatives use on multifaceted exposures among diverse types of firms.

We used the Corporate Affiliations database to classify firm types. We distinguished between two types of domestic firms, i.e. between uni-national domestic firms, i.e. firms with no overseas investments, and domestic MNCs, which include firms that are part of a

domestically owned MNC. Similarly, foreign affiliates belong to incoming MNCs, i.e. with a parent company based elsewhere in the world (Pantzalis *et al.*, 2001; Castellani and Zanfei, 2006).

As eight countries in our sample have different local currencies with different values, sampling bias may have occurred. Hence, we decided to use a common currency for the amount of derivatives use and all other financial data, and we chose US dollars (US$). Regarding the reporting currency is not US$, data are converted into US$ using exchange rates on the Datastream database. We collected financial data on control variables from the Datastream database, Economist Intelligence Unit and the World Bank. All financial data are yearly and in thousands of US$.

Summary statistics on the use of derivatives by the sample firms is reported in Table I. Across all countries, approximately 53.5 percent of our sample observations use at least one type of derivative, while the usage rate in the Japan, Philippines and Thailand is 100 percent, indicating that the use of derivatives is common among non-financial firms in East Asian countries. Firms using foreign currency derivatives account for 42.55 percent, while 25.81 percent firms use interest rate derivatives.

Table I also shows that there is an obvious change in derivatives use before and after the global financial crisis of 2007-2008. In particular, derivatives usage increases markedly after 2009 in response to the crisis, as shown by 46.08 percent foreign currency derivatives users in the post-crisis period compared to 36.71 percent in the pre-crisis period.

Panel A: derivatives use by country

Countries	Total	Any derivatives		Foreign currency derivatives		Interest rate derivatives	
	N	*N*	%	*N*	%	*N*	%
Indonesia	429	158	36.83	122	28.44	111	25.87
Philippines	352	352	100.00	139	39.49	99	28.12
Singapore	1,639	651	39.72	735	44.98	434	26.58
Japan	1,661	1,661	100.00	1,293	78.22	1,020	61.71
Hong Kong	1,606	382	23.79	350	21.88	265	16.56
Malaysia	1,760	669	38.01	661	37.58	219	12.46
China	1,111	179	16.11	202	18.20	100	9.01
Thailand	1,133	1,133	100.00	613	54.10	247	21.84
Total	9,691	5,185	53.50	4,115	42.55	2,495	25.81

Panel B: firms' derivatives use information

	Observations	Mean	SD
Notional value of FCD	8,842	245,118.4	2,121,091
Notional value of IRD	9,095	328,000.5	4,793,611
Notional value of any derivative	6,070	339,721.1	4,300,822

Panel B: derivatives use by year

Years	Total	Any derivatives		Foreign currency derivatives		Interest rate derivatives	
	N	*N*	%	*N*	%	*N*	%
2003-2006	3,524	1,752	49.72	1,293	36.71	782	22.20
2007-2008	881	477	54.14	387	43.98	225	25.57
2009-2013	4,405	2,462	55.89	2,021	46.06	1,261	28.77
Total	9,691	5,185	53.50	4,115	42.55	2,495	25.81

Notes: This table shows the number of firms and the percentage of firms that use derivatives. We present derivatives users separately for any derivatives, foreign currency derivatives (FCD) and interest rate derivatives (IRD). Panel A presents derivatives use based on firm-year observations by country. Panel B reports the information about the use of derivatives by derivative users, non-users and notional value of derivatives contracts. Panel C shows the trend of derivatives use over time

Table I.
Descriptive statistics of derivatives use of sample firms

4. Research method and variable construction

4.1 Measuring dependent variables and empirical specifications

In this paper, we apply the two-stage approach, following most previous studies (e.g. Allayannis and Ofek, 2001; Clark and Mefteh, 2011; Zhou and Wang, 2013; Berghofer and Lucey, 2014). The dependent variables are exposures to country risks, exchange rate risk and interest rate risk, i.e. the coefficients estimated by the market model[8] in the first stage.

4.1.1 Stage one: exposure estimation. We use the total monthly sample from January 2003 to December 2013 to estimate exposures augmented market model (cross-sectional) regressions[9]. For individual firms, we calculate stock returns in US$, the US$ returns of the corresponding national stock market index, the percentage change in the nominal exchange rate (in local currency relative to one unit of US$), interest rates and country risks. We use the one-year Interbank offered rate, which is compounded monthly, in each country obtained from Datastream as a proxy for the interest rate. We use overall country risk rating, which is obtained from the Economist Intelligence Unit to measure country risk. The overall country risk rating is the average scores for sovereign risk, currency risk, banking sector risk and economic structure risk of each country on a scale from 0 (minimum risk) to 100 (maximum risk). In particular, we estimate the following equations for each firm:

$$R_{ijt} = \mu_{0i} + \mu_{1ijt} R_{mjt} + \beta_{2ijt} CR_{jt} + \varepsilon_{ijt} \tag{1}$$

$$R_{ijt} = \alpha_{0i} + \alpha_{1ijt} R_{mjt} + \beta_{3ijt} FX_{jt} + \varepsilon_{ijt} \tag{2}$$

$$R_{ijt} = \gamma_{0i} + \gamma_{1ijt} R_{mjt} + \beta_{4ijt} IR_{jt} + \varepsilon_{ijt} \tag{3}$$

$$i = 1, \ldots, n;\ j = 1{-}8,\ t = 1, \ldots, k$$

where R_{ijt}, the rate of return on stock of firm i located in country j in period t; $R_{mjt,}$, the rate of return on country j's benchmark stock index in period t; CR_{jt}, the rate of change in country j's overall risk index in period t; FX_{jt}, the rate of change in nominal exchange rate in country j in period t; IR_{jt}, the rate of change in Interbank offered rate in country j in period t; β_{2ijt}, exposure to country risk of firm i located in country j in period t; β_{3ijt}, exchange rate exposure of firm i located in country j in period t; β_{4ijt}, interest rate exposure of firm i located in country j in period t; and ε_{itt}, error term clustered by country.

The coefficients β_{2ijt}, β_{3ijt} and β_{4ijt} represent exposures to country, exchange rate and interest rate risks, respectively. The exposure to exchange rate risk measures the percentage change in the rate of return on a firm's common stock against a 1 percent change in the exchange rate (Allayannis and Ofek, 2001). Similar to the exchange rate exposure, the exposures to country risk and to interest rate risk measure the percentage change in the rate of return on a firm's common stock against a 1 percent country risks and a 1 percent change in the interest rate, respectively.

4.1.2 Stage two: modeling estimated exposures. In the second stage, potential effects of firms' derivatives use on exposure to country risks and the impacts of the use of specific derivative types on equivalent exposures will be investigated. In particular, absolute values of the estimated exposure coefficients in Equations (1)-(3) act as dependent variables in multivariate analysis[10]. In testing the above-stated hypotheses, our baseline models can be written in condensed forms in Equations (4)-(6) as follows:

$$\left|\widehat{\boldsymbol{\beta}}_{2ijt}\right| = \delta_0 + \delta_1 DER_{ijt} + \sum_{t=1}^{k} \boldsymbol{\delta_k V_{ijt}} + \varepsilon_{ijt} \tag{4}$$

$$\left|\widehat{\boldsymbol{\beta}}_{3ijt}\right| = \lambda_0 + \lambda_1 FCD_{ijt} + \sum_{t=1}^{k} \boldsymbol{\lambda_k X_{ijt}} + \varepsilon_{ijt} \tag{5}$$

$$\left|\widehat{\boldsymbol{\beta}}_{4ijt}\right| = \varphi_0 + \varphi_1 IRD_{ijt} + \sum_{t=1}^{k} \boldsymbol{\varphi_k Y_{ijt}} + \varepsilon_{ijt} \tag{6}$$

$$i = 1 \ldots n,\ j = 1{-}8,\ t = 2003{-}2013$$

where $\left|\widehat{\boldsymbol{\beta}}_{2ijt}\right|$, $\left|\widehat{\boldsymbol{\beta}}_{3ijt}\right|$, $\left|\widehat{\boldsymbol{\beta}}_{4ijt}\right|$ are absolute values of exposures to country risks, exchange rate risks and interest rate risks estimated from Equations (1)-(3) of firm i located in country j in year t, respectively; DER_{ijt}, FCD_{ijt}, IRD_{ijt} are general derivative, foreign currency, interest rate derivative intensity of firm i located in country j in year t, measured by notional amount of derivative contracts scaled by total assets, respectively; $\boldsymbol{V_{ijt}}$, $\boldsymbol{X_{ijt}}$, $\boldsymbol{Y_{ijt}}$: vector of firm- and country-specific variables in year t, including operational hedging, international involvement, firm size, leverage and country-level variables (GDP per capita, financial system deposits to GDP and rule of law); ε_{ijt}, error terms clustered by country.

In our initial tests, we use a pooled regression model for equations from (4) to (6) with the subsamples of domestic firms, domestic MNCs and foreign affiliates. To control for unobserved time-varying effects and to measure within-country and within-industry differences in the effect of derivatives use on exposures, we use country, industry and year-fixed effects. Further, we employ a clustering method developed by Rogers (1993) to adjust for heteroscedasticity and the serial correlation of standard errors. We then assess the robustness of our results by carrying out panel data regressions with random effect specifications. Although the regression results from both fixed effect and random effect specifications are comparable, Hausman's (1978) test shows a preference for the random effect model over the fixed effect model.

4.2 Independent variable – the use of derivatives

We construct derivative intensity by using notional amount of derivatives scaled by firm size. Consistent with the literature, we use the natural logarithm of the book value of total assets to proxy for firm size (e.g. Allayannis and Ofek, 2001; Guay and Kothari, 2003; Lievenbruck and Schmid, 2014). When a firm is not considered a derivative user, we set the notional derivative value to zero. This derivative intensity is censored at zero by construction. Further, in this study, we classify derivatives by underlying assets and investigate general derivatives use, including foreign currency, interest rate and commodity price derivatives, and two specific types: foreign currency and interest rate derivatives.

4.3 Control variables

4.3.1 Operational hedging. Empirical research documents that many firms actively manage exposures to market risks though the use of operational hedging (e.g. Choi and Jiang, 2009; Pantzalis *et al.*, 2001; Berghofer and Lucey, 2014), as Pantzalis *et al.* (2001), so it is necessary to control for operational hedging when trying to understand firms' exposures. We use a diversification dummy that equals one for firms operating in more than one business segment in the SIC industry classification, and zero otherwise.

4.3.2 International involvement. It is well established in the existing literature that foreign sale ratios are important determinants of exposures (Jorion, 1990; Bodnar and Wong, 2000; Allayannis and Ofek, 2001), as they indicate that firms with a large proportion of foreign sales

tend to be more exposed to market risks. Following Allayannis and Ofek (2001), we use the ratio of foreign sales to total sales, denoted as FORSALES, to measure a firm's degree of international involvement (Table II).

4.3.3 Firm size. Recent studies have identified that smaller firms are more subject to market risk exposures than larger firms (Pantzalis *et al.*, 2001; Hutson and Stevenson, 2010), and MNCs are associated with smaller and less significant exchange rate exposures than non-MNCs (Choi and Jiang, 2009). Thus, we use the natural logarithm of the book value of total assets as a proxy for firm size.

4.3.4 Leverage. The extent to which a firm is exposed to market risks has been shown to depend on leverage (He and Ng, 1998), as the use of derivatives reduces expected financial distress and bankruptcy costs (Smith and Stulz, 1985; Froot *et al.*, 1993). We therefore use the ratio of total debts to total assets as our definition of leverage.

4.3.5 Country-level control variables. We use GDP per capita to proxy for the countries' relative performance and financial system deposits to GDP to proxy for financial market development, an increase in GDP per capita and financial system deposits to GDP indicates growth in the economy and tends to signal a reduction in market risks. Additionally, Hutson and Stevenson (2010) find a significant negative link between exposure and the extent of creditor protection in a country. Thus, we use the rule of law to proxy for country-governance quality.

Variables	Definitions	Sources
Dependent variables		
$\lvert\widehat{\beta}_{2ijt}\rvert$	Absolute value of exposure to country risks estimated from equation (7.1) of firm i located in country j in year t	Authors' estimation
$\lvert\widehat{\beta}_{3ijt}\rvert$	Absolute value of exposure exchange rate risks estimated from equation (7.2) of firm i located in country j in year t	Authors' estimation
$\lvert\widehat{\beta}_{4ijt}\rvert$	Absolute value of exposure to interest rate risks estimated from equation (7.3) of firm i located in country j in year t	Authors' estimation
Main independent variables		
DER	General derivative intensity (notional value of derivatives contracts in thousand US$/total assets)	Authors' calculation
FCD	Foreign currency derivative intensity (notional value of FC derivatives contracts in thousand US$/total assets)	Authors' calculation
IRD	Interest rate derivative intensity (notional value of IR derivatives contracts in thousand US$/total assets)	Authors' calculation
Control variables		
Firm size	Natural logarithm of market value of total assets scaled by producer price index (PPI)	Datastream
Leverage	Total debt to total assets	Datastream
FORSALES	Foreign sales to total sales	Datastream
Diversification indicator	Dummy variable which equals one for firms operating in more than one business segment in the SIC industry classification, and zero otherwise	Authors' construction
GDP per capita	(Gross domestic products (GDP)/mid-year population)	World Bank
Financial system deposits to GDP	The demand, time, saving deposits in deposit money banks and other financial institutions as a share of GDP	World Bank
Rule of law	Index measuring the confidence of agents in and abide by the rules of society, the quality of contract enforcement, property rights with −2.5 (weak) to 2.5 (strong)	World Bank

Note: This table defines the dependent and independent variables, and control variables that we examine

Table II. Definitions of variables

5. Findings and discussion

5.1 Univariate results

The means of exposure coefficients reported in the second column show that domestic firms have the highest overall exposures, while domestic MNCs have smaller exposures than domestic firms and foreign affiliates. In particular, the average exposure to country risks $|\widehat{\beta}_{2ijt}|$ for domestic MNCs is approximately 25 percent lower than that for domestic firms and approximately 8 percent lower than that for foreign affiliates. Likewise, average exchange rate and interest rate risk exposures $|\widehat{\beta}_{3ijt}|$ and $|\widehat{\beta}_{4ijt}|$ for domestic MNCs are 48.47 and 38.95 percent lower than those for domestic firms, while they are 33.85 and 74.31 percent, respectively, lower than those for foreign affiliates (Table III).

Regarding the comparison between derivative users and non-users for domestic firms, panel A shows that derivative users have lower average exposure to country risks than non-users (0.1484 vs 0.2004). Although this is not statistically significant at any standard level, we observe that derivative users have both significant lower average exposures to exchange rate and interest rate risks than non-users (0.2012 vs 0.3442, and 0.5604 vs 0.9068).

For domestic MNCs, the results indicate that derivative users have lower overall exposures than non-users, as expected. All exposures of derivative users are lower than those of non-users, and statistically significant differences in means at the standard level. Similarly, for foreign affiliates, derivative users have lower exposures to country risks and interest rate risks than non-users. However, they have higher exchange rate exposure than non-users, although the mean difference is not significant at standard levels.

5.2 Multivariate analysis

5.2.1 A comparison of exposures and derivatives use for domestic firms, domestic MNCs and foreign affiliates. In terms of exposure to country risks in the panel C, we find some interesting results. For domestic firms, we observe that the derivatives use variable is significant and negatively related to exposure to country risks ($\beta = -0.1091$, $p < 0.1$), which indicates that firms using derivatives reduce exposure by 10.91 percent for each 1 percent increase in the notional value of general derivatives. It is also clear that, in the case of domestic MNCs, exposure to country risks decreases when the general notional amount of derivatives increases. Particularly, exposure declines by 14.42 percent for each 1 percent increase in notional holdings ($\beta = -0.142$, $p < 0.01$), which is higher than the corresponding figure for domestic firms. However, for foreign affiliates, we cannot find any evidence supporting a relationship between derivatives use and exposures to host country risks, even though derivative usage has a negative effect on exposure ($\beta = -0.094$, $p > 0.1$). In general, the overall results reported in panel C support *H2* and *H3*.

Similar results are found with regard to exchange rate exposure. Panel A supports *H3* and indicates that the use of foreign currency derivatives is inversely associated with exchange rate exposure in the case of domestic firms and domestic MNCs ($\beta_{domestic\ firms} = -0.1021$, $p < 0.01$; $\beta_{Domestic\ MNCs} = -0.1247$, $p < 0.05$). We also note that the derivatives use of foreign affiliates has a negative effect on exposure, although it is not significantly different from zero ($\beta = -0.1149$, $p > 0.1$).

With respect to interest rate exposure, we find that the regression results comply with *H1b* insofar as the negative and significant signs on the use of interest rate derivatives show that derivative usage has a significant impact on mitigating interest rate exposure, irrespective of whether firms are domestic firms, domestic MNCs or foreign affiliates ($\beta_{domestic\ firms} = -0.1267$, $p < 0.1$; $\beta_{Domestic\ MNCs} = -0.1545$, $p < 0.05$; $\beta_{foreign\ affiliates} = -0.0151$, $p < 0.1$). The estimated coefficients indicate that the use of derivatives decreases interest rate exposure by 12.67, 15.45 and 1.51 percent per 1 percent increase in notional derivative holdings for domestic firms, domestic MNCs and foreign affiliates, respectively, which is consistent with *H3*.

Variables	Obs	All firms Mean	SD	General derivatives use Users Mean	Non-users Mean	Difference in means Non-users – Users	*p*-value
Panel A: domestic firm							
β country risks	3,959	0.1761	1.2305	0.1484	0.2004	0.0521	0.161
β FX risks	3,959	0.2772	2.0604	0.2012	0.3442	0.1429	0.022**
β IR risks	3,959	0.7445	4.1844	0.5604	0.9068	0.3463	0.007***
DER	4,034	0.8231	10.3247	1.8855	0	−1.8855	0.000***
FCD	4,268	0.3664	5.2647	0.8856	0	−0.8856	0.000***
IRD	4,085	0.3449	5.4118	1.9681	0	−1.9681	0.000***
Firm size	4,218	5.4300	2.2217	5.7169	5.1739	−0.5430	0.000***
Leverage	4,237	25.016	75.1544	23.823	26.072	2.2484	0.309
FORSALES	2,952	41.836	39.1131	42.566	41.147	−1.4191	0.323
Diversification indicator	4,158	0.3942	0.48873	0.4035	0.3857	−0.0177	0.241
GDP per capita	4,279	13.7885	1.2030	13.8673	13.7181	−0.1482	0.000***
DEPOSITSTOGDP	4,279	137.0977	74.6620	129.4406	143.8553	14.4147	0.000***
Rule of law	4,279	0.8110	0.8254	0.7897	0.8297	0.0400	0.112
Panel B: domestic MNCs							
β country risks	4,390	0.1405	0.5739	0.1324	0.1495	0.0169	0.311
β FX risks	4,390	0.1867	1.7363	0.1681	0.2074	0.0393	0.431
β IR risks	4,390	0.5358	3.0716	0.4310	0.6528	0.2217	0.017**
DER	4,425	0.2508	3.9113	0.5084	0	−0.5084	0.000***
FCD	4,668	0.0674	0.9581	0.1517	0	−0.1517	0.000***
IRD	4,289	0.0697	1.0786	0.2890	0	−0.2890	0.000***
Firm size	4,603	6.3791	2.4129	7.0131	5.6861	−1.326	0.000***
Leverage	4,620	23.7549	40.4103	22.890	24.697	1.8069	0.137
FORSALES	3,219	31.9955	32.7232	32.842	30.830	−2.0124	0.091*
Diversification indicator	4,565	0.5301	0.5878	0.5454	0.5131	−0.0322	0.068*
GDP per capita	4,695	13.4650	1.1758	13.4433	13.4888	0.0454	0.1921
DEPOSITSTOGDP	4,697	141.5091	80.9590	158.9537	122.4072	−36.5465	0.000***
Rule of law	4,697	0.7035	0.8572	0.9074	0.4804	−0.4269	0.000***
Panel C: foreign affiliates							
β country risks	679	0.1323	0.2194	0.1137	0.1462	0.0325	0.043**
β FX risks	679	0.2499	0.7324	0.2513	0.2488	−0.0024	0.967
β IR risks	679	0.934	4.0564	0.8793	0.9749	0.0956	0.766
DER	701	0.8400	7.5685	2.1259	0	−2.1259	0.003***
FCD	712	0.5170	5.3418	0.1516	0	−0.1516	0.000***
IRD	693	0.2680	2.4170	1.5479	0	−1.5479	0.003***
Firm size	704	5.4215	2.2246	5.6719	5.2502	−0.4216	0.015**
Leverage	702	29.9375	182.9618	24.466	33.699	9.2331	0.431
FORSALES	507	34.418	35.6521	36.440	32.752	−3.688	0.245
Diversification indicator	704	0.4218	0.4942	0.3298	0.4866	0.1567	0.000***
GDP per capita	715	13.9812	1.1311	14.2523	13.7952	−0.45719	0.000***
DEPOSITSTOGDP	715	154.8604	89.6138	147.5522	159.8762	12.3240	0.065*
Rule of law	715	0.6948	0.7912	0.6349	0.7360	0.1011	0.093*

Notes: This table presents a summary statistics of characteristics between firms use derivatives and those firms do not. Panel A reports summary statistics for the variables for the domestic firms that use derivatives (derivative users) and firms that do not (derivatives non-users). Panel B displays the mean, standard deviation for variables of domestic MNCs only separately for derivatives users and non-users. Panel C presents these values for foreign affiliates only. *P*-values for testing the difference in mean are also reported. *,**,***Significant 10, 5 and 1 percent levels, respectively

Table III.
Summary statistics: derivatives users vs non-users

5.3 Robustness tests

5.3.1 Random effects model. For domestic firms, the estimated coefficients on foreign currency, interest rate and general derivative intensities are significantly negative at −0.0695, −0.1188 and −0.1104 ($p < 0.01$, $p < 0.1$ and $p < 0.1$), respectively, indicating that, in all cases, the use of derivatives contributes to a reduction in exposures to exchange rate, interest rate risks and home country risks. For foreign affiliates, we obtain findings very similar to those found in Table IV, in which only the coefficient on interest rate derivatives is significantly inverse to interest rate exposure ($\beta = -0.0151$, $p < 0.1$), while we fail to find any evidence supporting a negative link between derivatives use and exposures to exchange rate risks, and to home country risks ($\beta_{in\ panel\ A} = -0.1336$, $p > 0.1$; $\beta_{in\ panel\ C} = 0.0417$, $p > 0.1$)[11] (Table V).

For domestic MNCs, similar findings to those found in Table IV are observed, as we find that the use of any derivatives, foreign currency derivatives and interest rate derivatives are separately associated with lower degrees of equivalent types of exposures ($\beta_{in\ panel\ C} = -0.1430$, $p < 0.01$; $\beta_{in\ panel\ A} = -0.1473$, $p < 0.1$; $\beta_{in\ panel\ B} = -0.1483$, $p < 0.05$). We also observe that the estimated coefficients on derivatives use for domestic MNCs are larger in magnitude than domestic firms and foreign affiliates, confirming the findings in the previous section that the negative relation between derivatives use and exposures is strongest for domestic MNCs.

5.3.2 Instrumental variable (IV) model: controlling for potential endogeneity problem. We notice that in regressions, the use of derivatives and exposures may be endogenously determined due to omitted variables and reserve causality. In view of such potential endogeneity problem, we undertake the IV method similar to Gay *et al.* (2011), Chang *et al.* (2013), among others. In this approach, derivative intensity is regarded as an endogenous variable. The first stage of IV regression is an OLS regression model of derivatives use on all explanatory variables in Equations (4)-(6); in the second stage, we apply the two-stage least squares (2SLS) to obtain efficient estimators for heteroskedasticity.

In the first stage, the choice of IV, which are potentially related to derivatives use, but are unrelated to exposure, is mainly suggested by previous studies on hedging theories and those on exposures. Specifically, based on the idea of Campello *et al.* (2011) about a tax-based instrumental approach, we use first difference of tax rate, defined as income taxes to pre-tax income, as an IV. The theoretical research linking derivatives use and tax benefits suggest that progressive marginal tax rates, and tax shields such as tax credits, tax loss carry forwards are closely related to the decision to hedge (e.g. Smith and Stulz, 1985; Stulz, 1996, among others). However, tax convexity is a non-linear function of taxable income, tax codes and various tax credits (Campello *et al.*, 2011). Therefore, this measure exhibits characteristics of tax system and structure eventually lead to an exogenous variation to identify the unbiased influence of derivatives use on exposures.

Furthermore, following Magee (2013) and Chang *et al.* (2013), we use R&D expenditures scaled by total sales, first difference of R&D expenditures and ROA as IV. The hedging theory and many previous empirical studies suggest that firms with substantial R&D expense are more likely to hedge (Froot *et al.*, 1993; Géczy *et al.*, 1997; Clark and Judge, 2009; Aabo and Ploeen, 2014). A negative relation between ROA and foreign currency hedging is found by some studies such as Allayannis and Ofek (2001) and Bartram *et al.* (2009), which suggests that the likelihood of financial distress increases for firms that fail to fully hedge. On the other hand, R&D expenditure is a proxy for growth opportunity and found to be positively related to firm value (Marami and Dubois, 2013), while ROA measures a firm's profitability and positive association with firm value is found (Allayannis and Weston, 2001; Belghitar *et al.*, 2013). Thus, they may be unrelated to exposures.

Variables	Domestic firms		Domestic MNCs		Foreign affiliates	
Panel A: FX exposures						
FCD	−0.1021***	(0.000)	−0.1247**	(0.027)	−0.1149	(0.230)
Firm size	−0.0101	(0.135)	−0.0203*	(0.059)	−0.0104	(0.385)
Leverage	−0.0023	(0.762)	−0.0416*	(0.086)	−0.0126***	(0.001)
FORSALES	0.0194	(0.760)	0.0326	(0.377)	0.0128	(0.237)
Diversification indicator	0.0555*	(0.068)	−0.0414	(0.146)	−0.0320	(0.541)
GDP per capita	0.2194***	(0.004)	0.202*	(0.070)	−2.212***	(0.003)
DEPOSITSTOGDP	−0.0613**	(0.013)	−0.0462***	(0.009)	0.0215	(0.566)
Rule of law	−0.0519	(0.773)	0.160	(0.482)	0.379	(0.589)
Intercept	−3.1646***	(0.003)	−2.645*	(0.072)	2.1538***	(0.004)
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
No of observations	1,053		1,250		446	
R^2	0.225		0.290		0.270	
Panel B: IR exposures						
IRD	−0.1267*	(0.058)	−0.1545**	(0.039)	−0.0151*	(0.075)
Firm size	−0.0196	(0.364)	−0.0832*	(0.061)	−0.0347	(0.107)
Leverage	−0.0254**	(0.038)	−0.0143	(0.308)	−0.0327**	(0.045)
FORSALES	0.0528	(0.513)	0.0116	(0.221)	0.0780	(0.846)
Diversification indicator	0.134	(0.630)	−0.1065	(0.373)	−0.321	(0.290)
GDP per capita	−0.119	(0.905)	−1.639	(0.234)	−1.729	(0.509)
DEPOSITSTOGDP	−0.0445*	(0.059)	−0.0416**	(0.022)	−0.0476*	(0.064)
Rule of law	−0.5790	(0.173)	−0.1654	(0.148)	−0.3139	(0.197)
Intercept	−5.395	(0.618)	8.8270	(0.358)	21.97	(0.583)
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
No of observations	645		2,398		430	
R^2	0.326		0.278		0.362	
Panel C: exposure to country risks						
DER	−0.1091*	(0.059)	−0.1442***	(0.001)	−0.094	(0.327)
Firm size	−0.0940	(0.454)	−0.0747**	(0.033)	−0.494	(0.251)
Leverage	−0.034	(0.477)	−0.0386	(0.686)	0.069	(0.373)
FORSALES	0.0566	(0.196)	0.0107*	(0.073)	0.096**	(0.029)
Diversification indicator	−0.288	(0.359)	−0.0411*	(0.071)	−0.820	(0.780)
GDP per capita	0.568	(0.946)	0.1458	(0.088)	0.629	(0.477)
DEPOSITSTOGDP	−0.0695***	(0.003)	−0.116	(0.130)	−0.073**	(0.025)
Rule of law	4.911	(0.853)	0.1026	(0.174)	−0.4054**	(0.038)
Intercept	−1.4906	(0.208)	−1.8547	(0.125)	−5.986**	(0.012)
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
No of observations	2,007		1,272		198	
R^2	0.323		0.256		0.404	

Notes: DER is the notional value of any derivative contracts in thousand USD scaled by total assets. FCD is the notional value of foreign currency derivatives in thousand US$ scaled by total assets. IRD is the notional value of interest rate derivatives in thousand US$ scaled by total assets. This table reports the effects of derivatives use on exposures across domestic firms, domestic MNCs and foreign affiliates from pooled regression models split up with regard to exposure to country risks, exchange rate and interest rate risks. The dependent variable are absolute values of exposures to country risks $\left|\widehat{\beta}_{2ijt}\right|$ (panel A), exchange rate risks $\left|\widehat{\beta}_{3ijt}\right|$ (panel B) and interest rate risks $\left|\widehat{\beta}_{4ijt}\right|$ (panel C). All other independent variables definitions are reported in Table II. Standard errors are clustered by country to control for heteroscedasticity and serial correlation. *p*-values are in parentheses. *,**,***Significant 10, 5 and 1 percent levels, respectively

Table IV. Exposures and derivatives use

Variables	Domestic firms		Domestic MNCs		Foreign affiliates	
Panel A: FX exposures						
FCD	−0.0695***	(0.001)	−0.1473*	(0.093)	−0.1336	(0.758)
Firm size	−0.0317*	(0.056)	−0.0212	(0.873)	−0.0108	(0.216)
Leverage	−0.0156	(0.459)	−0.0638*	(0.056)	0.0133*	(0.044)
FORSALES	0.0335	(0.515)	0.0391	(0.476)	0.0164*	(0.069)
Diversification indicator	0.6151	(0.178)	−0.0395	(0.177)	−0.1297	(0.973)
GDP per capita	−0.0125	(0.943)	0.0185**	(0.049)	0.0765***	(0.001)
DEPOSITSTOGDP	−0.2156***	(0.006)	−0.0472**	(0.020)	−0.1971	(0.409)
Rule of law	−0.0537*	(0.078)	0.159	(0.430)	−0.4365	(0.878)
Intercept	0.2460	(0.341)	−2.404	(0.430)	1.494	(0.396)
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
No of observations	2,616		2,859		481	
Panel B: IR exposures						
IRD	−0.1188*	(0.064)	−0.1483**	(0.041)	−0.0151*	(0.063)
Firm size	−0.0279	(0.937)	−0.0644**	(0.047)	−0.0347	(0.637)
Leverage	−0.0142	(0.911)	−0.0209**	(0.017)	−0.0406*	(0.064)
FORSALES	0.0397**	(0.037)	0.0110	(0.571)	0.0388	(0.947)
Diversification indicator	0.1757	(0.860)	−0.107	(0.253)	−0.0287	(0.937)
GDP per capita	−0.1370**	(0.022)	−0.876	(0.516)	−0.0252	(0.178)
DEPOSITSTOGDP	−0.0606***	(0.000)	−0.0419***	(0.000)	−0.0476**	(0.028)
Rule of law	−0.2718***	(0.001)	0.453	(0.258)	−0.3873	(0.212)
Intercept	9.6163*	(0.083)	7.3024	(0.479)	6.953	(0.836)
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
No of observations	2,311		2,604		464	
Panel C: exposures to country risks						
DER	−0.1104*	(0.087)	−0.1430***	(0.007)	0.0417	(0.282)
Firm size	−0.1238	(0.470)	−0.0313	(0.277)	−0.0702*	(0.087)
Leverage	−0.0346	(0.401)	0.0449	(0.563)	−0.0360**	(0.016)
FORSALES	0.0680*	(0.065)	0.0108	(0.536)	0.0698**	(0.038)
Diversification indicator	−0.2883	(0.361)	0.0276*	(0.033)	−0.0955	(0.768)
GDP per capita	0.568**	(0.046)	−0.1033	(0.457)	−0.0395	(0.664)
DEPOSITSTOGDP	−0.819	(0.340)	−0.0984**	(0.038)	−0.0639	(0.103)
Rule of law	0.4911	(0.912)	0.1339	(0.536)	−0.0307	(0.167)
Intercept	0.2021	(0.859)	1.6581	(0.360)	0.3372	(0.786)
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
No of observations	2,007		2,716		473	

Notes: DER is the notional value of any derivative contracts in thousand US$ scaled by total assets. FCD is the notional value of foreign currency derivatives in thousand US$ scaled by total assets. IRD is the notional value of interest rate derivatives in thousand US$ scaled by total assets. This table presents the impacts of derivatives use on exposures across domestic firms, domestic MNCs and foreign affiliates from random effects models split up with regard to exposure to country risks, exchange rate and interest rate risks. The dependent variable are absolute values of exposures to country risks $|\widehat{\beta}_{2ijt}|$ (panel A), exchange rate risks $|\widehat{\beta}_{3ijt}|$ (panel B) and interest rate risks $|\widehat{\beta}_{4ijt}|$ (panel C). All other independent variables definitions are reported in Table II. Standard errors are clustered by country to control for heteroscedasticity and serial correlation. *p*-values are in parentheses. *,**,***Significant 10, 5 and 1 percent levels, respectively

Table V.
Random effects model

For conciseness, we only report results of the second-stage IV estimation in Table VI. To substantiate if the instruments are weak instruments, we estimate Kleibergen-Paap Wald rank F statistic. The F statistics are always greater than Stock and Yogo's (2005) critical value (or greater than 10), implying the rejection of null hypothesis that the instruments are weak. In addition, the Kleibergen-Paap Wald rank LM statistics are strongly significant ($p < 0.05$, or $p < 0.01$), indicating that the IV model does not have an under-identification problem.

We observe that our main findings presented in Table IV still hold after accounting for potential endogeneity reported in the 2SLS regressions. In panel A, for exposure to country risks, we observe a significant negative relation between derivatives use and exposure when firms are domestic firms ($\beta = -0.0761$, $p < 0.05$), or domestic MNCs ($\beta = -0.1654$, $p < 0.01$), while in the case of foreign affiliates, the estimated coefficient on derivative use variable is found to be insignificant at any standard level ($\beta = -0.0344$, $p > 0.1$). In panels B and C, we find conforming results with prior section when the analysis is conducted separately on exposure to exchange rate and interest rate risks. The coefficients on foreign currency derivatives in panel B for domestic firms and domestic MNCs are −0.1498 ($p < 0.1$) and −0.1558 ($p < 0.05$), but it is not different from zero at any conventional significance level for foreign affiliates ($\beta = -0.167$, $p > 0.1$). In panel C, we note that there is a significant inverse relationship between the use of interest rate derivatives and interest rate exposure, regardless of firm types ($\beta_{domestic\ firms} = -0.125$, $p < 0.05$; $\beta_{Domestic\ MNCs} = -0.1667$, $p < 0.05$; $\beta_{foreign\ affiliates} = -0.0910$, $p < 0.01$).

6. Conclusion

In this study, we investigated the impacts of derivatives use on multifaceted exposures, including exposures to home/host country risks, exchange rate exposure and interest rate exposure, by utilizing a large unique hand-collected data set containing information on the derivatives activities of non-financial firms in eight East Asian countries over the period from 2003-2013. To our knowledge, this study is one of the first to explore this dynamic relationship when comparing different firm types: domestic firms, domestic MNCs and foreign affiliates.

The primary theoretical contribution of this study is applying the market model to estimate exposures to home and host country risks. As such, we demonstrate how country risk exposures can be measured using well-established linear regression techniques and, in this way, conforming to the interests of policy-makers, stockholders, investors and analysts. The concept that exposure to country risks can be measured as a regression coefficient should be attractive to that group, as firms are not free from country risks and efforts must be made by each firm to approximate and quantify their exposure.

The first and major empirical contribution of this research is to provide strong evidence that the use of financial derivatives by domestic firms and domestic MNCs significantly contributes to a decline in exposure to home country risks at the rate of 10.91-14.42 percent per 1 percent increase in notional derivative holdings, respectively. However, the financial hedging of foreign affiliates cannot reduce exposure to host country risks. These findings are robust after accounting for endogeneity and many specifications.

We then complement and shed new light on the current literature on hedging when we evidence the outperformance of domestic MNCs in reducing exposures to exchange rate and interest rate risks *vis-à-vis* domestic firms and foreign affiliates. We first report that derivative users have, on average, a lower degree of exposure than non-users, and domestic MNCs have lower exposure to country, exchange rate and interest rate risks than domestic firms and foreign affiliates. In all models, we find that the observed reductions in exposures are more striking for domestic MNCs, while domestic firms using derivatives experience a smaller decline in their exposures, and the use of derivatives by foreign affiliates is able to reduce only interest rate exposure.

Variables	Domestic firms		Domestic MNCs		Foreign affiliates	
Panel A: exposure to country risks						
DER	−0.0761**	(0.038)	−0.1654***	(0.003)	−0.0344	(0.508)
Firm size	0.0444	(0.224)	−0.855***	(0.002)	−0.0134***	(0.001)
Leverage	0.0341	(0.432)	−0.0126	(0.221)	−0.0119	(0.362)
FORSALES	0.0162**	(0.029)	0.0362***	(0.000)	−0.0285	(0.586)
DEPOSITSTOGDP	−0.0347	(0.279)	−0.0333**	(0.019)	0.0112	(0.938)
Rule of law	0.0190	(0.321)	−0.2870**	(0.027)	0.0180	(0.924)
Intercept	4.453***	(0.000)	−5.468**	(0.035)	−9.510***	(0.001)
Other control variables	Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
Kleibergen-Paap Wald rk *F* statistic	132.00		49.16		125.13	
Kleibergen-Paap rk LM statistic (*p*-value)	0.0064		0.0291		0.0042	
No of observations	1,437		965		241	
R^2	0.210		−0.249		0.172	
Panel B: FX exposures						
FCD	−0.1498*	(0.063)	−0.1558**	(0.022)	−0.167	(0.915)
Firm size	−0.4228	(0.215)	−0.0736***	(0.000)	−0.065	(0.970)
Leverage	−0.0315	(0.682)	0.0505	(0.952)	−0.092*	(0.058)
FORSALES	−0.241	(0.177)	−0.0323	(0.763)	−0.0514	(0.111)
DEPOSITSTOGDP	−0.100	(0.102)	0.0605	(0.358)	0.0114	(0.366)
Rule of law	0.1592	(0.111)	−0.161**	(0.036)	−0.146	(0.328)
Intercept	−108.4	(0.369)	−11.398**	(0.024)	−5.136***	(0.002)
Other control variables	Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
Kleibergen-Paap Wald rk *F* statistic	121.54		141.79		127.13	
Kleibergen-Paap rk LM statistic (*p*-value)	0.0039		0.0071		0.0423	
No of observations	1,025		1,173		243	
R^2	−0.167		−23.611		−0.112	
Panel C: IR exposures						
IRD	−0.125**	(0.033)	−0.1667**	(0.043)	−0.0910***	(0.000)
Firm size	−0.0707	(0.256)	−1.225**	(0.025)	−0.0462	(0.110)
Leverage	−0.0258	(0.154)	−0.0356**	(0.029)	−0.0119*	(0.061)
FORSALES	0.0184	(0.495)	−0.0107	(0.263)	−0.0170	(0.473)
DEPOSITSTOGDP	−0.0404**	(0.020)	−0.0471**	(0.041)	−0.0315	(0.249)
Rule of law	−0.279***	(0.009)	−1.750	(0.245)	0.280	(0.366)
Intercept	−1.185	(0.193)	−12.43	(0.162)	3.418***	(0.000)
Other control variables	Yes		Yes		Yes	
Country dummies	Yes		Yes		Yes	
Industry dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
Kleibergen-Paap Wald rk *F* statistic	142.23		55.71		122.09	
Kleibergen-Paap rk LM statistic (*p*-value)	0.0061		0.0308		0.0002	
No of observations	426		1,853		238	
R^2	0.218		−0.306		0.337	

Notes: DER is the notional value of any derivative contracts in thousand US$ scaled by total assets. FCD is the notional value of foreign currency derivatives in thousand US$ scaled by total assets. IRD is the notional value of interest rate derivatives in thousand US$ scaled by total assets. This table presents the impacts of derivatives use on exposures across domestic firms, domestic MNCs and foreign affiliates from instrumental variable models (IV) split up with regard to exposure to country risks, exchange rate and interest rate risks. The dependent variable are absolute values of exposures to country risks $|\widehat{\beta}_{2ijt}|$ (panel A), exchange rate risks $|\widehat{\beta}_{3ijt}|$ (panel B) and interest rate risks $|\widehat{\beta}_{4ijt}|$ (panel C). All other independent variables definitions are reported in Table VI. Standard errors are clustered by country to control for heteroscedasticity and serial correlation. *p*-values are in parentheses. *,**,***Significant 10, 5 and 1 percent levels, respectively

Table VI.
Instrumental variable (IV) model

Despite our significant contributions to the growing body of research on derivatives use and exposures, this research has several limitations.

First, we measure exposures, especially exposure to country risks, by applying the market model augmented by Jorion (1990). Although the market model is the most commonly used approach to estimate exposure to exchange rates in the existing literature, this measurement is relatively subjective, so more research may be needed in the future to develop a model to measure the proper exposure to country risks. For example, we could build a model that controls for the relationship between the return of firms and a few country-level institutional factors.

Second, we estimate the derivative intensity by using the notional value of derivatives contracts held by each firm because in previous studies, sample firms have not been required to report detailed information on specific positions of notional holdings. Although total notional value effectively measures derivative ownership, more detail on how firms actually use derivatives would be helpful. For example, a firm might state that it uses a certain amount of money for foreign currency hedging. If so, it would be interesting to know if this is actually related to transfer pricing or to other motives. If data are available, future research should address these issues not only in the context of countries from Southeast Asia but also for other groups of countries.

Third, while the number of sample foreign affiliates we studied identifies the effects of derivatives use on exposures relatively well, a study of a larger number of firms could provide further evidence on that effect. Thus, a potential direction for future research could cover a broader range of foreign affiliates in a wider range of countries, which will allow researchers to further explore the differences in the effect between foreign-owned firms and domestically owned firms.

Notes

1. According to the annual survey of the Future Industry Association, in 2014, the derivative trading volume of those firms account for about one-third of global volume.
2. A firm is subject to exposure to market risks if changes in market prices or indices, such as exchange rates and interest rates, negatively influence that firm's future cash flows and, ultimately, firm value.
3. Political risk is the risk that a government will unexpectedly change the rules of games under which firms operate. Financial risks can be defined as unexpected events in a country's financial and economic situation, and it is determined by financial and economic factors, many of which are interrelated with political risk (Butler, 2008, p. 285).
4. FSAs are benefits and strengths specific to a firm as compared to rivals, such as management and administrative knowledge, know-how, marketing and innovation (Rugman, 1981).
5. For example, financial reporting could be structured conforming to the home country's law and codes or by the parent company in order to have consistency across subsidiaries in different countries, although the law and regulations in host countries may not warrant them, thereby increasing governance and monitoring costs associated with hedging exchange rate exposure, especially translation exposure.
6. http://quote.morningstar.com/stock-filing/Annual-Report/
7. According to the annual survey of the Future Industry Association in 2015, the trading volume in Asia-Pacific is $7.25 billion, accounting for about one-third of global trading volume.
8. The market model is developed by Adler and Dumas (1984) and augmented by Jorion (1990).
9. Daily and weekly data are noisier and usually afflicted by non-synchroneity problems (Allayannis and Ofek, 2001).

10. In the multivariate tests, we use absolute rather than actual estimated exposures because the sign of exposures measures only the direction of risk exposures, while the magnitude of exposures are more important (Faff and Marshall, 2005).

11. Although the regression results from both fixed effect and random effect specifications are comparable, Hausman's (1978) test shows a preference for the random effect model over the fixed effect model.

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