The world price of tail risk

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July 31, 2017

Abstract

We examine the pricing of co-tail risk, or tail risk arising from the co-movement in lower left-tail distribution of stock and market returns, for 43,000 stocks from 46 countries during 1995 and 2013. We decompose global co-tail risk into non-local global, U.S. market-related, and non-U.S. global components and find that all these risks as well as local market-related co-tail risk are independently priced after controlling for stock characteristics. The pricing is stronger in countries with well-developed fund industry, large presence of foreign investors, and less restrictions on capital flows, reflecting large demand for hedging co-tail risks in more open countries.

Keywords: tail risk, left-tail, international stock markets

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We thank Yongho Cheon, Robin K. Chou, Victor Jiho Son, graduate students in the spring 2017 class of Portfolio Management, Asian Finance Association Meeting of 2017, Joint Conference of Korean Finance Association of 2017 and seminar participants at Seoul National University for their helpful comments. Lee thanks the Institute of Management Research and the Institute of Finance and Banking at Seoul National University. Financial support from the Institute for Research in Finance and Economics of Seoul National University is gratefully acknowledged. All errors are our own.

I. Introduction

The correlation between stock returns and market returns is shown to be greater in downside than in upside in the U.S. (Ang and Chen, 2002) and in international financial market (Longin and Solnik, 2001), and it is even more so in the extreme downside in the U.S. (Ang and Chen, 2002) *Co-tail* risk arises from the co-movement of stock returns with market returns in the *extreme* downside and the risk entails a significant premium since investors' demand for hedging extreme downside risk is material. For example, returns required to compensate for bearing crash risk take up substantial portion of average stock returns (Bollerslev and Todorov, 2011) and are related to stock return predictability (Bollerslev, Todorov and Xu, 2015). Bali et al. (2014) show that hybrid-tail risk, or co-tail risk, of stock returns with market return conditional on left-tail movement of stock returns, entails both statistically and economically significant premium in the U.S. market. More recently, Chabi-yo, Ruenzi, and Weigert (2015) show that stocks that are sensitive to market crash, or stocks with large lower-tail dependence with the market, are traded at a discount in the U.S. However, studies on the pricing of tail risk have been mostly focused on the U.S. and whether similar pricing implication can be found in the global financial markets is yet to be studied.

Inconsistent with the U.S. evidence of priced downside risk (Ang, Chen and Xing, 2002), Atilgan, Bali, Demirtas and Gunaydin (2016) recently show that the risk from the downside correlation of stock returns with market returns is not priced for 51 countries around the world. Since what they examined is mere downside risk, which includes both extreme and non-extreme downside, the evidence of Atilgan et al. (2016) may imply the importance of distinguishing extreme downside risk from non-extreme or mild downside risk in international study. In this paper, we extend the issue of the pricing of extreme downside or tail risks to global financial market and investigate the cross-country variation in the pricing of tail risks. To the best of our knowledge, this is the first paper that deals with the pricing of extreme downside risk in international financial market.

By focusing on international stock market, we can investigate new dimension in the pricing of co-tail risk, which has not been examined in the previous literature: co-movement of stock returns with *global* market return in the extreme downside. Given that the progression of global financial market integration and the increased presence of global investors rendered the unconditional linkage among stock markets across countries generally stronger (Longin and Solnik, 1995; Flood and Rose, 2010; Dutt and Mihov, 2013) and raised the importance to hedge against global source of risks, it is natural to extend the examination to the inter-dependence among stock markets in the extreme downside. Therefore, we investigate in this paper whether investors request proper reward for running the risk of coincidence with lower tail of global market returns. Related to this issue, we also examine the impact of financial globalization of a country in the pricing of co-tail risks. Since global investors, who are mostly present in liberalized countries, rebalance their portfolios globally rather than locally, the pricing of co-tail risk with respect to global market shocks should be stronger in a more open economy or in an economy sufficiently integrated with global financial market than in a more closed economy. Hence, the pricing implication of the co-tail risks is a manifestation of the degree of financial market globalization of a country, revealed from lower-tail coincidence rather than from unconditional correlations. Because global market shock can affect stocks in a country through its impact on local market returns of the same country, we compute co-tail risks separately for local market return and for *non-local* global market return, which is obtained from orthogonalizing global market return against local market returns as in Jorion and Schwartz (1986).

In the next step, we investigate the role of the U.S. market in the pricing of co-tail risks. Recent experiences of financial market crash such as the collapse of the Long-Term Capital Management (LTCM) and the Subprime mortgage crisis show that U.S. market shock can be spread violently and have substantial influence on stock markets worldwide. Coupled with the fact that U.S. stocks take lion's share of world stock market[1], these crash experiences imply that

[1] According to the World Bank, the total market capitalization of stocks listed in the U.S. takes 42.20%

the global co-tail risks may be driven by the U.S. market, leaving only a marginal impact for the non-U.S. global component. Contrary to this view, Bekaert et al. (2014) recently provide empirical evidence that contagion arose largely from local factors rather than from U.S. or global factors during 2007-2009 financial crisis. It would therefore be interesting to empirically test the pricing of co-tail risks with respect to U.S. market and non-U.S. global market component, both of which are independent of one another, since the tests will provide additional evidence on the dominant role of U.S. stock market. In doing so, we further decompose non-local global market return, which is already orthogonalized to local market return, into U.S. market return and non-U.S., or U.S.-unrelated, global market returns. Based on this decomposition, we can finally evaluate the relative importance of three independent sources of lower-tail co-movement of stock returns, i.e., local market, U.S. market, and non-local & non-U.S. component of global market returns, in the pricing of extreme returns worldwide.

Overall, we ask the following research questions in this paper: Is extreme return of stocks priced globally? What specific type of tail risks are priced globally? Are stocks whose crash tends to coincide with market crash traded at a discount? Is sensitivity of stock returns to local market return in a downside properly compensated? Is global financial market sufficiently integrated such that left-tail dependence of stock returns with global market returns is properly reflected in asset prices? Is the lower-tail co-movement with the local market compensated more than that with the global financial market? What is the relative importance of co-tail risks with respect to U.S. market and those with respect to non-U.S. global component in asset pricing? Are there differences in the pricing of tail risks between emerging market and developed markets? Does degree of openness of a country influence the pricing of tail risks? These are the questions still uninvestigated in the previous research.

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of the world total stock market capitalization in 2016.

By seeking answers to these questions, we contribute to the literature in the following ways. First, we contribute to the tail risk literature by showing new and robust evidence for the pricing of tail risks in global financial market. Second, we add support to the literature on global financial market integration by documenting that correlation of stock returns with global market returns has pricing effect in the extreme downside. Third, we highlight the relative importance of local, U.S., and non-U.S. global markets in the pricing of co-tail risks. Lastly, we provide insight on the cross-country differences in the pricing of co-tail risks, emphasizing the potential role of global investors.

Our empirical tests are based on a broad sample of about 43,000 stocks from 46 countries, including both emerging markets and developed markets. We examine the pricing implication of tail risks both in cross-sectional regressions at the stock-level and in portfolio-level analysis with factor models. We first find that the co-tail risk with respect to local market returns is significantly priced worldwide. The cross-sectional regressions show that one unit increase in the co-tail risk with respect to local market returns increases monthly stock returns of 1.41% globally, 2.03% in developed markets and 0.96% in emerging markets, the magnitude of which is economically significant. The result is robust to the inclusion of other forms of tail risks and stock characteristics. Our U.S. results are consistent with those in Bali *et al*. (2014). The subsequent analyses for global co-tail risk show even stronger results in that the economic magnitude of the premium is larger than that of the co-tail risks with respect to local market return. The coefficient, or marginal premium for unit increase, of global co-tail risk in the cross-sectional regression is 3.30% for all sample countries, 3.83% and 2.85% for developed and emerging markets, respectively. Interestingly, we observe larger premium in developed markets than in emerging markets for co-tail risks with respect to both local and global market returns.

Next, to distinguish the pricing of co-tail risks with respect to local market and global market, we decompose global market returns into local and non-local global components and compute co-tail risks accordingly. Specifically, we compute local (non-local global) co-tail risk as lower tail correlation of stock return with local (non-local global) market return. Regressions with both local co-tail risk and non-local global co-tail risk show that both risks are priced globally and the results are significant for both developed markets and emerging markets. Consistent with the previous results, the economic magnitude is again larger for non-local global co-tail risks than for local co-tail risks. Further empirical evidence supports the important role of globalization of a country in explaining the cross-country differences in the pricing of co-tail risks. As expected, we find evidence that investors are highly rewarded for enduring non-local global co-tail risk in countries that are more open, using development of fund industry, investment flows held by U.S. institutions, and the degree of overall capital market restriction (Fernández et al., 2015) as country-level proxies for openness. Interestingly, co-tail risk with respect to *local* market return is also highly compensated in more open countries. That is, pricing of *both* local and non-local global co-tail risks is stronger in countries with well-developed fund industry, more U.S. institutional investors, and less capital controls. This is not surprising because global investors rebalance their portfolio upon facing extreme downside risk, be it local or global, making them to be sensitive to global as well as local market returns in an extreme downside.

In subsequent analyses, by decomposing non-local global market returns further into U.S. market-related component and the remaining component (non-local & non-U.S. component), we test the pricing of co-tail risks with respect to local market, U.S. market, and non-local & non-U.S. global markets all together. We find that, even after controlling for stock characteristics, co-tail risks from all three sources are significantly priced in overall global financial markets, developed, and emerging markets, with the coefficient being much larger for non-local & non-U.S. co-tail risk than for U.S. co-tail risk.

We mainly use bottom 10% of return distribution as a cutoff in the empirical analyses. Our choice of such tail size may be arbitrary, but is based on the trade-off between accuracy and adequacy. Large tail size helps minimize the estimation errors by allowing sufficient number of observations, whereas tail risk based on the large tail size will reflect only mild downside risk rather than extreme downside risk. We check the robustness of our results based on varying tail sizes up to 40% and find that the results are robust to alternative tail sizes. Interestingly, we find that the pricing pattern is quite different when we apply 50% tail size. That is, when co-tail risk becomes a mere downside risk with 50% tail size, the sign of the coefficient of co-tail risk from cross-sectional regressions flips and becomes negative. This sharp contrast between the pricing of tail risk and mere downside risk highlights the importance of distinguishing these two types of risks in asset pricing studies. Our results are also robust to the alternative estimation period for tail risks and to the inclusion of additional control variables beyond market beta, size, book-to-market, and illiquidity such as downside beta (Ang, Chen, and Xing, 2006), momentum (Jegadeesh and Titman, 1993), coskewness (Harvey and Siddique, 1999, 2000), idiosyncratic volatility (Ang et al. 2006, 2009), and preference for lottery-like assets (Bali, Cakici, and Whitelaw, 2011).

Lastly, we estimate abnormal return, or alpha, of investment strategies formed based on co-tail risks relative to global three- and five-factor models. The alpha based on the global five factor model is monthly 0.830% (annual 10.47%), 1.199% (annual 15.47%), and 1.455% (annual 19.08%) for portfolios based on the co-tail risk with respect to local market, U.S. market, and non-local & non-U.S. global market, respectively. Consistent with the results from the cross-sectional regressions, the pricing of global co-tail risks is generally stronger in developed markets than in emerging market.

II. Data

We compute daily stock returns from daily total return index (RI), which is adjusted for dividend payment and stock splits, from Datastream for all countries except for the U.S. Following Ince and Porter (2006) and Lee (2011), we set the daily return to be missing if the value of the total return index for either the previous or the current day is below 0.01. We also set the daily return as missing if any daily return which is greater than or equal to 100% is reversed the following day. That is, the daily returns for both days t and t-1 are set to be missing if $R_{i,t}R_{i,t-1} \leq 1.5$ and at least one of the two returns is 200% or greater, where $R_{i,t}$ is a gross return of stock i for day t. We also drop the stock-year observations if the previous year-end price is in the extreme 2.5% of either top or bottom (inclusive) of the cross-section for each country (Lee, 2011). For the U.S., we obtain data for stocks in NYSE, Amex, and Nasdaq from CRSP. Following Bali, Cakici and Whitelaw (2014), we exclude stocks for each month if month-end market capitalization is below the smallest decile of NYSE breakpoint.[2] We also discard stocks for the year whose previous year-end price is less than $5 per share.

Following Griffin, Kelly and Nardari (2010), Lee (2011), and Karolyi, Lee and van Dijk (2012), we restrict the sample to common stocks listed on the major exchanges in a country. All sample countries have a single major exchange except for Canada (Toronto Stock Exchange and TSX Venture Exchange), China (Shenzen and Shanghai Stock Exchange), Japan (Tokyo Stock Exchange and Osaka Securities Exchange), Russia (Moscow Interbank Currency Exchange (MICEX) and Russian Trading System (RTS)), Korea (Korean Stock Exchange and KOSDAQ), Taiwan (Taiwan Stock Exchange and Taiwan OTC Exchange) and the U.S. (Amex, NYSE, and Nasdaq)[3]. In addition, to maintain only the common stocks in the sample, we exclude stocks with special features such as preferred stocks, Depository Receipts (DRs), and Real Estate Investment Trusts (REITs).[4]

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[2] We thank K. French for providing the data on his website.

[3] The Japan Exchange Group (JPX) was launched on January 1, 2013, by merging the Tokyo Stock Exchange and Osaka Securities Exchange. The Korea Exchange was created on January 27, 2005, by the integration of Korea Stock Exchange, Korea Futures Exchange, and KOSDAQ. The Moscow Exchange was established on December 19, 2011, by merging the two largest Moscow-based exchanges, the Moscow Interbank Currency Exchange (MICEX) and the Russian Trading System (RTS).

[4] We drop non-common shares from the sample by applying the name filtering. For more detailed information, refer to the footnote 5 of Lee (2011) and the footnote 3 of Karolyi, Lee, and van Dijk (2012).

Our final sample includes 42,567 stocks from 46 countries during January 1995 to December 2013. Following International Finance Corporation of the World Bank Group, we classify 22 sample countries as developed countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, the U.K., and the U.S.) and 24 countries as emerging market countries (Argentina, Brazil, Chile, China, Greece, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Portugal, Russia, South Africa, South Korea, Sri Lanka, Taiwan, Thailand, Turkey, and Venezuela).

Similarly to daily return computation, we construct monthly stock returns by using the month-end total return index from the screened daily data files of Datastream for all countries except for the U.S., for which we use CRSP data. For monthly returns, we drop stock-month observations if $R_{i,t}R_{i,t-1}\leq 1.5$ and either one of the two returns is 300% or greater, where $R_{i,t}$ is the gross return for month t (Ince and Porter, 2006). Due to concerns on the stock splits, mergers, and potential data errors (Lee, 2011), we also drop monthly returns of the extreme 0.1% (inclusive) at either the top or the bottom of the cross-section for each country. After all these screening, stocks that have at least 12 months of data from 1995 to 2013 are included in the sample.

Monthly market capitalization and book-to-market ratio are obtained from Datastream for sample countries other than the U.S. For the U.S., monthly stock return, market capitalization and book-to-market ratio are calculated from CRSP monthly file and COMPUSTAT.

III. Co-tail risk

The limitation of statistical variance as a measure of risk has been highlighted in that the variance does not distinguish losses from gains. To overcome this limitation, Markowitz (1959) introduced as a more appropriate measure of risk the notion of semi-variance, or lower partial moment, which estimates the variance of *losses* relative to a pre-specified reference point. Along this line of research, Bali, Cakici and Whitelaw (2014) propose that three different types of the lower partial moment contribute to the tail risk of the overall portfolio position when investors have concentraded stock holdings as well as a well-diversified portfolio.[5] The first is stock-specific tail risk, directly motivated by the lower partial moment or the variance of stock returns in a loss region, proposed by Markowitz (1959). Since the large fluctuation of returns in the loss region poses greater possibility of crash indicating greater tail risk, we define lower semi-variance (*LSV*) of stock return as a measure of stock-specific tail risk:

$$LSV_i = \sum_{R_i < k_i} (R_i - k_i)^2 \quad (1)$$

k_i is the pre-specified reference level of return for stock i, R_i. Restricting the domain to lower regions below the reference level, the *LSV* measures the risk of losses relative to the reference point. This contrasts with variance which treats gains and losses symmetrically.

The other two measures of tail risks are based on the conditional covariance of stock and market returns. If a stock return co-varies much with market return in an extreme down market, the stock is more likely to crash when the market experiences strong negative shock. Therefore, we measure the tail risk, or co-tail risk (*CTR*), as a lower partial moment of covariance conditional on left-tail distribution of local market return, R_L, relative to the reference point of k_L:

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5 Concentrated stock ownership together with well-diversified funds are common in the U.S. and frequently reported in the media: "Households directly own 38 percent of the US equity market… the total effective household ownership is closer to 80 percent when combined with indirect ownership in the form of mutual funds (20 percent), pension funds (16 percent), and insurance policy holdings (7 percent)." ("Here's who owns the stock market," *Business Insider*, March 13, 2013). Polkovnichenko (2005) shows that U.S. households invest in both well-diversified and under-diversified assets and provides theoretical justification for such holdings based on rank-dependent preferences. Van Nieuwerburgh and Veldkamp (2010) provide theoretical framework for investing in diversified fund and an under-diversified set of stocks by analyzing the interplay between information acquisition decision and investment decision when information acquisition is costly. Turning to asset holdings outside of the U.S., Ynesta (2008) show that households in 25 OECD countries hold their financial assets in the form of currency and deposits, equity, mutual funds, life insurance and pension funds over 1995-2006. For example, households in Australia, Netherlands, Switzerland, Norway, and Sweden held 53%, 48%, 34%, 28%, and 21%, respectively, of their financial assets in pension funds in 2006. The ratio of mutual fund holdings relative to total financial assets varies across sample countries with Belgium having the highest ratio of 16.7%, followed by the U.S. (13.5%), Austria (12.4%), Spain (12.1%), Sweden (12.0%), and Germany (11.6%) in 2006.

$$CTR\_M_i^L = \sum_{R_L<k_L}(R_i - k_L)(R_L - k_L) \quad (2)$$

We use the local market index from Datastream for each sample country.

The third measure is the tail risk associated with the co-movement of stock and market returns conditional on sufficiently negative stock return.

$$CTR\_I_i^L = \sum_{R_i<k_i}(R_i - k_i)(R_L - k_L). \quad (3)$$

Since under-diversified stock positions are generally more volatile than the diversified portfolios, tail events for the overall position of portfolio of stocks and diversified funds will coincide more with the tail events of stocks than with the tail events of diversified portfolios. Hence, *CTR_I* is the co-tail risk conditional on stock return rather than local market return.

In our international setting, we can investigate the additional dimension of the two co-tail risks, which arises from the co-movement of stock returns with global market return in the extreme downside. Although previous studies showed the trend of increasing unconditional linkage among stock markets across countries (Longin and Solnik, 1995; Flood and Rose, 2010; Dutt and Mihov, 2013), we still do not have empirical evidence on the linkage among stock markets in the extreme downside and its pricing implication. Therefore, we employ two kinds of market index returns to compute co-tail risks: local market index and the global market index. Accordingly, we compute the two co-tail risks in Eqs. (2) and (3) with respect to a global market return, R_G with a reference point of k_G.

$$CTR\_M_i^G = \sum_{R_G<k_G}(R_i - k_G)(R_G - k_G) \quad (4)$$

$$CTR\_I_i^G = \sum_{R_i<k_i}(R_i - k_i)(R_G - k_G). \quad (5)$$

We use the global market index from Datastream. As in Bali et al. (2014), we normalize the co-tail risk measures of CTR_M^L and CTR_M^G by dividing them with conditional semi-variance of local market return, $\sum_{R_L<k_L}(R_L - k_L)^2$, similar to market beta. We compute all these tail risk measures for each month for each firm using daily returns over the past six months. To enhance

the reliability of measures, we do not estimate the tail risk for month *t*, if the number of daily observations in the lower 10% cutoff is less than five in the estimation period from month *t*-6 to *t*-1. For all tail risk measures introduced above, we set 10th percentile as a reference value for both stock and market returns. We show that our empirical results are robust to an alternative choice of reference values and the estimation period in the robustness tests later.

[INSERT TABLE 1 HERE]

Table 1 reports the number of stocks, sample beginning-year and the summary statistics of tail risk measures and monthly stock returns. The number of stocks in the sample varies across countries and years. The total number of sample stocks is 42,567. The U.S. has the largest number of stocks of 8,992, and Luxembourg has the smallest coverage of only 20 stocks. The starting year of sample is 1995 for all sample countries except for Ireland, Luxembourg, and Russia for which data is available from 2000, 1999, and 1998, respectively.

The next five columns report averages of tail risk measures. The two columns on the left under the label "Local" are for co-tail risks with respect to local market returns, while the two columns labeled "Global' are for co-tail risk measures with respect to global market return. The column LSV indicates the stock-specific tail risk as specified in Eq. (1). We first see that the average CTR_I is negative for many sample countries, both for local and global, whereas average CTR_M is mostly positive. The negative CTR_I indicates that extreme down movement of stock returns frequently occurs even when the market return, both local and global, is not in the extreme downside. However, the positive value of average CTR_M shows that crash in stock returns is likely when the market is in the extreme downside. CTR_I^L ranges from -0.322 of Canada to -0.033 of Spain for developed markets and from -0.181 of China to 1.109 of Venezuela for emerging markets. The local co-tail risk of CTR_I^L is generally greater in absolute terms in developed -market countries than in emerging-market countries. The global co-tail risk of CTR_I^G ranges from -0.257 (Canada) to -0.056 (Italy) for developed markets, and from -0.251 (Venezuela) to -0.032 (Mexico) for emerging markets. The absolute value of average global co-tail risk, CTR_I^G, is slightly larger in emerging-market countries than in developed-market countries. The magnitude of co-tail risks conditioning on market returns' loss region, CTR_M^L and CTR_M^G, is generally greater than that of CTR_I^L and CTR_I^G, respectively. The stock-specific tail risk of LSV ranges from 0.387 of Luxembourg to 2.951 of Canada for developed markets, and from 0.440 of Taiwan to 3.050 of Venezuela for emerging markets.

The last two columns of Table 1 show averages of the cross-sectional averages of monthly returns and the cross-sectional averages of the standard deviation of stock returns. The figures are in percentage and computed on the basis of U.S. dollar. The average of the returns shown in the table ranges from -1.13% to 1.03% for developed markets and from -0.43% to 1.00% for emerging markets. The standard deviations are generally larger in emerging-market countries than in developed-market countries. The standard deviations of returns exceed 15% for 12 emerging-market countries and for 5 developed-market countries.

[INSERT TABLE 2 HERE]

Table 2 reports averages of tail risk measures across countries for each of the portfolios based on firm size. In forming size portfolios, a stock is sorted every year into deciles based on its previous year-end market capitalization in each country. Then, the decile ranks are linked across countries to form equally-weighted country-neutral portfolios. The two columns on the left under the label "Local" are for co-tail risks with respect to local market returns, while the two columns labeled "Global" are for co-tail risk measures with respect to global market return. The column LSV indicates the stock-specific tail risk as specified in Eq. (1).

CTR_I^L increases monotonically from negative -0.263 for the smallest portfolio to positive 0.177 for the largest portfolio in the overall sample, indicating lower tail co-movement with the local market return is larger for large firms than for small firms (panel A). The global co-tail risk of CTR_I^G also grows monotonically from -0.240 to -0.052 across size deciles in the same panel. We observe this monotonic pattern not only in the overall sample countries (panel A), but also in the developed- and emerging-market categories (panels B and C). The co-tail risks conditioning on market returns, CTR_M^L and CTR_M^G, are generally positive and also vary monotonically by firm size. Given market turmoil, either local or global, large stocks are much more likely to experience turmoil than small stocks are. Interestingly, CTR_M^G is generally larger than CTR_M^L in developed market, while the latter is larger than the former in emerging market countries. This pattern implies that stocks in developed (emerging) countries are more sensitive to global (local) market turmoil in the lower-tail movement, reflecting the different degree of exposure to global market shock between developed and emerging markets. The stock-specific tail risk measure of *LSV* monotonically decreases from 2.561 for the smallest portfolio to 0.737 for the largest portfolio in the overall sample (panel A). This monotonic relation for *LSV* is also observed in the developed- and emerging-market categories (panels B and C), but not in the U.S. (panel D). The pattern implies that small stocks are generally riskier than large stocks in terms of extreme downside return fluctuation.

IV. The world price of tail risk

In this section, we examine the pricing of tail risks in a cross-sectional regression framework. Specifically, we test the pricing of co-tail risks with respect to local market, global market and the U.S. market by decomposing global market returns into non-local global and non-local & non-US global component. We also examine the cross-country differences in the pricing of co-tail risks in this section.

4.1. The pricing of tail risks

In this section, we perform the first set of tests. We consider co-tail risks with respect to local market and those with respect to global market separately under the assumption that world financial markets are fully segmented and fully integrated, respectively.

[INSERT TABLE 3 HERE]

Table 3 shows time series averages of the estimated coefficients in Fama-MacBeth type cross-sectional regressions over all sample countries, developed markets, emerging markets, and the U.S. in separate panels. The regressions are performed with country dummies as well as stock characteristics such as market beta (BETA; obtained from a regression of daily returns on local market returns over the past one year), log of previous year-end market capitalization in U.S. dollar (SIZE), previous year-end book-to-market ratio (BM), and previous-year average of daily illiquidity from Amihud (2002) (ILLIQ). The cross-sectional regressions show that CTR_I^L is significantly priced in all specifications and in all regions in the table. The coefficient on CTR_I^L is positive (1.409) and highly significant at 1% level with a *t*-value of 11.11 in overall sample countries. The coefficient for CTR_I^L is almost twice as big in the developed markets as in the emerging markets, with a coefficient being 2.025 (*t*-value of 11.82) in the developed markets and 0.959 (*t*-value of 8.07) in the emerging markets. The significance is also maintained in the regression including other tail risk measures and control variables.[6] While the pricing of co-tail risk conditional on lower-tail movement of stock return, CTR_I^L, is highly significant,

[6] We show that the results are robust to the inclusion of additional stock characteristics such as downside beta, momentum, co-skewness, idiosyncratic volatility and price jump (MAX) in the robustness tests.

other forms of tail risks are not significant or significant with an unexpected sign in the table. For example, the coefficient on CTR_M^L is insignificant in all panels. The negative value of the coefficient is puzzling since it indicates that stocks that tend to collapse in a market crash are traded at a lower return or at higher price. The coefficient of idiosyncratic tail risk, *LSV*, is significant but negative, implying that stocks with high crash risk tend to be traded at a higher, not lower, price. The pattern is consistent across all regions considered in the table. Overall, the exercises in this section show that CTR_I^L is significantly priced while other tail risk measures are either insignificant or significant with an unexpected sign. These results are consistent with the U.S. results of Bali et al. (2014). Next, based on the assumption of fully integrated world stock markets, in which only global market return matters while local market returns do not, we examine the pricing implication of tail risks with respect to global market returns. These analyses may provide new evidence on the integration of global stock markets from the perspective of tail risk.

[INSERT TABLE 4 HERE]

Table 4 shows the results from the cross-sectional regressions with country dummies and stock characteristics using global tail risk measures. Since the pricing implication of idiosyncratic tail risk, *LSV*, is not affected by the assumption of the degree of financial integration, results for *LSV* are the same with that in Table 3, and hence, we drop the specification with only *LSV* among three tail risk measures in the table. We see that CRT_I^G is highly significant and positive in all specifications and in all panels in the table. CTR_I^G is significantly priced with a coefficient of 3.826 and a *t*-value of 13.01 in the developed markets (panel B) and with a coefficient of 2.849 and a *t*-value of 9.01 in the emerging markets (panel C), indicating that the premium for global co-tail risk is greater in the developed markets than in the emerging markets. In the U.S. (panel D), CTR_I^G is also priced with a coefficient of 1.174 and a *t*-value of 2.24. While the pricing of

CTR_I^G is universal and robust to the inclusion of other tail risk measures and control variables, CTR_M^G is not priced or priced with a wrong sign.

Interestingly, the magnitude of the premium for CTR_I^G is roughly more than twice the magnitude of its local market counterpart, CTR_I^L. For example, in panel A, the coefficient on CTR_I^G is 3.301 (*t*-value of 11.75), which is much bigger than 1.409 for CTR_I^L in Table 3. This phenomenon is also found in both developed and emerging markets (panels B and C). The higher premium for global co-tail risk than for local co-tail risk implies the important role of the presence of global investors in the pricing of extreme downside risk. The difference in the magnitude of the coefficient for local and global co-tail risks, however, is not that large in the U.S. market (panel D), the finding of which may reflect the significant role of U.S. market in global financial market. We will re-visit the issue of relative importance of co-tail risks with respect to local, global, and U.S. market and the differences in the pricing of the risks across countries in the section below.

4.2. Local vs. global co-tail risks

If world financial markets are mildly integrated, lying somewhere in-between full segmentation and full integration, co-tail risks with respect to both local and global markets may have an impact on asset pricing.[7] In this section, we examine the pricing of local and global tail risk measures in a cross-sectional regression framework. Given the significance in the pricing of tail risks shown

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[7] Emphasizing "decoupling" of emerging market countries from developed countries, the *Economist* wrote: "… surprisingly, economic activity in emerging economies has diverged (or decoupled) from that of developed economies over the past two decades. The impact of rich economies on emerging economies' growth has fallen sharply" since "… perhaps the first time ever, developing countries would be able to make full use of monetary and fiscal policy to cushion their economies" thanks to ample amount of foreign reserves, which has been accumulated from current account surplus ("The decoupling debate," Mar 6, 2008, *Economist*).

in the previous empirical analyses, we focus only on the co-tail risk of *CTR_I* from this section on.

It is possible that global market affects stock returns through its impact on local market return. Therefore, we decompose a global factor into two groups to differentiate the local market from the rest of the world: local market return and the "non-local global" market return, which is net of local market return. We obtain the non-local global market return in a manner similar to Jorion and Schwartz (1986) and Lee (2011). Specifically, we obtain the non-local global market return, R_{G-L}, by taking the residuals from the regression of global market return on local market return of each country. We compute the co-tail risk measure with respect to this orthogonalized non-local global market return:

$$CTR\_I_i^{G-L} = \sum_{R_i<k_i}(R_i - k_i)(R_{G-L} - k_{G-L}). \quad (6)$$

By distinguishing the local and non-local global component of global market returns, we can now test the relative importance of co-tail risks with respect to local market and the global market in multivariate regressions.

[INSERT TABLE 5 HERE]

Table 5 shows the results from the cross-sectional regressions of stock returns on local and non-local global co-tail risk measures together with stock characteristics and country dummies. We see that both local and non-local global *CTR_Is* significantly affect the expected returns at the 1% level in the overall world market (panel A), developed market (panel B) and emerging market (panel C). The magnitude of the coefficient on non-local global co-tail risk is much bigger than that on local co-tail risk. For example, the magnitude is almost five times bigger for non-local global co-tail risk in the overall countries, and nearly three times bigger in developed markets. The magnitude of the coefficient of non-local global co-tail risk is relatively small in the emerging market, but non-local component is more than three times larger than the local component in the regression with control variables of market beta, firm size, book-to-market ratio, and illiquidity. These findings imply that investors seek significant compensation for holding stocks whose return tends to plummet together with global and local market returns.

4.3. Cross-country differences in the pricing of co-tail risks

In this section, we examine country characteristics that contribute to the differences in the pricing of co-tail risks. Since global investors, who are mostly present in countries with less restriction on capital flows, rebalance their portfolios globally rather than locally, the pricing of co-tail risk with respect to global market shocks should be stronger in an open economy than in a closed economy. Specifically, to examine the roll of global investors in the cross-country differences, we focus on the country-level proxies for the degree of development of fund industry, openness of financial market to foreign investors, and the restriction on international capital flow.

According to Bali et al. (2014), the co-tail risk, or in their words the "hybrid tail risk," is more important when investors hold both individual equity and well-diversified portfolios, i.e. mutual funds or ETFs. Therefore, we predict that the pricing of co-tail risks would be stronger for countries with well-developed fund industry since investors are more likely to hold well-diversified portfolios. We employ a country's fund industry size scaled by GDP as a measure of the development of fund industry. We use equity mutual funds' assets under management as of 2002 (Khorana, Servaes, and Tufano, 2005).

We also posit that the presence of global investors in the market contributes to the relative importance of co-tail risks with respect to global and local markets. In this regard, we employ two measures of cross-border investment flows. One is the amount of stocks in a country held by U.S. institutions (Ferreira and Matos, 2008) and the other measure is the overall capital restrictions index of a country for all asset categories (Fernández et al., 2015). The higher values of capital restriction index indicate higher restrictions, thus less presence of global investors in the market.

[INSERT TABLE 6 HERE]

To see the effect of these country-level characteristics on pricing of local and global co-tail risks, we include co-tail risk measures interacted with the country-level proxies in the cross-sectional regressions. Consistent with our expectation, Table 6 shows that the pricing of co-tail risks with respect to global market return is stronger in countries that are more open than in countries that are more closed. The non-local global co-tail risk of CTR_I^{G-L} is significantly priced in countries with well-developed fund industry, a large amount of stocks held by U.S. institutions, and low restriction on international capital flows. Interestingly, co-tail risk with respect to local market return is also shown to be stronger in more open countries. That is, we find that the pricing of both local and non-local global co-tail risks is stronger in countries with well-developed fund industry, more U.S. institutional investors, and less capital controls. This is not surprising in that global investors rebalance their portfolio globally upon facing extreme downside risk, either locally or globally, making them to be sensitive to global as well as local market returns in an extreme downside.

4.4. Further decomposition of non-local global co-tail risk: U.S. vs. Non-U.S. global

The U.S. stock market, the largest stock market in terms of total market capitalization, is possibly the most influential one among many stock markets around the world. According to the World Bank, the ratio of total market capitalization of stocks listed in the U.S. and the world total stock market capitalization has been around 40% since 1995 – it was 39.72% in 1995, peaked at 50.02% in 2001, and was 42.20% in 2016. Recent experiences of financial market crash such as the collapse of the Long-Term Capital Management (LTCM) and the Subprime mortgage crisis show that U.S. market shock can be spread globally and violently, implying the possibility that the global co-tail risks are driven mostly by the U.S. market, leaving only a marginal impact on the non-U.S. global component. On the other hand, calling the dominant role of U.S. market in the world economy into question, Bekaert et al. (2014) recently provide empirical evidence that sharply contrasts to the dominant role of U.S. stock market in global financial markets. Based on the sample of 415 country-industry portfolios around the world, they show that contagion, or correlation of country-sector portfolio returns, arises largely from local factors rather than from U.S. or global factors during 2007-2009 financial crisis. Interestingly, they find no supporting evidence for the critical role of local factors in the contagion in the crisis events of LTCM meltdown or IT bubble burst. It would therefore be interesting to empirically test the pricing of co-tail risks with respect to local, U.S. market-related, and other global market component, since the tests will provide additional evidence on the role of U.S. market in global economy. In this section, we compare the pricing of co-tail risks with respect to the U.S. market with the pricing of co-tail risks with respect to global market return that is independent of both local and U.S. factors.

To differentiate the U.S. market from the rest of the world, we decompose non-local global market return into two groups: U.S. market return and the "non-local & non-US global" return, which is net of both local and U.S. market return. The non-local & non-US global return, $R_{(G-L)-US}$, is obtained as the residuals from the regression of non-local global returns on the U.S. market return. We compute co-tail risks with respect to the U.S. market return (R_{US}) and to the non-local & non-US global market return ($R_{(G-L)-US}$) to test the relative importance of U.S. market and the rest of the global market in the pricing of co-tail risks.

$$CTR\_I_i^{US} = \sum_{R_i<k_i}(R_i - k_i)(R_{US} - k_{US}) \quad (7)$$

$$CTR\_I_i^{(G-L)-US} = \sum_{R_i<k_i}(R_i - k_i)\big(R_{(G-L)-US} - k_{(G-L)-US}\big) \quad (8)$$

[INSERT TABLE 7 HERE]

Table 7 reports the results from the cross-sectional regressions with country dummies. We see that both U.S. and non-local & non-US global co-tail risks significantly affect the expected returns. In the overall world market (panel A), CTR_I^{US} ($CTR\_I^{(G-L)-US}$) is priced at the 1% significance level with a coefficient of 1.168 (3.796). Both co-tail risks are also significant in both developed markets and emerging markets. The results are also robust to the inclusion of control variables. The findings provide supporting evidence on the critical role of U.S. market and non-U.S. global market by showing that global investors request compensation for bearing co-tail risk that arises from the lower partial co-movement of stock returns with both U.S. and non-U.S. global market component.

4.5. Robustness tests

So far, we compute tail risk measures using the 10% cutoff of the relevant return distributions over the preceding six months. We admit that the choice of 10% tail size and the estimation period of six months is somewhat arbitrary. The choice of tail size or the reference value entails a trade-off. Large tail size helps minimize the estimation errors by allowing a sufficient number of observations, but the "tail" defined with large tail size will reflect only mild downside risk at best, rather than extreme downside risk. In this section, to check the robustness of our previous empirical results, we estimate *CTR_I* using different tail sizes from 5th to 50th percentile of the daily return distribution over the past one year, rather than six months. We have similar robust results for varying tail sizes with the estimation period of past six months (untabulated).

[INSERT TABLE 8 HERE]

Table 8 shows the average of coefficient on a co-tail risk measure in a cross-sectional regression of stock returns on three co-tail risk measures of CTR_I^{L}, CTR_I^{US}, and $CTR\_I^{(G\text{-}L)\text{-}US}$ with alternative choices of tail size along with the control variables (BETA, SIZE, BM, and ILLIQ) and country dummies. The results for control variables are not tabulated for brevity. We see that the pricing of co-tail risks, both local and global (i.e., U.S. and non-local & non-US global), is generally robust up to 40% cutoff points. For *CTR_I*, the coefficient peaks at 5% tail and decreases as tail size increases, reflecting significant pricing impact of extreme, rather than mild, downside risk. We also see the similar pattern for other co-tail risk measures. The results in this table show that the pricing of local and global co-tail measures is not sensitive to the choice of tail size. Interestingly, the pricing pattern is quite different for 50% tail size from other tail sizes for all co-tail risk measures in the table. For example, when we choose 50% as a tail size, all three *CTR_I*s become a mere downside risk rather than tail risk measure, and the coefficient becomes negative, contrasting to all other cases. This should not be surprising because the co-tail risks are measured to capture extreme downside co-movement of returns, rather than mild downside risk. This sharp contrast in the pricing implication between tail risk and downside risk shows the importance of distinguishing these two types of risks in asset pricing studies, as we do in this paper.

As a further robustness check, we include additional control variables in the regressions. The variables are downside beta, momentum, coskewness, idiosyncratic volatility, and preference for lottery-like assets. The downside beta (DBETA) is obtained from the regression of daily stock excess returns on local market excess return over the past one year, conditioning on the market excess returns below its average (Ang, Chen, and Xing 2006). The momentum (MOM) is calculated as the 6-month cumulative return from month t-7 to t-2 (Jegadeesh and Titman1993).

The coskewness (COSKEW) is calculated as the expected value of the product between deviation of individual stock return from its mean and the squared deviation of market return from its mean, divided by the product between the standard deviation of individual stock return and the variance of market return over the past one year (Harvey and Siddique, 1999, 2000). The idiosyncratic volatility (IVOL) is the standard deviation of regression residuals, where daily stock returns are regressed on the Fama-French three factor model over the past one month (Ang et al., 2006, 2009). The preference for lottery-like assets is measured by the maximum daily return (MAX) within the past one month (Bali, Cakici, and Whitelaw, 2011; Cheon and Lee, 2017).

[INSERT TABLE 9 HERE]

Table 9 reports the cross-sectional regressions that include co-tail risk measures and the additional control variables. In all specifications including additional control variables, we see that the co-tail risks remain economically and statistically significant.

V. Asset pricing of co-tail risk: Factor model regression

We now examine how much trading alpha, or risk-adjusted return, can be generated by trading on local and global co-tail risks. Using stocks from all sample countries other than the U.S., we run factor model regressions for co-tail risks that were priced in the preceding sections. In the factor model analysis, we use 41 sample countries after excluding four additional countries of Ireland, Luxembourg, Hungary, and Venezuela, for which the annual average of the number of stocks is less than 50.

In each month *t*, a stock is ranked into deciles in a given country on the basis of *CTR_I*. Subsequently, we combine stocks with the same rank to form ten equally-weighted portfolios across countries in the regions specified in the table. Each portfolio return (in U.S. dollars) in excess of the risk-free rate is regressed in a factor model framework. We test two global factor models: Global three factor model (Eq. 9), and Global five factor model (Eq. 10) as specified below.

$$R_{p,t} - R_{f,t} = \alpha_p^3 + \beta_p^{G,3}\left(R_{G,t} - R_{f,t}\right) + \beta_p^{S,3} SMB_t + \beta_p^{H,3} HML_t + \varepsilon_{p,t}^3 \quad (9)$$

$$R_{p,t} - R_{f,t} = \alpha_p^5 + \beta_p^{G,5}\left(R_{G,t} - R_{f,t}\right) + \beta_p^{S,5} SMB_t$$

$$+\beta_p^{H,5} HML_t + \beta_p^{R,5} RMW_t + \beta_p^{C,5} CMA_t + \varepsilon_{p,t}^5 \quad (10)$$

The global factors of SMB (small cap minus big), HML (high book-to-market minus low), RMW (robust operating profitability minus weak), and CMA (conservative investment minus aggressive) are developed by Fama and French (1993, 2015) and are obtained from K. French's website.

[INSERT TABLE 10 HERE]

Table 10 shows the estimated intercepts with the *t*-values in italics from the regression of each of the 10 portfolios that are formed based on global co-tail risk (panel A), co-tail risk with respect to the U.S. market (panel B), and non-local & non-US global co-tail risk (panel C). Rows labeled "Global three-factor alpha", and "Global five-factor alpha" indicate the intercepts from the models in Eqs. (9)-(10), respectively. The last column of the table (labeled "High–Low") shows the difference in the estimated intercepts or alpha that are obtained by longing portfolios with the highest co-tail risk (High) and shorting those with the lowest co-tail risk (Low).

Panel A of Table 10 shows the intercepts of portfolios based on global co-tail risk, CTR_I^L. In all countries other than the U.S. (panel A), the alpha of the High–Low portfolio produces significant monthly abnormal return of 0.894% and 0.830% relative to the three-factor model and the five-factor model, respectively. On an annual basis, these returns are 11.32% and 10.47%, respectively, both of which are highly significant economically. In developed (emerging) markets, the alpha of the High–Low portfolio is 1.417% (0.438%) for the three-factor model and 1.292% (0.428%) for the five-factor model. All alphas are highly significant both statistically and economically. The higher alpha for the developed markets than for emerging markets is consistent with the cross-sectional regressions, which show larger coefficient on co-tail risks in the developed markets.

In panel B, portfolios are formed based on the CTR_I with respect to U.S. market return, CTR_I^{US}. The High–Low spread alpha is 1.199% over all countries in the five-factor model, and it is highly significant at the 1% level (t-value of 10.25). Consistent with the preceding results, alpha of the High–Low portfolio based on the five-factor model is 1.629% and 0.826% for developed and emerging markets, respectively, and is highly significant at the conventional 1% level.

Regarding global co-tail risk with respect to non-local & non-US factors (panel C), a significant High–Low spread alpha of 1.455% arises from the five-factor model, which is significant at the 1% level and also significant economically. The alphas are also highly significant for both developed and emerging market samples.

Overall, a factor model regression framework provides supporting evidence for the pricing of co-tail risks by showing that trading based on co-tail risks with respect to local market, U.S. market, and non-local & non-US global generates substantial abnormal returns that are both statistically and economically significant. The trading alphas from the developed markets are larger than the alphas from emerging markets, the finding of which may highlight the role of global investors in the pricing of global co-tail risks.

VI. Conclusion

In this paper, we examine whether tail risk is priced in global financial markets. We find that co-tail risks, which are defined as lower semi-covariance of stock returns and market returns conditional on downside movement of stock return, is priced with statistical and economical significance in world financial markets. The co-tail risks with respect to local market return, U.S. market return, and non-U.S. & non-local component of global returns are all significantly and independently priced. The pricing is robust to the choice of tail size, to the alternative estimation period, to the inclusion of stock characteristics, and to the empirical methodologies – cross-sectional regression and factor model regressions. The pricing of co-tail risks, both from local and global market returns, is stronger in developed market countries and in countries with well-established fund industry, large presence of foreign investors, and less restrictions on capital flows, implying that the presence of global investors is important in the pricing of co-tail risks.

Extending our finding that unconditional premium for co-tail risks is substantial in global financial market, we believe that it will be an interesting topic to pursue for future research to examine the time variation of the tail risk premium.

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Table 1. The summary statistics of tail risk measures and returns by country.
The table shows the number of stocks and tail risk measures by country, the averages of the cross-sectional averages of monthly returns, and the cross-sectional averages of the standard deviation of returns (return statistics are in percentage) that are based on U.S. dollar. N denotes the total number of stocks across all sample periods in a given country. CTR_I^L (CTR_I^G) is a co-tail risk which is computed as a semi-covariance between stock return and local (global) market return, conditional on downside stock return, as specified in Eq. (3) (Eq. (5)). CTR_M^L (CTR_M^G) is a co-tail risk which is computed as a semi-covariance of stock return and local (global) market return, conditional on local (global) market downside return, as specified in Eq. (2) (Eq. (4)). Both CTR_M^L and CTR_M^G are scaled by conditional semi-variance of local and global market returns, respectively. LSV is a lower semi-variance of stock return in Eq. (1). For each country, tail risk measures are averaged over stocks and months.

			Local		Global				
Country	N	First Year	CTR_I^L	CTR_M^L	CTR_I^G	CTR_M^G	LSV	Ret. Mean	Ret. SD
Developed markets (22 markets)									
AUSTRALIA	2,608	1995	-0.176	0.789	-0.223	0.493	2.419	-0.76	19.34
AUSTRIA	141	1995	-0.061	0.289	-0.098	-0.001	1.037	0.10	10.25
BELGIUM	195	1995	-0.082	0.193	-0.087	0.145	0.763	0.16	10.00
CANADA	3,668	1995	-0.322	0.570	-0.257	0.827	2.951	-1.13	21.62
DENMARK	302	1995	-0.109	0.114	-0.113	-0.007	1.050	0.09	11.10
FINLAND	176	1995	-0.175	-0.137	-0.095	0.421	0.795	0.42	10.86
FRANCE	1,316	1995	-0.162	-0.026	-0.125	0.280	1.091	0.08	13.43
GERMANY	1,018	1995	-0.216	0.151	-0.160	0.623	1.898	-0.75	16.06
HONG KONG	1,164	1995	-0.147	0.602	-0.198	0.086	1.782	-0.31	18.04
IRELAND	70	2000	-0.171	0.254	-0.167	0.508	1.580	0.18	13.73
ITALY	465	1995	-0.034	0.354	-0.056	0.638	0.639	-0.07	11.23
JAPAN	3,364	1995	-0.042	0.549	-0.137	0.136	0.811	-0.23	11.83
LUXEMBOURG	20	1999	-0.060	-0.001	-0.095	-0.519	0.387	0.89	6.50
NETHERLANDS	257	1995	-0.088	0.385	-0.087	0.544	1.074	0.16	11.19
NEW ZEALAND	206	1995	-0.039	0.596	-0.121	-0.077	0.927	0.37	10.94
NORWAY	388	1995	-0.102	0.510	-0.108	1.164	1.418	0.06	14.06
SINGAPORE	666	1995	-0.076	0.827	-0.151	0.397	1.321	0.01	13.96
SPAIN	224	1995	-0.033	0.344	-0.057	0.521	0.616	0.32	10.39
SWEDEN	728	1995	-0.193	0.277	-0.130	1.015	1.498	-0.06	15.77
SWITZERLAND	352	1995	-0.071	0.313	-0.085	-0.093	0.691	0.43	9.79
UK	2,368	1995	-0.193	0.095	-0.164	0.160	1.886	-0.38	14.96
US	8,992	1995	-0.060	1.041	-0.069	1.085	1.064	1.03	14.85
Emerging markets (24 markets)									
ARGENTINA	93	1995	0.074	0.801	-0.072	1.055	0.961	-0.30	13.13
BRAZIL	448	1995	0.042	0.518	-0.055	-1.120	1.445	0.23	15.80
CHILE	186	1995	-0.004	0.601	-0.062	0.054	0.718	0.46	9.98
CHINA	2,458	1995	-0.181	-0.221	-0.168	-0.729	0.708	0.81	13.34
GREECE	395	1995	0.010	1.051	-0.118	0.642	0.895	-0.42	16.79
HUNGARY	61	1995	0.078	0.371	-0.095	0.644	1.130	-0.36	12.25
INDIA	2,635	1995	-0.075	0.706	-0.142	0.123	1.195	-0.23	19.44
INDONESIA	409	1995	0.118	0.561	-0.137	0.193	1.343	0.03	15.53
ISRAEL	486	1995	-0.059	0.719	-0.130	0.440	1.179	0.30	14.43

MALAYSIA	1,057	1995	0.167	0.948	-0.187	0.159	1.571	-0.41	14.65
MEXICO	172	1995	0.110	0.845	-0.032	1.512	1.069	0.42	12.35
PAKISTAN	206	1995	-0.023	0.634	-0.189	-1.515	0.998	0.11	14.32
PERU	94	1995	-0.007	0.969	-0.119	-0.049	1.300	0.77	14.10
PHILIPPINE	260	1995	-0.123	0.767	-0.211	-0.350	1.858	-0.43	16.57
POLAND	520	1995	-0.059	0.546	-0.094	1.391	1.453	-0.36	16.61
PORTUGAL	117	1995	-0.032	0.457	-0.083	0.076	0.764	0.02	10.29
RUSSIA	260	1998	0.047	0.550	-0.141	1.418	2.121	0.32	17.09
S.AFRICA	796	1995	-0.158	0.352	-0.174	0.396	2.081	-0.25	17.27
S.KOREA	988	1995	0.063	0.479	-0.158	0.428	1.189	-0.30	17.52
SRI LANKA	226	1995	0.048	1.304	-0.238	-1.573	1.534	0.11	13.86
TAIWAN	925	1995	0.031	0.734	-0.108	-0.019	0.440	-0.14	13.72
THAILAND	674	1995	-0.051	0.416	-0.172	0.042	1.322	-0.21	15.52
TURKEY	388	1995	0.549	0.807	-0.117	1.216	1.652	0.03	18.51
VENEZUELA	25	1995	1.109	0.925	-0.251	-0.889	3.050	1.00	15.16
Total	42,567								

Table 2. Average of tail risk measures by firm size.
The table shows the averages of tail risk measures for each portfolio formed based on market capitalization within the region specified in each panel. In forming size portfolios, a stock is sorted every year into deciles based on its previous year-end market capitalization in each country. Then, the decile ranks are linked across countries to form equally-weighted country-neutral portfolios. For each stock i, five measures of tail risk of month t are estimated using the daily returns over the past six months. CTR_I^L (CTR_I^G) is a co-tail risk which is computed as a semi-covariance between stock return and local (global) market return, conditional on downside stock return, as specified in Eq. (3) (Eq. (5)). CTR_M^L (CTR_M^G) is a co-tail risk which is computed as a semi-covariance of stock return and local (global) market return, conditional on local (global) market downside return, as specified in Eq. (2) (Eq. (4)). Both CTR_M^L and CTR_M^G are scaled by conditional semi-variance of local and global market returns, respectively. LSV is a lower semi-variance of stock return in Eq. (1). We obtain local and global market returns from Datastream.

	Local		Global		
rank(size)	CTR_I^L	CTR_M^L	CTR_I^G	CTR_M^G	LSV
Panel A: All countries					
1(Small)	-0.263	0.199	-0.240	-0.765	2.561
2	-0.133	0.286	-0.190	0.057	1.848
3	-0.088	0.369	-0.165	0.128	1.487
4	-0.064	0.423	-0.145	0.248	1.277
5	-0.019	0.461	-0.132	0.303	1.195
6	0.007	0.512	-0.117	0.323	1.042
7	0.011	0.550	-0.104	0.378	1.033
8	0.064	0.636	-0.091	0.494	0.930
9	0.104	0.776	-0.077	0.626	0.853
10(Large)	0.177	0.980	-0.052	0.778	0.737
Panel B: Developed markets (excluding U.S.)					
1(Small)	-0.355	-0.104	-0.269	-0.217	2.983
2	-0.245	0.109	-0.199	0.000	1.818
3	-0.194	0.140	-0.169	0.192	1.486
4	-0.161	0.182	-0.151	0.204	1.232
5	-0.131	0.242	-0.134	0.277	1.152
6	-0.097	0.306	-0.112	0.326	0.960
7	-0.068	0.377	-0.095	0.403	0.933
8	-0.036	0.485	-0.077	0.592	0.813
9	0.004	0.660	-0.059	0.724	0.737
10(Large)	0.066	0.968	-0.031	0.956	0.589
Panel C: Emerging markets					
1(Small)	-0.190	0.424	-0.221	-1.309	2.261
2	-0.037	0.416	-0.186	0.072	1.906
3	0.005	0.550	-0.165	0.035	1.497
4	0.021	0.604	-0.141	0.249	1.314
5	0.082	0.627	-0.132	0.290	1.227
6	0.101	0.667	-0.124	0.285	1.107
7	0.083	0.680	-0.114	0.322	1.116
8	0.156	0.752	-0.105	0.380	1.030
9	0.197	0.864	-0.094	0.515	0.955
10(Large)	0.282	0.991	-0.073	0.609	0.871
Panel D: U.S.					

1(Small)	-0.089	1.174	-0.085	0.750	0.900
2	-0.093	0.893	-0.092	0.923	1.101
3	-0.095	0.856	-0.096	1.016	1.246
4	-0.087	1.104	-0.091	1.129	1.305
5	-0.081	1.099	-0.086	1.153	1.316
6	-0.064	1.137	-0.076	1.192	1.223
7	-0.050	1.063	-0.064	1.197	1.116
8	-0.036	1.008	-0.049	1.168	0.976
9	-0.014	1.084	-0.034	1.208	0.832
10(Large)	0.005	0.992	-0.019	1.111	0.625

Table 3. Cross-sectional regressions of local co-tail risk.

For each stock i, we estimate the measures of tail risk of month t using the daily returns over the past six months. LSV is a lower semi-variance of stock return in Eq. (1). CTR_M^L is a co-tail risk which is computed as a semi-covariance of stock return and local market return, conditional on local market downside return, as specified in Eq. (2). CTR_M^L is scaled by conditional semi-variance of local market return. CTR_I^L is a co-tail risk which is computed as a semi-covariance of stock return and local market return, conditional on downside stock return, as specified in Eq. (3). We obtain local market return from Datastream. Cross-sectional regressions with country dummies are performed for each month over all the sample countries (panel A), developed countries excluding U.S. (panel B), emerging markets (panel C), and the U.S. (panel D). The table shows the averages of the estimated coefficients together with the t-values in italics. BETA is the market beta, obtained from the regression of daily stock returns on local market return over the past one year. SIZE is the log of the previous year-end market capitalization in U.S. dollars, and BM is the book-to-market ratio at the end of the previous year. ILLIQ is the Amihud illiquidity measure, absolute return over the currency value of trading volume, averaged over the past one year and multiplied by 10^3. Adj. R^2 and N are the averages of adjusted R^2s and the number of stocks used in regressions, respectively. Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Intercept	CTR_I^L	LSV	CTR_M^L	BETA	SIZE	BM	ILLIQ	Adj.R^2	N
Panel A. All countries									
-1.642	1.409 ***			-0.521 ***	0.060 *	0.056 ***	0.000 *	0.173	16,812
-1.14	*11.11*			*-2.64*	*1.94*	*7.28*	*1.73*		
-1.509		-0.102 ***		-0.379 **	0.091 ***	0.057 ***	0.000	0.173	16,812
-1.11		*-10.25*		*-2.01*	*2.86*	*7.41*	*1.24*		
-2.252			-0.011	-0.405 **	0.117 ***	0.058 ***	0.000	0.172	16,811
-1.64			*-0.57*	*-2.23*	*3.53*	*7.54*	*0.49*		
-1.381	1.154 ***	-0.061 ***	-0.025	-0.431 **	0.056 *	0.056 ***	0.000 *	0.174	16,811
-0.98	*9.45*	*-6.85*	*-1.31*	*-2.38*	*1.82*	*7.26*	*1.88*		
Panel B. Developed countries (excluding U.S.)									
-1.915 **	2.025 ***			-0.938 ***	0.126 ***	0.057 ***	0.001 **	0.118	8,508
-2.34	*11.82*			*-4.17*	*3.43*	*4.90*	*2.50*		
-3.053 ***		-0.114 ***		-0.688 ***	0.173 ***	0.057 ***	0.000 **	0.117	8,508
-3.56		*-10.60*		*-3.28*	*4.54*	*4.94*	*2.00*		
-3.881 ***			-0.011	-0.759 ***	0.208 ***	0.063 ***	0.000	0.116	8,508
-4.31			*-0.62*	*-3.67*	*5.27*	*5.33*	*0.73*		
-1.817 **	1.806 ***	-0.048 ***	-0.028	-0.839 ***	0.120 ***	0.055 ***	0.001 ***	0.120	8,508
-2.24	*9.77*	*-4.69*	*-1.42*	*-3.98*	*3.33*	*4.81*	*2.77*		

Panel C. Emerging countries									
-0.635	0.959***			-0.660***	0.029	0.067***	0.000	0.270	5,775
-0.51	*8.07*			*-3.44*	*0.89*	*7.11*	*0.76*		
-0.740		-0.119***		-0.515***	0.049	0.068***	0.000	0.270	5,775
-0.59		*-9.13*		*-2.79*	*1.47*	*7.30*	*0.62*		
-1.349			-0.004	-0.562***	0.070**	0.072***	0.000	0.270	5,775
-1.08			*-0.16*	*-3.12*	*2.08*	*7.60*	*0.37*		
-0.329	0.785***	-0.091***	-0.034	-0.620***	0.025	0.068***	0.000	0.272	5,775
-0.26	*6.13*	*-6.70*	*-1.38*	*-3.38*	*0.76*	*7.23*	*0.94*		
Panel D. U.S.									
3.070**	0.960**			0.088	-0.097	0.067	0.228	0.058	2,529
2.00	*2.22*			*0.22*	*-1.32*	*0.58*	*0.16*		
2.864*		-0.050*		0.106	-0.091	0.075	0.131	0.057	2,529
1.78		*-1.82*		*0.28*	*-1.19*	*0.64*	*0.09*		
2.610			-0.045	0.188	-0.081	0.094	0.458	0.056	2,529
1.57			*-1.09*	*0.50*	*-1.05*	*0.80*	*0.32*		
3.012**	0.779*	-0.031	-0.053	0.166	-0.096	0.056	0.036	0.062	2,529
1.98	*1.78*	*-1.33*	*-1.19*	*0.44*	*-1.34*	*0.49*	*0.03*		

Table 4. Cross-sectional regressions of global co-tail risk.

For each stock i, we estimate the measures of tail risk of month t using the daily returns over the past six months. LSV is a lower semi-variance of stock return in Eq. (1). CTR_M^G is a co-tail risk which is computed as a semi-covariance of stock return and global market return, conditional on global market downside return, as specified in Eq. (4). CTR_M^G is scaled by conditional semi-variance of global market return. CTR_I^G is a co-tail risk which is computed as a semi-covariance of stock return and global market return, conditional on downside stock return, as specified in Eq. (5). We obtain global market return from Datastream. Cross-sectional regressions with country dummies are performed for each month over all the sample countries (panel A), developed countries excluding U.S. (panel B), emerging markets (panel C), and the U.S. (panel D). The table shows the averages of the estimated coefficients together with *t*-values in italics. BETA is the market beta, obtained from the regression of daily stock returns on local market return over the past one year. SIZE is the log of the previous year-end market capitalization in U.S. dollars, and BM is the book-to-market ratio at the end of the previous year. ILLIQ is the Amihud illiquidity measure, absolute return over the currency value of trading volume, averaged over the past one year and multiplied by 10^3. Adj. R^2 and N are the averages of adjusted R^2s and the number of stocks used in regressions, respectively. Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Intercept	CTR_I^G	LSV	CTR_M^G	BETA	SIZE	BM	ILLIQ	Adj.R^2	N
Panel A. All countries									
-0.449	3.301 ***			-0.451 **	0.048	0.056 ***	0.000	0.173	16,812
-0.34	*11.75*			*-2.33*	*1.59*	*7.32*	*1.54*		
-2.221			-0.016	-0.397 **	0.117 ***	0.057 ***	0.000	0.172	16,810
-1.62			*-1.14*	*-2.20*	*3.56*	*7.37*	*0.54*		
-0.421	3.169 ***	-0.027 ***	-0.034 **	-0.378 **	0.045	0.054 ***	0.000	0.175	16,810
-0.32	*10.55*	*-3.59*	*-2.41*	*-2.14*	*1.53*	*7.12*	*1.52*		
Panel B. Developed countries (excluding U.S.)									
-1.668 **	3.826 ***			-0.809 ***	0.117 ***	0.055 ***	0.001 ***	0.118	8,508
-2.08	*13.01*			*-3.73*	*3.26*	*4.78*	*2.70*		
-3.880 ***			-0.020	-0.720 ***	0.207 ***	0.062 ***	0.000	0.116	8,508
-4.33			*-1.62*	*-3.45*	*5.25*	*5.25*	*0.79*		
-1.616 **	3.825 ***	-0.022 **	-0.045 ***	-0.705 ***	0.113 ***	0.054 ***	0.001 ***	0.120	8,508
-2.03	*11.83*	*-2.29*	*-3.45*	*-3.41*	*3.17*	*4.67*	*2.93*		
Panel C. Emerging countries									
-0.154	2.849 ***			-0.520 ***	0.026	0.068 ***	0.000	0.270	5,775
-0.12	*9.01*			*-2.82*	*0.80*	*7.23*	*0.84*		

-1.317			0.002	-0.575 ***	0.070 **	0.071 ***	0.000	0.270	5,774
-1.05			*0.14*	*-3.16*	*2.09*	*7.60*	*0.47*		
-0.088	2.576 ***	-0.053 ***	-0.018	-0.535 ***	0.026	0.068 ***	0.000	0.272	5,774
-0.07	*7.31*	*-3.93*	*-1.12*	*-2.98*	*0.80*	*7.31*	*0.93*		
Panel D. U.S.									
3.033 **	1.174 **			0.099	-0.096	0.067	0.404	0.057	2,529
1.97	*2.24*			*0.26*	*-1.31*	*0.58*	*0.28*		
2.715			-0.042	0.153	-0.084	0.079	0.310	0.057	2,528
1.65			*-0.98*	*0.41*	*-1.09*	*0.67*	*0.22*		
3.092 **	1.148 **	-0.020	-0.047	0.131	-0.098	0.040	0.084	0.063	2,528
2.04	*2.13*	*-0.88*	*-0.99*	*0.36*	*-1.37*	*0.35*	*0.06*		

Table 5. Cross-sectional regressions of local and non-local global co-tail risk.

We perform cross-sectional regressions of stock returns on co-tail risk measures and stock characteristics for each month over all the sample countries (panel A), developed countries excluding U.S. (panel B), emerging markets (panel C), and the U.S. (panel D). Regressions in panels A to C include country dummies. The table shows the averages of the estimated coefficients together with *t*-values in italics. For each stock *i*, we estimate the measures of co-tail risks of month *t* using the daily returns over the past six months. CTR_I^L (CTR_I^{G-L}) is a co-tail risk which is computed as a semi-covariance of stock return and local market return (non-local global market return), conditional on downside stock return, as specified in Eq. (3) (Eq. (6)). Non-local global market returns are obtained by orthogonalizing global market returns against the local market returns. Both local and global market returns are obtained from the Datastream. BETA is the market beta, obtained from the regression of daily stock returns on local market return over the past one year. SIZE is the log of the previous year-end market capitalization in U.S. dollars, and BM is the book-to-market ratio at the end of the previous year. ILLIQ is the Amihud illiquidity measure, absolute return over the currency value of trading volume, averaged over the past one year and multiplied by 10^3. Adj.R^2 and N are the averages of adjusted R^2s and the number of stocks used in regressions, respectively. Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Intercept	Local CTR_I^L	Non-local global CTR_I^{G-L}	BETA	SIZE	BM	ILLIQ	Adj.R^2	N
Panel A. All countries								
0.499	0.607***	3.201***					0.166	19,395
0.47	*4.91*	*8.32*						
-0.585	0.963***	2.900***	-0.409**	0.039	0.054***	0.000*	0.174	16,812
-0.43	*8.64*	*9.96*	*-2.17*	*1.29*	*7.13*	*1.96*		
Panel B. Developed countries (excluding U.S.)								
0.252	1.119***	3.623***					0.094	9,388
0.69	*6.14*	*7.52*						
-1.328*	1.477***	2.770***	-0.774***	0.103***	0.052***	0.001***	0.120	8,508
-1.71	*9.47*	*8.19*	*-3.69*	*2.93*	*4.59*	*2.81*		
Panel C. Emerging countries								
0.335	0.210	2.516***					0.257	7,065
0.32	*1.34*	*7.96*						
0.034	0.671***	2.256***	-0.587***	0.016	0.066***	0.000	0.271	5,775
0.03	*5.31*	*6.94*	*-3.14*	*0.49*	*7.09*	*0.96*		

Panel D. U.S.

1.086 ***	0.738 *	1.107					0.019	2,942
4.03	*1.85*	*0.74*						
3.195 **	0.452	1.402 **	0.162	-0.103	0.063	0.408	0.059	2,529
2.11	*1.15*	*2.22*	*0.41*	*-1.42*	*0.55*	*0.29*		

Table 6. Cross-country differences in the pricing of local and global co-tail risks

We perform cross-sectional regressions of stock returns on co-tail risk measures, interaction of tail risk with country characteristic, and stock characteristics for each month over all the sample countries. The table shows the averages of the estimated coefficients together with *t*-values in italics. For each stock *i*, we estimate the measures of co-tail risks of month *t* using the daily returns over the past six months. CTR_I^{L} (CTR_I^{G-L}) is a co-tail risk which is computed as a semi-covariance of stock return and local market return (non-local global market return), conditional on downside stock return, as specified in Eq. (3) (Eq. (6)). Non-local global market returns are obtained by orthogonalizing global market returns against the local market returns. Both local and global market returns are obtained from the Datastream. The interaction variable X is as follows. The fund industry size is the equity mutual funds' assets under management as of 2002, and is scaled by GDP (Khorana, Servaes, and Tufano, 2005). Amount of stocks held by U.S. institutions is the log of the market value of stock holdings (in billions of U.S. dollars) in a country held by U.S. institutions (Ferreira and Matos, 2008). Overall capital restrictions index is the restriction index for all asset categories from Fernández et al. (2015). BETA is the market beta, obtained from the regression of daily stock returns on local market return over the past one year. SIZE is the log of the previous year-end market capitalization in U.S. dollars, and BM is the book-to-market ratio at the end of the previous year. ILLIQ is the Amihud illiquidity measure, absolute return over the currency value of trading volume, averaged over the past one year and multiplied by 10^3. Adj.R^2 and N are the averages of adjusted R^2s and the number of stocks used in regressions, respectively. Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

	Local		Non-local Global							
Intercept	*CTR_I^{L}*	*CTR_I^{L}* *X	*CTR_I^{G-L}*	*CTR_I^{G-L}**X	BETA	SIZE	BM	ILLIQ	Adj. R^2	N
X=Fund industry size scaled by GDP										
-2.161 **	1.171 ***	0.362 ***			-0.523 ***	0.114 ***	0.065 ***	0.006	0.040	16,662
-2.16	*4.88*	*2.95*			*-2.49*	*2.57*	*5.90*	*0.35*		
-1.384			3.555 ***	0.280 ***	-0.315	0.091 ***	0.068 ***	0.005	0.040	16,662
-1.51			*7.17*	*2.25*	*-1.64*	*2.23*	*6.15*	*0.26*		
X=Amounts of stocks held by U.S. institutions										
-2.012 **	1.819 ***	0.064 ***			-0.559 **	0.077 *	0.073 ***	0.021	0.043	12,579
-2.02	*6.53*	*4.02*			*-2.16*	*1.80*	*4.21*	*1.11*		
-2.020 **			3.378 ***	0.050 ***	-0.284	0.094 **	0.073 ***	0.013	0.042	12,579
-2.04			*6.41*	*3.03*	*-1.21*	*2.17*	*4.22*	*0.70*		
X=Overall capital restrictions index										
-1.677 *	1.120 ***	-0.218 *			-0.476 **	0.120 ***	0.057 ***	0.001	0.043	13,797
-1.80	*4.24*	*-1.87*			*-2.10*	*2.79*	*4.70*	*0.05*		
-0.728			3.659 ***	-0.221 *	-0.262	0.084 **	0.056 ***	0.001	0.042	13,797
-0.85			*7.02*	*-1.87*	*-1.29*	*2.14*	*4.63*	*0.04*		

Table 7. Cross-sectional regressions of global co-tail risk: U.S. versus non-U.S.

We perform cross-sectional regressions of stock returns on co-tail risk measures and stock characteristics for each month over all the sample countries (panel A), developed countries excluding U.S. (panel B), and emerging markets (panel C). All regressions include country dummies. The table shows the averages of the estimated coefficients together with *t*-values in italics. For each stock *i*, we estimate the measures of co-tail risks of month *t* using the daily returns over the past six months. CTR_I^L ($CTR\_I^{US}, CTR\_I^{(G-L)-US}$) is a co-tail risk which is computed as a semi-covariance of stock return and local (U.S., Non-local & non-U.S. global) market return, conditional on downside stock return, as specified in Eq. (3) (Eq. (7) and (8)). Non-local & non-US global returns are obtained by orthogonalizing global market returns against the local market returns and U.S. market return. Both local and global market returns are obtained from the Datastream. BETA is the market beta, obtained from the regression of daily stock returns on local market return over the past one year. SIZE is the log of the previous year-end market capitalization in U.S. dollars, and BM is the book-to-market ratio at the end of the previous year. ILLIQ is the Amihud illiquidity measure, absolute return over the currency value of trading volume, averaged over the past one year and multiplied by 10^3. Adj.R^2 and N are the averages of adjusted R^2s and the number of stocks used in regressions, respectively. Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Intercept	Local CTR_I^L	US CTR_I^{US}	Non-local & non-US $CTR\_I^{(G\text{-}L)\text{-}US}$	BETA	SIZE	BM	ILLIQ	Adj. R^2	N
Panel A. All countries									
0.655	0.496 ***	1.168 ***	3.796 ***					0.178	16,453
0.63	*3.82*	*6.21*	*7.67*						
-0.486	0.888 ***	1.036 ***	3.443 ***	-0.552 ***	0.062 **	0.053 ***	0.000 **	0.192	14,283
-0.37	*7.65*	*5.46*	*7.75*	*-3.80*	*2.21*	*7.52*	*2.48*		
Panel B. Developed countries (excluding U.S.)									
0.416	1.021 ***	0.861 ***	4.631 ***					0.096	9,388
1.20	*5.38*	*3.58*	*6.91*						
-1.137	1.370 ***	0.754 ***	3.646 ***	-0.705 ***	0.099 ***	0.052 ***	0.001 ***	0.120	8,508
-1.49	*8.06*	*3.68*	*6.87*	*-3.48*	*2.83*	*4.59*	*3.10*		
Panel C. Emerging markets									
0.449	0.154	1.010 ***	3.091 ***					0.258	7,065
0.42	*0.96*	*4.67*	*6.47*						
0.313	0.588 ***	1.074 ***	2.786 ***	-0.551 ***	0.011	0.066 ***	0.000	0.272	5,775
0.24	*4.25*	*4.17*	*5.50*	*-2.98*	*0.34*	*7.11*	*0.96*		

Table 8. Cross-sectional regressions of co-tail risk measures, with alternative tail size and estimation period.

For each stock i, we estimate the measures of co-tail risks of month t using the daily returns over the past *one year*, rather than the past six months. CTR_I^{L} ($CTR\_I^{US}, CTR\_I^{(G-L)-US}$) is a co-tail risk which is computed as a semi-covariance of stock return and local (U.S., Non-local & non-U.S. global) market return,, conditional on downside stock return, as specified in Eq. (3) (Eq. (7) and (8)). We obtain local and global market return from Datastream. Tail risk measures for the 5%, 10%, 20%, 30%, 40%, and 50% tails are calculated using daily returns over the past one year. Cross-sectional regressions of stock returns on three tail risk measures with control variables and country dummies are performed for each month over all the sample countries (panel A), developed countries excluding U.S. (panel B), and emerging markets (panel C). The table shows the averages of the estimated coefficients of tail risk measures together with the *t*-values in italics. BETA is the market beta, obtained from the regression of daily stock returns on local market return over the past one year. SIZE is the log of the previous year-end market capitalization in U.S. dollars, and BM is the book-to-market ratio at the end of the previous year. ILLIQ is the Amihud illiquidity measure, absolute return over the currency value of trading volume, averaged over the past one year and multiplied by 10^3. Adj.R^2 and N are the averages of adjusted R^2s and the number of stocks used in regressions, respectively. Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively. For brevity, results for the control variables are not reported.

	Tail size											
	5%		10%		20%		30%		40%		50%	
Panel A. All countries												
Local: CTR_I^{L}	0.619	***	0.461	***	0.267	***	0.215	***	0.088		-0.245	***
	8.14		*7.16*		*4.73*		*3.91*		*1.48*		*-3.40*	
US: CTR_I^{US}	0.789	***	0.664	***	0.550	***	0.502	***	0.391	***	-0.159	**
	5.80		*5.79*		*5.63*		*5.95*		*5.21*		*-2.19*	
Non-local & non-US Global: $CTR\_I^{(G-L)-US}$	1.758	***	2.067	***	1.914	***	2.049	***	1.839	***	-0.200	
	5.92		*7.49*		*7.95*		*8.92*		*8.85*		*-1.11*	
Panel B. Developed countries (excluding U.S.)												
Local: CTR_I^{L}	0.940	***	0.757	***	0.525	***	0.494	***	0.353	***	-0.287	***
	7.73		*7.20*		*5.99*		*6.38*		*4.41*		*-2.66*	
US: CTR_I^{US}	0.526	***	0.465	***	0.422	***	0.361	***	0.284	***	-0.125	
	3.33		*3.44*		*3.57*		*3.52*		*3.10*		*-1.45*	
Non-local & non-US Global: $CTR\_I^{(G-L)-US}$	1.982	***	1.977	***	1.822	***	2.084	***	2.076	***	-0.210	
	5.38		*5.97*		*6.24*		*7.71*		*8.29*		*-0.87*	

Panel C. Emerging markets												
Local: CTR_I^{L}	0.467	***	0.340	***	0.168	**	0.106		-0.008		-0.201	***
	4.88		*4.12*		*2.36*		*1.56*		*-0.12*		*-2.90*	
US: CTR_I^{US}	0.689	***	0.693	***	0.636	***	0.640	***	0.506	***	-0.099	
	3.57		*4.31*		*4.63*		*5.18*		*4.46*		*-1.01*	
Non-local & non-US Global: $CTR\_I^{(G-L)-US}$	1.479	***	1.953	***	1.788	***	1.865	***	1.533	***	-0.200	
	4.62		*6.83*		*7.16*		*7.71*		*6.40*		*-0.88*	

Table 9. Cross-sectional regressions of tail risk measures with additional control variables.

We perform cross-sectional regressions of stock returns on tail risk measures and stock characteristics for each month over all the sample countries (panel A), developed countries excluding U.S. (panel B), emerging markets (panel C), and the U.S. (panel D). Regressions in panels A to C include country dummies. The table shows the averages of the estimated coefficients together with t-values in italics. For each stock i, we estimate the measures of co-tail risks of month t using the daily returns over the past six months. CTR_I^L is a co-tail risk which is computed as a semi-covariance of stock return and local market return, conditional on downside stock return, as specified in Eq. (3). Non-local global tail risk, CTR_I^{G-L}, is a co-tail risk which is computed as a semi-covariance of stock return and non-local global market return, conditional on downside stock return, as specified in Eq. (6). Non-local global market returns are obtained by orthogonalizing global market returns against the local market returns. Both local and global market returns are obtained from the Datastream. BETA is the market beta, obtained from the regression of daily stock returns on local market return over the past one year. SIZE is the log of the previous year-end market capitalization in U.S. dollars, and BM is the book-to-market ratio at the end of the previous year. ILLIQ is the Amihud illiquidity measure, absolute return over the currency value of trading volume, averaged over the past one year and multiplied by 10^3. DBETA is the downside beta, obtained from the regression of daily stock returns on local market return over the past one year, conditioning on the market excess returns below its average. MOM is the 6-month cumulative return from t-7 to t-2. COSKEW is the coskewness of daily returns over the past one year. IVOL is the idiosyncratic volatility, obtained from the standard deviation of daily residuals estimated by the Fama-French three factor model over the past month. MAX is the maximum daily return within the past month. Adj.R^2 and N are the averages of adjusted R^2s and the number of stocks used in regressions, respectively. Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

Intercept	Local CTR_I^L	Non-local global CTR_I^{G-L}	BETA	SIZE	BM	ILLIQ	DBETA	MOM	COSKEW	IVOL	MAX	Adj.R^2	N
Panel A. All countries													
-0.651	1.005 ***	2.822 ***	-0.382 **	0.038	0.055 ***	0.000 *	-0.059					0.175	16,812
-0.48	*8.81*	*10.12*	*-2.16*	*1.28*	*7.24*	*1.94*	*-0.83*						
-0.700	0.939 ***	2.791 ***	-0.432 **	0.041	0.055 ***	0.000 *		0.345 ***				0.176	16,812
-0.51	*8.37*	*9.87*	*-2.12*	*1.35*	*7.18*	*1.89*		*3.67*					
-0.667	0.908 ***	2.921 ***	-0.405 **	0.040	0.054 ***	0.000 *			-0.347 **			0.175	16,812
-0.49	*8.25*	*10.15*	*-2.15*	*1.33*	*7.14*	*1.92*			*-2.59*				
0.878	0.648 ***	1.998 ***	-0.319 *	-0.015	0.053 ***	0.001 ***				-0.231 ***		0.178	16,736
0.65	*6.09*	*8.18*	*-1.80*	*-0.54*	*7.09*	*3.92*				*-10.73*			
0.546	0.740 ***	2.205 ***	-0.319 *	-0.004	0.054 ***	0.000 ***					-7.277 ***	0.178	16,748
0.41	*6.80*	*8.35*	*-1.76*	*-0.14*	*7.19*	*3.53*					*-13.19*		
0.715	0.635 ***	1.974 ***	-0.257	-0.010	0.054 ***	0.000 ***	-0.070	0.346 ***	-0.383 ***	-0.082 ***	-5.237 ***	0.182	16,736
0.54	*6.08*	*8.61*	*-1.34*	*-0.34*	*7.27*	*3.72*	*-1.33*	*3.93*	*-3.19*	*-2.97*	*-7.99*		
Panel B. Developed countries (ex. US)													
-0.076	1.044 ***	1.845 ***	-0.576 ***	0.045	0.047 ***	0.001 ***	-0.056	0.515 ***	-0.360 **	-0.081 ***	-5.965 ***	0.128	8,501
-0.10	*7.21*	*6.46*	*-2.82*	*1.33*	*4.41*	*6.06*	*-1.11*	*4.49*	*-2.06*	*-2.73*	*-7.25*		
Panel C. Emerging countries													
1.412	0.417 ***	1.324 ***	-0.432 *	-0.029	0.068 ***	0.000 **	-0.056	0.301 ***	-0.254 *	-0.132 ***	-6.874 ***	0.279	5,764
1.08	*3.37*	*4.76*	*-1.95*	*-0.88*	*7.22*	*2.41*	*-0.73*	*2.71*	*-1.82*	*-3.39*	*-6.27*		
Panel D. U.S.													
3.565 ***	-0.202	0.642	0.484	-0.122 **	0.058	1.053	-0.367 *	0.491	-0.912 **	-0.071	-2.032	0.077	2,471
2.96	*-0.59*	*1.10*	*1.24*	*-2.15*	*0.61*	*0.76*	*-1.77*	*1.57*	*-1.99*	*-1.22*	*-1.56*		

Table 10. Factor model regressions of co-tail risk.

In each month t, a stock is ranked into deciles in a given country on the basis of co-tail risk (*CTR_I*), which is estimated using daily returns over the past six months. Subsequently, stocks with the same rank are combined to form ten equally-weighted portfolios across countries within the regions specified in the table. Each portfolio return (in U.S. dollars) in excess of the risk-free rate is regressed on Global three- and five-factor models as specified in Eqs. (9)-(10). CTR_I^{L} is a co-tail risk which is computed as a semi-covariance of stock return and local market return, conditional on downside stock return, as specified in Eq. (5). CTR_I^{US} is a co-tail risk which is computed as a semi-covariance of stock return and U.S. market return, conditional on downside stock return. $CTR\_I^{(G-L)-US}$, is a co-tail risk which is computed as a semi-covariance of stock return and non-local & non-US global market return, conditional on downside stock return, as specified in Eq. (8). Non-local & non-US global returns are obtained by orthogonalizing global market returns against the local market returns and U.S. market return. Both local and global market returns are obtained from the Datastream. The SMB (small cap minus big), HML (high book-to-market minus low), RMW (robust operating profitability minus weak), and CMA (conservative investment minus aggressive) are obtained from K. French's website. The table shows the estimated alphas with the t-values in italics from the regression of each of the ten portfolios formed based on global tail risk (panel A), co-tail risk with respect to the U.S. market return (panel B), and non-local & non-US global tail risk (panel C). The U.S. stocks are dropped from the sample. Rows labeled "Global three-factor alpha" and "Global five-factor alpha" indicate the intercepts from the models in Eqs. (9)-(10), respectively. The last column of the table (labeled "High–Low") shows the difference in the estimated intercepts that are obtained from the strategy that longs stocks with the highest co-tail risk (p=High) and sells short those with the lowest co-tail risk (p=Low). Asterisks of ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

	Low	P2	P3	P4	P5	P6	P7	P8	P9	High	High-Low
Panel A. Portfolios sorted on CTR_I^{L}											
All countries (excluding U.S.)											
Global three-factor alpha	-1.912***	-1.293***	-1.041***	-0.904***	-0.836***	-0.776***	-0.727***	-0.763***	-0.824***	-1.017***	0.894***
	-10.24	*-7.26*	*-6.01*	*-5.24*	*-5.03*	*-4.46*	*-4.24*	*-4.45*	*-4.64*	*-5.54*	*8.06*
Global five-factor alpha	-1.898***	-1.295***	-1.095***	-0.956***	-0.922***	-0.838***	-0.800***	-0.832***	-0.911***	-1.064***	0.830***
	-9.67	*-6.96*	*-6.09*	*-5.35*	*-5.33*	*-4.67*	*-4.52*	*-4.72*	*-4.99*	*-5.60*	*7.01*
Developed countries (excluding U.S.)											
Global three-factor alpha	-2.376***	-1.694***	-1.256***	-1.010***	-0.868***	-0.812***	-0.621***	-0.679***	-0.710***	-0.958***	1.417***
	-11.85	*-9.83*	*-8.02*	*-6.47*	*-6.12*	*-5.89*	*-4.50*	*-5.12*	*-5.28*	*-6.63*	*9.34*
Global five-factor alpha	-2.338***	-1.708***	-1.283***	-1.101***	-0.976***	-0.901***	-0.755***	-0.813***	-0.852***	-1.047***	1.292***
	-11.03	*-9.37*	*-7.78*	*-6.80*	*-6.60*	*-6.25*	*-5.32*	*-6.04*	*-6.20*	*-7.02*	*7.98*
Emerging countries											
Global three-factor alpha	-1.518***	-0.953***	-0.862***	-0.822***	-0.817***	-0.753***	-0.826***	-0.844***	-0.931***	-1.079***	0.438***
	-6.53	*-4.04*	*-3.65*	*-3.51*	*-3.54*	*-3.03*	*-3.39*	*-3.36*	*-3.59*	*-4.08*	*3.17*
Global five-factor alpha	-1.524***	-0.947***	-0.939***	-0.839***	-0.884***	-0.793***	-0.848***	-0.856***	-0.972***	-1.090***	0.428***
	-6.19	*-3.81*	*-3.80*	*-3.42*	*-3.64*	*-3.07*	*-3.33*	*-3.26*	*-3.60*	*-3.93*	*2.90*
Panel B. Portfolios sorted on CTR_I^{US}											
All countries (excluding U.S.)											
Global three-factor alpha	-1.972***	-1.458***	-1.173***	-1.113***	-0.880***	-0.792***	-0.753***	-0.663***	-0.592***	-0.685***	1.288***
	-9.97	*-7.80*	*-6.22*	*-6.36*	*-5.05*	*-4.78*	*-4.53*	*-3.94*	*-3.60*	*-4.19*	*11.68*

Global five-factor alpha	-1.937 ***	-1.483 ***	-1.196 ***	-1.171 ***	-0.957 ***	-0.868 ***	-0.843 ***	-0.734 ***	-0.675 ***	-0.735 ***	1.199 ***
	-9.43	*-7.62*	*-6.13*	*-6.52*	*-5.26*	*-5.08*	*-4.92*	*-4.21*	*-3.96*	*-4.32*	*10.25*
Developed countries (excluding U.S.)											
Global three-factor alpha	-2.502 ***	-1.743 ***	-1.343 ***	-1.159 ***	-0.900 ***	-0.821 ***	-0.700 ***	-0.559 ***	-0.572 ***	-0.681 ***	1.821 ***
	-11.91	*-10.12*	*-8.23*	*-7.87*	*-6.16*	*-5.92*	*-5.14*	*-4.34*	*-4.34*	*-4.84*	*11.55*
Global five-factor alpha	-2.418 ***	-1.767 ***	-1.372 ***	-1.225 ***	-1.000 ***	-0.933 ***	-0.856 ***	-0.696 ***	-0.716 ***	-0.789 ***	1.629 ***
	-11.00	*-9.75*	*-8.04*	*-8.03*	*-6.55*	*-6.49*	*-6.17*	*-5.26*	*-5.28*	*-5.35*	*9.90*
Emerging countries											
Global three-factor alpha	-1.519 ***	-1.221 ***	-1.036 ***	-1.083 ***	-0.871 ***	-0.775 ***	-0.806 ***	-0.762 ***	-0.615 ***	-0.696 ***	0.824 ***
	-6.13	*-4.87*	*-4.03*	*-4.37*	*-3.58*	*-3.32*	*-3.39*	*-3.13*	*-2.61*	*-3.06*	*7.13*
Global five-factor alpha	-1.529 ***	-1.246 ***	-1.053 ***	-1.134 ***	-0.928 ***	-0.820 ***	-0.839 ***	-0.776 ***	-0.646 ***	-0.697 ***	0.826 ***
	-5.88	*-4.74*	*-3.93*	*-4.40*	*-3.62*	*-3.37*	*-3.37*	*-3.04*	*-2.61*	*-2.93*	*6.63*

Panel C: Portfolios sorted on $CTR\_I^{(G-L)-US}$											
All countries (excluding U.S.)											
Global three-factor alpha	-2.103 ***	-1.448 ***	-1.181 ***	-1.135 ***	-0.884 ***	-0.833 ***	-0.734 ***	-0.697 ***	-0.567 ***	-0.525 ***	1.579 ***
	-10.39	*-7.70*	*-6.35*	*-6.35*	*-4.94*	*-4.87*	*-4.45*	*-4.24*	*-3.52*	*-3.40*	*14.00*
Global five-factor alpha	-2.067 ***	-1.437 ***	-1.211 ***	-1.178 ***	-0.939 ***	-0.896 ***	-0.816 ***	-0.797 ***	-0.664 ***	-0.614 ***	1.455 ***
	-9.78	*-7.35*	*-6.27*	*-6.35*	*-5.07*	*-5.02*	*-4.81*	*-4.72*	*-4.02*	*-3.85*	*12.23*
Developed countries (excluding U.S.)											
Global three-factor alpha	-2.543 ***	-1.736 ***	-1.428 ***	-1.223 ***	-0.993 ***	-0.840 ***	-0.690 ***	-0.580 ***	-0.486 ***	-0.483 ***	2.060 ***
	-12.16	*-10.02*	*-9.00*	*-8.20*	*-6.74*	*-5.99*	*-5.07*	*-4.38*	*-3.72*	*-3.63*	*12.82*
Global five-factor alpha	-2.450 ***	-1.698 ***	-1.460 ***	-1.303 ***	-1.083 ***	-0.971 ***	-0.822 ***	-0.722 ***	-0.651 ***	-0.633 ***	1.817 ***
	-11.12	*-9.31*	*-8.74*	*-8.34*	*-7.13*	*-6.66*	*-5.94*	*-5.32*	*-4.93*	*-4.63*	*10.89*
Emerging countries											
Global three-factor alpha	-1.729 ***	-1.207 ***	-0.974 ***	-1.066 ***	-0.798 ***	-0.835 ***	-0.779 ***	-0.809 ***	-0.646 ***	-0.569 ***	1.161 ***
	-6.73	*-4.75*	*-3.80*	*-4.24*	*-3.19*	*-3.43*	*-3.34*	*-3.47*	*-2.80*	*-2.61*	*9.76*
Global five-factor alpha	-1.744 ***	-1.220 ***	-1.004 ***	-1.078 ***	-0.825 ***	-0.840 ***	-0.819 ***	-0.872 ***	-0.683 ***	-0.605 ***	1.142 ***
	-6.46	*-4.58*	*-3.74*	*-4.10*	*-3.14*	*-3.29*	*-3.34*	*-3.59*	*-2.84*	*-2.65*	*8.92*