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# Office Market Interconnectedness and Systemic Risk Exposure

**Abstract**

This paper empirically studies how systemic risk in the banking sector affects return co-movements among financial center office markets. We compute an aggregated measure of systemic risk in financial centers that is related to the expected capital shortfall of financial institutions. The empirical results show that office market interconnectedness arises from systemic banking risk during financial turmoil periods. Our identification strategy is based on a double counterfactual approach. We find no evidence of return co-movements during normal times and among the counterfactual retail markets. The decline in office market returns during financial turmoil is larger in financial centers compared to non-financial centers. Our findings demonstrate how correlated risk among seemingly uncorrelated assets emerges in times when risk diversification is most needed.

**Keywords:** Commercial real estate; cross-sectional dependence; financial center; spatial econometrics; systemic risk.
**JEL Classification:** $G15$, $R30$

# 1 Introduction

In financial centers, office space is occupied by property-owners and tenants from the financial service industry which links rental values and property returns to fluctuations in financial markets.[1] The stock market performance affects the net worth of financial institutions due to the marked-to-market valuation of their assets. When market prices fall, banks have to adjust their balance sheets to keep their leverage targets (see, e.g., Adrian and Shin (2010, 2014)). Capital shortage, triggered by asset price declines, and fire-sales during financial turmoil increase the probability of bank failures (Berger and Bouwman (2013)). Potential defaults, job cuts of tenants, and higher financial sector unemployment lower the demand for office space and reduce investors' expectations about future rent cash flows and office market returns.[2] This mechanism reveals the fragility of commercial real estate markets, particularly at times when yields are low and office markets are highly vulnerable to valuation shocks. More generally, it illustrates how a shock in one asset market can lead to correlated risk in other asset markets and intensifies a financial crisis.

This paper studies the interconnectedness of international financial center office markets that is implied by their underlying systemic banking sector risk. To assess the financial center-specific systemic risk, we use the Brownlees and Engle (2017) SRISK measure, which calculates the expected capital shortfall of financial institutions conditional on a hypothetical decline in asset market prices. Based on domestic and foreign head office locations of financial institutions, we first compute the aggregated potential undercapitalization in financial centers. In a second step, we quantify the common systemic risk

[1]See, e.g., Lizieri, Baum, and Scott (2000), Lizieri and Pain (2014). The concept of financial centers as a concentration of financial activity goes back to Kindleberger (1974). International banks, hedge funds, specialized lawyers, and consulting companies gain from network effects, informational economies of scale, and direct interaction with clients and trading partners in financial centers (e.g., Gehrig (2000), Lizieri (2009)).

[2]Note that even though rents might be sticky in the short run, return expectations of property investors are instantaneously affected. Lower rental income in the future and the demand for a higher risk premium increase the required yield (capitalization rate), and thus, reduce property values.

contribution between financial centers. We then empirically analyze whether systemic risk in the financial service sector serves as a transmission channel for return dependence among commercial real estate office markets during financial turmoil periods and how this specific risk exposure affects the stability of office markets in financial centers.

Our identification strategy is based on a double counterfactual approach. Imposing restrictions in our empirical model, we test for cross-sectional dependence among office markets during financial crises relative to normal times. The expected undercapitalization of financial institutions should only have an impact on the financial service sector during periods of financial distress, when market prices fall. During normal times, when balance sheets are not exposed to valuation shocks, the hypothetical common systemic risk contribution of financial institutions between financial centers should not imply return co-movements among the related office markets. As financial turmoil times, we consider the dotcom equity bubble burst in 2001/2002 and the recent financial crisis 2007/2008.[3] We also apply a placebo test for the dependence among financial center retail markets as a counterfactual. Office and retail markets follow a common city-specific trend, however, their performances deviate during financial turmoil times. Office market returns are exposed to the common systemic risk contribution of financial institutions between financial centers. In contrast, retail markets are not directly affected by this sector-specific risk, particularly when we control for the stock market performance in the financial center. For instance, a poor banking sector performance during bust periods might lead to less bonus payments and less income, which might lower the demand on retail markets, especially in financial centers where a large population share is employed in the banking sector.

We base our analysis on a large cross-section of international commercial real estate markets. Returns reflect the marked-to-market valuation of commercial real estate at the city-level. Exploiting spatial econometrics to model the transmission channel of systemic

[3]The stock market bubble burst in 2001 had its origin in the overvaluation of publicly traded shares of new technology companies (e.g., Ofek and Richardson (2003), Pastor and Veronesi (2006), Griffin, Harris, Shu, and Topaloglu (2011)). In contrast, the recent financial crisis 2007/2008 originated in the U.S. residential subprime mortgage market and led to a global banking crisis (Brunnermeier (2009)).

risk among financial centers, we find empirical evidence of return dependence among financial center office markets during financial turmoil periods that can be explained by the systemic risk in the banking sector. Specifically, a higher level of aggregated expected capital shortfall in the banking sector of a certain financial center does not imply a clear statistically or economically significant risk exposure to the local office market. However, the common systemic risk contribution of financial institutions between financial centers leads to significant cross-sectional dependence during periods of asset price decline. In contrast, we find no return dependence among financial center office markets during normal times or among the counterfactual retail markets during crisis periods. Furthermore, our results suggest no interconnectedness among non-financial center office markets that could be related to the implied transmission channel. This is corroborated by our finding of a lower level of aggregated expected capital shortfall in non-financial compared to financial centers. Therefore, non-financial centers are not vulnerable to the common systemic risk contribution of financial institutions during periods of financial distress.

We also rule out alternative explanations for the observed return dependence among international property markets, such as the credit supply of the banking sector (e.g., Davis and Zhu (2011), Ling, Naranjo, and Scheick (2016)). To address this concern, our regression models include international banks' claims on a country level or the U.S. CMBS yield spread which reflects the perceived banking risk from the securitization channel. Furthermore, if a funding liquidity dry-up during crisis periods would explain the office market return co-movements among financial centers, we should observe a similar effect on the counterfactual retail sector. We also distinguish between return co-movements among office markets that arise from the exposure to *systemic* risk in the banking sector and common *systematic* risk of local banks, such as interest rate or credit risk (e.g., Begenau, Piazzesi, and Schneider (2015)).

To quantify the impact of systemic risk on the office market return performance, we apply a difference-in-difference model. Compared to the counterfactual retail sector, office markets are more vulnerable during financial distress. Since the aggregated level of expected capital shortfall is on average larger in financial than in non-financial centers, we also test for a systematic difference in their return performance during crisis periods. The decline of office market returns is stronger in financial than in non-financial centers during the aftermath of the recent financial crisis 2007/2008. In general, office markets with a related banking sector's total expected capital shortfall belonging to the upper $25^{th}$-percentile indicate a larger exposure to the recent financial crisis.

Our paper is related to the recent literature on systemic risk. Allen, Babus, and Carletti (2012) and Greenwood, Landier, and Thesmar (2015) show how asset commonality in banks' balance sheets leads to systemic risk in the banking sector. Brunnermeier, Rother, and Schnabel (2017) relate a higher systemic risk contribution in the banking sector to asset price bubbles. Motivated by them, we build on the literature of systemic risk contribution of financial firms which is based on the correlation of the market price of assets in their balance sheets. Specifically, we focus on the SRISK measure, which reflects the expected capital shortfall of financial institutions that would be observed during a systemic event affecting the whole financial system (Acharya, Engle, and Richardson (2012), Acharya, Pedersen, Philippon, and Richardson (2017), Brownlees and Engle (2017)). Our identification strategy exploits the hypothetical characteristic of the SRISK measure during normal financial periods.

We contribute to the empirical discussion of co-movements among financial markets during turmoil periods. Several papers study the interconnectedness of equity markets during the recent financial crisis. For instance, Bekaert, Ehrmann, Fratzscher, and Mehl (2014) analyze excess return co-movements across global equity markets that cannot be explained by common systematic risk factors. The literature is mostly silent on co-movements among commercial real estate markets. Exceptions are Case, Goetzmann, and Rouwenhorst (2000) who relate real estate market correlation to global GDP growth or Stevenson, Akimov, Hutson, and Krystalogianni (2014), finding evidence of concordance in international property markets. We contribute to the literature by identifying co-movements among office markets during financial distress as implied by the common systemic risk contribution of financial institutions in the banking sector. Our findings contrast to the current stream of research which attributes cross-sectional dependence among local residential housing markets to funding supply of the banking sector (see, e.g., Cotter, Gabriell, and Roll (2015), Landier, Sraer, and Thesmar (2017)). We relate office market dependence to systemic risk through the demand-side from the banking sector. In this context, our paper is more in line with recent studies, such as Levitin and Wachter (2013), and Duca and Ling (2018) who argue that residential and commercial real estate follow individual boom and bust periods.

Our findings provide a better understanding of the interconnectedness of international commercial real estate markets. The knowledge about the vulnerability of office markets in financial centers due to their exposure to systemic banking sector risk is essential for policy makers and regulatory authorities. We also highlight the importance of considering correlated risk triggered by this specific linkage to the banking sector for the risk management of investors. Implied return co-movements among different assets during periods when yields are extremely low and the magnitude of price drops is large lead to correlated risks. As a consequence, risk diversification strategies among international office markets and across asset classes lose their effectiveness in times when it is most needed. Hence, regulatory stress tests for the banking sector should not only focus on systemic risk but also on its amplification mechanism for correlated risk between asset classes.

The remainder of the paper is structured as follows. Section 2 introduces the data. Section 3 presents our econometric methodology and discusses the identification strategy. Section 4 shows the empirical results. Section 5 concludes.

# 2 Data

We use commercial real estate office and retail market returns in international financial and non-financial centers from 1995 to 2015. Our sample includes market returns of 61 cities from 28 countries in the United States, Europe, and Asia-Pacific. Property Market Analysis (PMA) provides the data. Returns are constructed at the city-level from prime rents per square meter and the initial yield taking into account depreciation and management costs. We use total returns including the income and the capital growth component. Our data has several advantages compared to established index construction methodologies. First, they reflect the true marked-to-market value of commercial real estate. Second, unlike appraisal-based indices, they do not suffer from a smoothing bias because of historical price information. Third, international appraisal-based indices are difficult to compare because of different valuation techniques. In contrast, our city-level data is based on a homogeneous methodology which allows an international comparison. Finally, they also need no adjustment for time-varying market liquidity, as transaction based indices would require (e.g., Fisher, Geltner, and Webb (1994)).[4]

***Selection of Financial Centers.*** We identify 29 cities as financial centers.[5] Conceptionally, there exists no unique definition of a global financial center.[6] Survey-based indices, such as the Global Financial Center Index (GFCI) and the Xinhua/Dow Jones International Financial Centers Development Index, rank international cities based on their competitiveness. Criteria are the business environment, infrastructure, political stability, the ease of doing business, tax incentives, the attractiveness of the labor market,

[4]To address potential concerns about the PMA database, we test its correlation with the established international, appraisal-based IPD index series. We find a correlation of 72% for office markets and 63% for the retail sector. Note that even though IPD indices are only available at the country-level, its market coverage of cities should coincide more or less with the PMA sample.

[5]We list the cities in Table A.1 of the Appendix. Panel A indicates the market coverage of financial centers. Panel B specifies all non-financial centers.

[6]Some cities dominate in specialized financial services. Examples are Zurich for wealth management, or Chicago for commodity futures trading. Other cities, such as Frankfurt, Hong Kong, Singapore, or Tokyo, are considered as regional financial centers. We refer to Lizieri (2009) for a general discussion. Wójcik (2013), for instance, considers only London and New York as dominant global financial centers.

and access to international capital. However, these indices do not clearly distinguish between financial and non-financial centers. Historically, the financial service industry has been built near local stock exchanges to benefit from international capital and from floor trading access (see, e.g., Lizieri, Baum, and Scott (2000), Wójcik (2013)). Therefore, we define cities as financial centers if they host the national stock exchange trading platform. Our approach is motivated by Cetorelli and Peristiani (2013) who highlight the importance of stock exchanges as a proxy for the attractiveness of financial centers. We also rule out offshore financial centers, such as the Cayman Islands, the British Virgin Islands, or Jersey. Even more important, following this definition, financial centers in our sample are historically predetermined. Hence, the classification is exogenous for the current office market performance.[7]

***Relation to Stock Markets.*** We use international stock market price indices that are representative for the financial center stock exchange. For example, the representative listed price index for the New York Stock Exchange (NYSE) is the S&P500. Similarly, we use the FTSE500 for the London Stock Exchange (LSE), or the Hang Seng Index for the Hong Kong Stock Exchange.[8] We use log-differences of the price index to compute annual returns.

To give the reader some intuition of the performance of commercial real estate, Figure 1 compares the return variation of regional real estate office and retail markets with the stock market behavior from 1995 to 2015. In the Panels A to C, we use average market returns across all financial centers to compare the performance between office and retail markets for the United States (U.S.), Europe, and Asia-Pacific relative to changes in the average stock market price index. The figures are based on local currencies to illustrate the return performance which is unaffected by movements of the USD relative to the local

[7] This exogeneity assumption would be violated when we use the classification criteria of GFCI to identify financial centers. To measure the attractiveness of a financial center, the criteria include the office market condition of the city, such as building infrastructure.

[8] Table A.1 of the Appendix provides an overview of the listed stock market indices and the corresponding trading platforms.

currency.[9] Office and retail markets follow a common cyclical trend with the average stock market. However, we observe a much stronger downward trend in international office markets compared to the corresponding retail sector during the aftermath of the dotcom bubble burst in 2001 and 2002 and the recent financial crisis period in 2007/2008. For instance, in European office and retail markets average returns were about 16% in 2000. However, in the subsequent years office returns fell to -2.4%, while retail returns decreased only to 7% in 2002. Similarly, U.S. office markets dropped on average from 25% in 2007 to -25% in 2009. For comparison, retail market returns decreased from 10% to -11% during the same period.

[INSERT Figure 1 HERE]

Figure 2 illustrates impulse response functions from a panel vector autoregression (VAR) to further establish the dynamics between stock markets and office market returns in financial centers. The graph suggests that local stock market returns positively affect the related office market. The positive relationship might be channeled through employment. The financial service sector hires employees during financial boom periods and requires additional office space. The positive impact on the expected discounted rental cash flow translates into higher office market returns. During bust periods, the poor performance of the financial service industry leads to job losses and lowers the demand for office space. We expect a similar relation between the stock market and the retail sector. A poor local banking sector performance implies lower bonus payments for bankers and less income for consumption, which should also reduce the demand on the corresponding retail market. To capture the effect of the local stock market performance on both commercial real estate sectors in financial centers, we include stock market returns as an additional control variable when we test for the relation between office market dependence and systemic risk of the banking sector.

[9]In the empirical analysis, we then use USD-denominated returns for comparability and control for the exchange rate between the local currency and the USD. However, in unreported regressions we find similar results for returns denominated in local currencies.

We also analyze how a positive office market shock affects the stock market performance. The contemporaneous increase is short-living and immediately declines. We interpret this relation in terms of opportunity costs of capital, leading to immediately higher required stock market returns, followed by a potential capital switching of investors from stocks to more attractive office property investments. However, the confidence band of the impulse response function widens and includes zero.

[INSERT Figure 2 HERE]

***Expected Capital Shortfall.*** The most prominent systemic risk measures proposed by the literature are the Marginal Expected Shortfall (MES) of Acharya, Pedersen, Philippon, and Richardson (2017), the Systemic Risk Measure (SRISK) of Acharya, Engle, and Richardson (2012) and Brownlees and Engle (2017), and the Delta Conditional Value-at-Risk ($\Delta$CoVaR) of Adrian and Brunnermeier (2016). The MES measure captures the marginal risk contribution of a financial institution to systemic risk based on the value-weighted market return, whereas SRISK not only takes account of the size but also of the liabilities of a financial institution. The $\Delta$CoVaR takes the difference between the VaR of the financial system conditional on a particular bank being in financial distress and the VaR of the financial system given the bank is in a normal state. Benoit, Colliard, Hurlin, and Pérignon (2017) show that the MES measure, and thus the corresponding systemic risk ranking of financial institutions, is highly correlated with the banks' market beta and that this measure fails to forecast the contribution to systemic risk. Similarly, they illustrate that $\Delta$CoVaR is proportional to the bank's tail risk and that the most risky institutions in terms of VaR are not inevitably the ones showing the highest systemic risk. In contrast, according to them, the relation between systematic and systemic risk is less severe for SRISK, since it includes both market capitalization and leverage.[10]

To compute the aggregated expected capital shortfall in the financial center, we use the Brownlees and Engle (2017) SRISK measure of international financial institutions from 2000 to 2015.[11] SRISK quantifies the dollar-denominated expected capital shortfall of a financial institution $i$ in period $t$ which would occur from a hypothetical decline of 40% or more in the MSCI world equity price index return over the next period of $h = 6$ months:

$$SRISK_{it} = E_t(CS_{it+h} \mid R_{MSCI,t+1,t+h} < -40\%), \tag{1}$$

with capital shortfall $CS = k(D + W) - W$, market value $W$, book value of debt $D$, prudential capital ratio $k$, and the multiperiod equity return between period $t + 1$ and $t + h$.[12] Based on balance sheet information, the expected capital shortfall measures the difference between the capital reserves a financial institution must hold because of regulatory requirements or prudential management and the equity that arises from the expected decline in the market value of the assets. We only include financial firms with a positive expected capital shortfall to focus on systemically relevant banks.

In a next step, we compute the total level of expected capital shortfall of the banking sector in the financial center. For each financial center $c$, we calculate the sum of the expected capital shortfall, i.e., the individual $SRISK$ value, of financial institutions with domestic and foreign head offices (headquarters, branches, or subsidiaries) in the financial

[10]Given our definition of a financial center it is important to clearly separate systemic from systematic risk. For instance, if banks specialized in similar business areas choose to be present in the same market, a shock to this respective business field will commonly affect banks in this specialized field. By controlling for systematic banking sector risk as well as financial center fixed effects, we rule out that an omitted regional systematic risk factor leads to co-movements and not necessarily a systemic risk exposure.

[11]The data is provided by the NYU Stern Volatility Lab. Table A.2 of the Appendix provides a snapshot of financial institutions with the highest SRISK level observed during our sample period.

[12]Following Brownlees and Engle (2017), we set the prudential capital ratio equal to 8% for the U.S. and Asia-Pacific, but restrict the parameter to 5.5% for Europe. This allows us to capture differences in the Generally Accepted Accounting Principles (GAAP) for the U.S. and the International Financial Reporting Standards (IFRS) applied in Europe. However, as mentioned in their paper, the ranking of financial institutions based on their expected capital shortfall is robust to changes in parameter $k$.

center

$$SRISK_{c,t} = \sum_{i=1}^{n} SRISK_{it}. \tag{2}$$

To identify the head office locations of financial institutions, we use their corresponding SWIFT codes.[13] Figure 3 illustrates the distribution of the financial institutions among financial centers. For instance, the largest concentration of financial institutions can be observed in London, Hong Kong, and New York.[14]

[INSERT Figure 3 HERE]

Since the financial firms' SRISK measures are denominated in USD, we can aggregate the expected capital shortfall of the financial institutions. The denomination in USD also allows us to compare the potential undercapitalization across financial centers.[15] Following the economic intuition of Brownlees and Engle (2017), the aggregated SRISK of the financial center can be interpreted as the required amount of capital that would be needed to bail out the city-specific banking sector during a crisis.

Figure 4 illustrates the performance of the aggregated SRISK measure. In Panel A, we rank the 15 financial centers with the highest SRISK from high (London, Hong Kong, Singapore, and New York) to low (Madrid, Amsterdam, and Luxembourg). For instance, the SRISK value of 1,408,394 million USD for London can be interpreted as the city-specific total amount of dollar-denominated expected capital shortfall of financial institutions with domestic and foreign head offices located there. International cities with the highest systemic risk contributed by the financial institutions' local head offices are also ranked as most relevant financial centers according to the GFCI and the Xinhua/Dow Jones International Financial Centers Development Index. Panel B of Figure 4 shows the

[13] The SWIFT (Society for Worldwide Interbank Financial Telecommunication) established a standardized communication and service network for transactions among financial institutions. The SWIFT code contains information about the geographic location of financial institutions.

[14] Taking into account all financial institutions, the total number of domestic and global head offices are 150 (114) for London, 120 (91) for Hong Kong, and 93 (83) for New York (when we consider financial institutions with at least two global head office locations).

[15] Similarly, Brownlees and Engle (2017) compute the global systemic risk by aggregating the individual SRISK values of financial firms.

average SRISK computed from the cross-sectional city-specific levels over time. The average systemic risk of all financial centers follows an increasing trend during our sample period from 2000 to 2015 and reaches its peak in 2012.

[INSERT Figure 4 HERE]

The total amount of expected capital shortfall of systemically relevant financial institutions is significantly different between office markets in financial centers and non-financial centers.[16] Figure 5 illustrates the mean difference between the aggregated SRISK of both groups. On average, the total expected capital shortfall of the banking sector in financial centers equals 687,305 million USD. Office markets in non-financial centers are only exposed to an average amount of expected capital shortfall of 118,282 million USD. Financial center office markets should be more vulnerable during financial turmoil times because of the higher systemic banking sector risk.

[INSERT Figure 5 HERE]

***Additional Control Variables.*** We include a set of country-specific and global risk factors. GDP growth per capita captures potential business cycle movements that drive the return performance of office and retail markets. The inflation rate, measured as log-difference in the consumer price index (CPI), serves as a proxy for the economic strength of the host country and indicates the relative attractiveness, which would also be reflected in international capital flows. The empirical analysis is based on USD-denominated returns. Therefore, we include changes of the exchange rate to capture movements between the local currency and the USD as additional explanatory variable. We want to rule out that return co-movements are driven by a common exchange rate component.

[16] To allow a clear distinction, we exclude Boston, Chicago, San Francisco, and Washington from our sample. Following our definition, these cities are identified as non-financial centers, while the GFCI ranks them among financial centers.

We are interested in the correlated risk between financial markets and private commercial real estate which is channeled through the systemic risk contribution of financial institutions in the banking sector. Therefore, we control for returns of domestic real estate investment trusts (REITs) to mitigate potential concerns that the linkage mechanism emerges from publicly listed companies which buy and sell properties. Furthermore, we include the dollar-denominated MSCI World equity index return to capture fluctuations in global stock markets. By construction, the SRISK is triggered by the MSCI world equity index. Therefore, we want to rule out that the office market dependence is merely driven by the performance of the global stock market.

We also control for the credit supply of the banking sector to rule out that return co-movements among office markets during crisis periods are implied by a dry-out of funding liquidity. Our argumentation is based on Davis and Zhu (2011) who find a relation between credit cycles of the banking sector and international commercial real estate price developments. As a rough proxy for bank loans, we use international cross-border claims on each country as the residence counterparty, provided by the Bank of International Settlement. This proxy measures the change in dollar-denominated international amounts outstanding from the national non-bank sector and captures loans, deposits, and other instruments, such as debt securities. Co-movements across property markets might also be related to the securitization process in the commercial real estate industry, providing funding liquidity via structured commercial mortgage backed securities (Levitin and Wachter (2013), Duca and Ling (2018)). We compute the spread between the yields on the U.S. CMBS index and the long-term government bond. A larger spread is related to higher perceived market risk and might lead to a decline in funding liquidity.

To ensure that the systemic risk contribution does not merely reflect the exposure of locally active banks to bank-specific risk factors, we disentangle both effects in our empirical models. We explicitly control for systematic risk in the local banking market, specifically, interest rate risk and credit risk, as proposed by Begenau, Piazzesi, and

Schneider (2015). In addition to the CMBS spread, we control for the TED spread, which is computed as the difference between the LIBOR rate and the risk-free U.S. Treasury bill rate and measures global liquidity risk.[17] The TED spread particularly increases during financial crisis periods (Brunnermeier (2009)). As a local risk factor, we use the term spread, which is measured as the country-specific long-term government bond yield relative to the corresponding short-term interest rate.[18]

Additionally, we include the construction rate of the office and retail market in the financial center, defined as the log-difference in floor space, to capture systematic differences in their stock supply. At the city-level, we use population growth to control for differences in the trend among commercial real estate office and retail markets. Since the population reflects the demand side for goods in cities, its growth rate should be more important for the retail than for the office sector. We also include the correlation between the national stock market return and the global MSCI world return as a proxy for the financial market integration of the representative trading platform. Financial centers whose equity markets are more integrated might be more attractive for financial institutions, which should impact the office market performance.

Table 1 presents summary statistics for the variable in our sample. We pool across all cities and countries over the sample period. The average annual office return equals 6%, while the annual retail market performance is on average 9%. Comparing the returns with a $t$-test, the mean difference is statistically significant. The corresponding construction rates, defined as a change in floor space, are on average 2% and 3% for the office and retail market, respectively. The average systemic risk exposure of the financial centers equals 435,398 million USD with a standard deviation of 557,111 million USD. The correlation among our control variables varies from 0.001 between REIT returns and the U.S. CMBS

[17]For the European area, we use the three month EURIBOR instead of the LIBOR rate and the EONIA rate as proxy for the risk-free rate.

[18]In Table A.3 of the Appendix, we show the relation between the aggregated SRISK measure and the bank-specific risk factors. We identify the CMBS spread as well as short- and long-term interest rates as potential risk factors; both are explicitly (U.S. CMBS spread) or implicitly (Term Spread, TED Spread) included as controls in our empirical models.

spread to 0.474 between growth in GDP per capita and REIT returns.

[INSERT Table 1 HERE]

# 3 Measuring Cross-Sectional Dependence

In this section, we present our spatial econometric framework. To model the dependence between financial center office market returns, we specify the following model

$$r_{it} = \lambda \sum_{j \neq i} w_{ij} r_{jt} + X_{it}\beta + \eta_i + \varepsilon_{it}, \tag{3}$$

where we regress office market returns in financial center $i$ on the weighted average of contemporaneous office markets returns in other financial centers. The weighted average $\sum_{j \neq i} w_{ij} r_{jt}$ is defined as the spatially lagged dependent variable. The pre-specified weight $w_{ij}$ between office markets $i$ and $j$ reflects the underlying linkage mechanism. The spatial lag parameter $\lambda$ measures the degree of cross-sectional dependence from the interconnectedness between the cross-sectional units of the endogenous variable. We also include a set of common risk factors, captured by matrix $X_{it}$, and individual fixed effects $\eta_i$.

***Specification of the Weighting Matrix.*** Our methodology allows us to empirically test whether the common systemic risk contribution of the banking sector between financial centers implies cross-sectional dependence among the underlying office markets. The spatial weight $w_{ij}$ between office market $i$ and $j$ is defined as the sum of individual binary linkages for financial institutions with head offices in both financial centers. The binary indicator variable $\mathbb{1}$ equals one if head office locations of financial institution $l$ exist in cities $i$ and $j$, and zero otherwise. Using the Brownlees and Engle (2017) SRISK measure, we multiply the binary linkage for each financial institution with the percentage

SRISK ($\%SRISK_l$). Specifically, we compute

$$w_{ij} = \sum_l \mathbb{1}\big(head\ office_{il} \cap head\ office_{jl}\big) \times \%SRISK_l. \tag{4}$$

The percentage SRISK indicates a financial firm's contribution to the overall global systemic risk. This measure is comparable to the established ΔCoVaR, which is based on the tail dependency between a firm and the financial system and measures how the systemic risk of the overall system is related to the distress of an individual institution. The additional weighting with the $\%SRISK$ also ensures that financial institutions with a higher systemic risk contribution get a larger weight in both financial centers. A higher common systemic risk contribution between two financial centers, reflected in a larger spatial weight, should imply stronger co-movements among their related office markets during financial crisis periods. We apply a row-normalization to the weighting matrix to interpret the spatially lagged dependent variable as weighted average. As is standard in the literature of spatial models, we also impose $w_{ii} = 0$ such that each office market return is exposed to the weighted average of the contemporaneous office market returns but not to itself. To capture fluctuations of the expected capital shortfall over time, we allow for a time-varying weighting matrix. Panels A and B of Figure 6 compare the interconnectedness of financial and non-financial centers as implied by their weighting matrix for the year 2007.[19] We illustrate the network maps for both groups as an example to show the stronger linkage of the banking sector among financial compared to non-financial centers. For example, as indicated by Panel A, the financial center Osaka is only linked to London and Tokyo. The interconnectedness depends on (i) all financial institutions that have international head offices in both financial centers, e.g., Osaka and Tokyo, as well as (ii) their positive expected capital shortfall. This implies that financial institutions which

[19]The network maps look similar for the other years during our sample period. However, because of the hypothetical characteristic of the SRISK measure, the office markets should only be commonly affected through this linkage mechanism during financial turmoil periods when the asset price decline materializes on the balance sheet. During normal times, the interconnectedness is hypothetical without real consequences for the financial centers.

might have office locations in Osaka and other financial centers, but whose balance sheets would not suffer a potential undercapitalization, are not considered.

[INSERT Figure 6 HERE]

***Identification Strategy.*** In order to isolate the common systemic banking sector risk as source of office market co-movements, we apply placebo tests that are based on a double counterfactual approach. The systemic risk measure used in our research design is based on the expected capital shortfall of financial institutions that would occur given a hypothetical decline in the global equity market. Consequently, we should observe an effect of the systemic banking sector risk on office market return co-movements only during periods of financial distress, when asset prices fall and, therefore, affect the balance sheet of financial institutions. In contrast, the balance sheets are unaffected during normal financial market times. As crisis periods we define the dotcom bubble burst in 2001/2002 and the financial crisis period 2007/2008. Brunnermeier, Rother, and Schnabel (2017) find a higher systemic risk in the banking sector as a consequence of asset price bubbles. Our chosen crisis periods match with the subsequent financial turmoils of their identified stock market bubbles during the sample period.

We first estimate our spatial lag model for financial center office market returns. Imposing restrictions in the time-varying weighting matrix such that all spatial weights are set equal to zero during normal financial market periods, we test for cross-sectional dependence among office markets during financial crises. We then restrict the elements of the weighting matrix to zero during financial turmoil periods and re-estimate our spatial lag model as a placebo test for spatial dependence among office markets during normal times.

Second, we apply the same approach to financial center retail markets during crisis periods. The retail market in the same financial center serves as an ideal counterfactual for the office market. Both markets follow the same common trend driven by local market characteristics. However, the retail sector should not be directly exposed to the systemic risk of the banking sector, particularly when we control for macroeconomic fundamentals, such as GDP growth. Hence, we should not find any empirical evidence of co-movements among retail markets that are related to the common banking sector risk. Exploiting the retail sector as a counterfactual also helps us to disentangle our transmission channel from international investment flows during crisis periods. Because of the common trend assumption, an investment outflow during crisis periods should commonly affect the office and the retail sector within financial centers. Our identification strategy allows us to distinguish between the common systemic banking sector risk as an underlying source of dependence and potential omitted common factors. Common institutional factors, e.g., similarities in transparency, infrastructure, culture, or geographic distance, might affect office market return co-movements not only during financial distress but also during normal times and should jointly lead to statistically significant co-movements among financial center retail markets.

***Reflection Problem.*** Spatial models raise concerns about the reflection problem (Manski (1993)). The dependence that is captured by the weighted average of the endogenous variable might reflect the cross-sectional dependence that arises from explanatory variables.[20] For instance, office market return in country $i$ might be affected by a change in GDP of country $j$. We disentangle both sources of cross-sectional dependence. The endogenous spatial lag reflects the common exposure to the systemic banking sector risk as specified by the weighting matrix. The latter effect is captured by the cross-sectional average of the explanatory variable as an additional regressor. However, it only indicates the systematic risk of explanatory variables on contemporaneous, cross-sectional units of the endogenous variable. To mitigate concerns about the reflection problem, we include a cross-sectional average of explanatory variables that captures the spatial dependence arising from explanatory risk factors. In this context, we also control for the common

[20]Taking into account the cross-sectional dependence from explanatory variables, the model specification would be $r_{it} = \lambda \sum_{j \neq i} w_{ij,t} r_{jt} + X_{it}\beta + \delta \sum_{j \neq i} w_{ij,t} X_{jt} + \eta_i + \varepsilon_{it}$.

impact of the global GDP trend, denoted as average of country-specific GDP growth on international commercial real estate markets (Case, Goetzmann, and Rouwenhorst (2000)).

***Fixed Effects.*** We include individual fixed effects at the financial center level for two reasons. First, this specification allows us to mitigate the omitted variable bias from time-invariant factors that might explain systematic differences among office markets, e.g., currency zones, gateway cities, quality of life, and local regulation, or attractiveness of financial centers. This unobserved heterogeneity might be correlated with the spatially lagged dependent variable. For example, property markets in gateway cities are particularly attractive for international investors, which should channel international investment flows to both the corresponding commercial real estate office and the retail sector. More restrictive domestic banking regulations might imply a lower demand for office space of locally active banks in the financial center. Second, as imposed by the within-structure of fixed effects, our model explains the variation of office market returns over time within each financial center. Consequently, the estimated coefficient of the spatial lag parameter not only measures the degree of dependence among contemporaneous office market returns, but also reflects the degree of co-movements among them. We do not include year fixed effects in our models. The variation in the data that is left under such specification would be the idiosyncratic component of the cross-sectional unit. Yet, we explicitly want to test for the transmission channel of spatial correlation among office markets. To mitigate the omitted effect of time dummies, we include global factors as control variables that commonly affect all office markets each year.

# 4 Empirical Results

This section presents the empirical results. All regression models are based on USD-denominated returns to allow for a comparability among international office market performance.

## 4.1 Systemic Risk as Transmission Channel

We test for the common systemic risk contribution of financial institutions between financial centers as a transmission channel for co-movements among office markets during periods of global equity market turmoil. International banks are exposed to stock market fluctuations through the marked-to-market value of assets in their balance sheets.[21] A high expected capital shortfall during financial crisis periods leads to an undercapitalization of the banking sector and might affect office markets through potential fire-sales and insolvencies in the financial service sector that reduce the demand for office space and lower investors' office market return expectations.

Table 2 shows different specifications of the spatial lag model (Model I as the baseline model and Models II and III for robustness). We apply the Wang and Lee (2013) GMM estimator to account for the endogeneity between cross-sectional units of the market return that arises from the spatial dependence. Their estimation strategy allows us to include a time-varying weighting matrix and to estimate a spatial lag model with fixed effects using unbalanced panel data. Following Kelejian and Prucha (2007), we use heteroscedasticity and autocorrelation consistent (HAC) standard errors that are adjusted for the dependence structure of the weighting matrix.

Our findings suggest spatial dependence among financial center office markets during periods of financial distress that can be related to the common systemic risk in the banking sector. We use the dotcom bubble burst 2001/2002 and the recent financial crisis 2007/2008 as turmoil periods. We allow for a time-varying weighting matrix for these years and restrict the spatial weights to zero for the rest of the sample period. For each

[21] For instance, the most prominent example when the financial crisis hits the banking sector in 2008 was marked by the collapse of the investment banks Bear Stearns and Lehman Brothers (see, e.g., Brunnermeier (2009)). As indicated by Table A.2 in the Appendix, with 57,692 million USD, Lehman Brothers had its highest expected capital shortfall in March 2008, six months prior to its insolvency in September 2008.

model specification, we find a statistically and economically significant high degree of cross-sectional dependence as implied by the spatial lag coefficient $\lambda$. Models I to III suggest return co-movements with estimated spatial lag parameters of about 32% during financial turmoil periods.

We re-estimate each model to test for office market dependence during normal periods. Therefore, we restrict the elements of the weighting matrix to zero for the defined crisis periods and allow for time-varying weights during normal times. However, we do not observe a statistically significant spatial lag coefficient. During normal times, the expected capital shortfall of financial institutions provides only a hypothetical measure of the undercapitalization in the banking sector that would be observed in the event of a global stock market decline. Hence, the common systemic risk in financial centers should not translate into office market return co-movements during normal times. Since we find no evidence of spatial dependence among office markets during normal times, we can rule out that the office market dependence might be related to some omitted time-invariant institutional factors during the sample period.

We also compare the dependence among office markets to the counterfactual retail market during turmoil periods.[22] Using retail market returns as the endogenous variable, we re-estimate Models I to III to test for spatial dependence during financial turmoil periods by restricting the weighting matrix to zero in normal times. Again, we do not find a statistically significant spatial lag coefficient for the counterfactual. This supports our hypothesis that office market return co-movements might be transmitted through the common systemic banking sector risk during financial distress.

[INSERT TABLE 2 HERE]

The observed return dependence among financial center office markets cannot be explained by the exposure to common systematic macroeconomic risk factors. We use

[22] Our sample does not include retail market data for all financial centers. This limitation explains why the sample for the counterfactual retail market contains a smaller cross-section. The cross-sectional units that are excluded can be seen in Table A.1 in the Appendix.

contemporaneous covariates in our model to rule out that the observed spatial dependence might arise from omitted common risk factors. The models control for the positive relation between office markets and the underlying stock market performance within financial centers. The estimated coefficient in Model I implies that a 1%-change of stock market returns increases the local office market return by 0.15%. The exposure to the systemic risk of the banking sector prevails conditional on the relationship between stock market returns and office market performance. As expected, we find a similar effect on the retail market performance which could be explained by the consumption expenditures of employees from the financial service industry in the retail sector.

We also include the aggregated level of expected capital shortfall in the financial center. If any, some model specifications indicate only a weak statistically significant negative relation between the hypothetical capital shortfall of financial institutions in the financial center, and the related office market. Intuitively, a higher exposure of the local office market to the expected undercapitalization of the local banking sector might have a dampening effect on expected rental cash flows. However, the effect is economically insignificant. We additionally control for the total expected capital shortfall to isolate the common systemic risk contribution between financial centers as the transmission channel for office market return co-movements. The concentration of systemic relevant banks in financial centers might increase the vulnerability of the underlying local office market during periods of financial distress. However, this effect should be captured by the spatial lag parameter which measures the overall dependence among office markets during turmoil periods. During normal times, the financial center-specific SRISK reflects only a hypothetical effect.[23]

[23] Conceptionally, this variable differs from the transmission channel which is indicated by the weighting matrix. The aggregated SRISK measures the total expected capital shortfall of the local banking sector, whereas the weighting matrix reflects the interconnectedness of financial centers based on their common systemic risk contribution. Technically, the interconnectedness is based on head office locations of financial firms weighted by their $\%SRISK$. In this context, we can rule out that our model suffers from an overfitting. In a robustness test, we re-estimate the models without including the aggregated SRISK of the financial center. The results are qualitatively the same.

We capture country-specific and local market characteristics as additional controls. Model I includes macroeconomic fundamentals, such as GDP growth, the term spread, and the inflation rate. These variables reflect the growth potential of the property market. Since returns are denominated in USD, we control for potential exchange rate effects relative to the local currency. At the city-specific level, population growth and the additional supply of commercial real estate capture systematic differences between the office and the retail sector. National REIT market returns control for the direct channel between the country-specific stock market performance and property market returns. Additionally, we take into account international bank lending activity. We find a positive relation between office market returns and the performance of mortgage-backed securities as a source of funding liquidity. As an additional control, we include the potential return correlation of the representative national stock market with the MSCI world index.

The results are similar, when we add control variables for robustness. Model II captures the overall global interbank credit risk as reflected in the TED spread. A widened spread as a proxy for a higher default risk of the banking sector lowers the office market performance. Model III accounts for spatially lagged explanatory variables by introducing the average GDP growth. This common factor captures the systematic risk of macroeconomic fundamentals $i$ on the cross-sectional unit $j$ of office market returns, thereby, controlling for the potential reflection problem (Manski (1993)). The local office market exposure to other cross-sectional units of GDP growth is on average positive (with an estimated magnitude of 0.55% during turmoil times), which reflects a positive relation between international commercial real estate markets and global GDP growth. The introduction of a spatially lagged explanatory variable in our model does not affect the main results.

## 4.2 Robustness Tests

This section presents several robustness tests. We address several empirical strategies to support the systemic risk contribution of financial firms between financial centers as transmission channel for the underlying office market dependence.

***Non-Financial Centers.*** We re-estimate the spatial regression models using a sample that includes only non-financial center office markets. Since the expected capital shortfall of the banking sector in non-financial centers is significantly smaller than in financial centers, office markets in these cities should be less vulnerable to the global systemic risk during periods of financial distress. Table 3 presents the estimated coefficients. We find no statistically significant effect of office market co-movements implied by the common banking sector risk in our model specifications. Following our criterion of how we define financial centers, our sample of non-financial centers also includes the cities Boston, Chicago, San Francisco, and Washington. These cities are ranked among the top 15 financial centers according to the GFCI but do not host national stock exchanges for equities. Before estimating the model, we therefore exclude these four cities from our sample.

[INSERT TABLE 3 HERE]

***MSCI World Index as Common Factor.*** A potential concern could also be that our transmission channel reflects the common effect of the MSCI world equity index on international commercial real estate in financial centers. By construction, the SRISK measure of financial institutions depends on the performance of the global equity market. In Table 4, we re-estimate the spatial model for financial and non-financial centers when we include global MSCI world equity index returns as an additional control variable instead of national stock market returns. We show that even after controlling for the global equity market performance, our transmission channel of common systemic risk contribution among financial centers prevails and implies statistically significant return co-movements among the related office markets during turmoil periods. The estimated coefficients of the spatial model are qualitatively the same. As expected, we find no evidence of office market dependence among non-financial centers.

[INSERT TABLE 4 HERE]

***Evidence from the Sovereign Debt Crisis.*** Table 5 tests for spatial dependence during the European sovereign debt crisis. We apply the same identification strategy and compare the spatial dependence across financial centers and the counterfactual retail market during the crisis periods 2010 and 2011, when the European sovereign debt crisis hit the banking sector. The estimated spatial lag coefficients are insignificant for both sectors. This finding is in line with our economic intuition. The origin of the European sovereign debt crisis was mainly confined to Ireland and Southern European countries, such as Italy, Portugal, Spain, and particularly Greece. The crisis was immediately followed by specific bailout strategies for local banks to prevent spillover effects to the overall financial banking sector (Lane (2012)). Based on our finding, we can also rule out that our identification strategy merely captures crisis effects on financial center office markets.

[INSERT TABLE 5 HERE]

## 4.3 Evidence from Asset Price Bubbles

Subsection 4.1 shows empirical evidence of cross-sectional dependence among office markets during financial turmoil periods. If the common systemic banking sector risk implies office market co-movements among financial centers, we should observe a significant downward trend in their returns relative to retail markets during periods of financial distress when asset market prices fall. As an additional robustness test, we therefore analyze the return performance of office markets relative to the corresponding retail sector during periods of financial distress. Motivated by Brunnermeier, Rother, and Schnabel (2017) we separately use the recent financial crisis period and the dotcom bubble burst in a quasi-experimental setting. Concerns might arise from the question to what extent the recent financial crisis can be considered as an exogenous event for commercial real estate markets that emerged from stock markets. Several studies, such as Brunnermeier (2009), detect the origin of the recent financial crisis in the residential housing bubble burst and its transmission to the financial service industry through the subprime mortgage market. In line with Levitin and Wachter (2013), we observe a decrease in commercial real estate markets that was not parallel to the housing market bust in 2007, but occurred during the aftermath of the recent financial crisis.

We specify the following linear difference-in-difference model

$$r_{it} = \beta_0 + \beta_1 D_{Crisis} + \beta_2 D_{Office} + \beta_3 (D_{Crisis} \times D_{Office}) + X_{it} + \epsilon_{it}, \quad (5)$$

with property market returns $r_{it}$ regressed on the dummy variable for the financial crisis period, $D_{Crisis}$, the office market dummy, $D_{Office}$, and their interaction term conditional on a set of control variables $X_{it}$. For the recent financial crisis period, we split the sample into two sub-samples. The pre-crisis period ranges from 2005 to 2007. The years 2008 and 2009 resemble the aftermath of the financial crisis. To analyze the impact of the dotcom bubble burst, we split the sample into a pre-crisis period from 1995 to 2000 before the bubble burst, and the subsequent turmoil during the years 2001 and 2002, for which the crisis dummy is equal to one. We then apply the difference-in-difference approach between office and retail markets during the financial crisis turmoil relative to the pre-crisis period. Based on the parametric specification, the interaction term assesses the office market performance during the financial market turmoil when we use retail market returns as counterfactual.

Using retail markets of the financial centers as a counterfactual fulfills the required common trend assumption for the difference-in-difference framework. The common trend assumption also mitigates potential concerns about the effect of a lower credit availability on the performance of commercial real estate markets. Assuming that bank loans to real estate are more or less similarly distributed across the retail and the office sector, this effect would be captured by the common trend, while the systematic difference between both markets during financial distress can be related to the systemic risk in the banking sector. We also distinguish between the immediate effect of the crisis period on the financial service sector occupying office space and the long-term consequences on the real economy that might also affect the retail market performance. Therefore, we restrict the crisis periods to the years 2001 and 2002 to capture the effect immediately after the dotcom bubble burst, while we use the aftermath period 2008/2009 of the recent financial crisis.

Model I of Table 6 indicates a coefficient estimate of -0.11 for the interaction term between the post-crisis dummy (2008/2009) and the binary office market indicator. The negative coefficient implies an average decrease in office market returns relative to the counterfactual during the aftermath of the recent financial crisis. Common factors and city-level specific controls are removed by construction of the difference-in-difference setup. Model II controls for systematic differences in floor space between both sectors. Floor space is measured in levels to capture the difference in the available supply of space which would not be reflected in the construction rate of new space.

For the dotcom bubble burst, we estimate a negative impact of the turmoil period after the bubble burst in 2000 on office market returns relative to the retail sector (-0.081). Model II indicates a similar magnitude (-0.098), when we control for floor space from the construction sector. The decline is smaller in magnitude compared to the one of the recent financial crisis. However, the implications are the same.

[INSERT TABLE 6 HERE]

## 4.4 Financial versus Non-Financial Center Office Markets

We also compare office market returns between financial and non-financial centers. To clearly distinguish between financial and non-financial centers, we exclude Boston, Chicago, San Francisco, and Washington from our sample. To further analyze the implications of the difference in aggregated level of expected capital shortfall, we provide a mean return comparison between financial center and non-financial center office markets during turmoil periods. We follow the same methodology as in the previous subsection. Table 7 suggests 12% lower office market returns in financial than in non-financial centers during the recent crisis period 2008/2009. While the common trend assumption might be fulfilled because of a global office market trend, we do not have sufficient city-level controls to fully capture all systematic differences between financial and non-financial centers. Therefore, our intention in this robustness test is not to make any causal statement but to use the difference-in-difference approach as a mean comparison for office market returns between both groups.

We find no significant mean difference after the dotcom bubble burst in 2001/2002.[24] The results are intuitive: The dotcom bubble burst triggered a general stock market crisis, whereas the recent financial crisis was directly related to the banking sector, leading to an undercapitalization of financial firms (Brunnermeier (2009)). Hence, the negative effect on office markets should be larger in financial centers, where the total expected capital shortfall of the banking sector is higher, compared to non-financial centers. Overall, the results are similar when we control for the lagged supply of office space and city-level population growth (Model II) and additional country-specific macroeconomic control variables (Model III). We do not control for international bank claims. Because of the limited data availability prior to 2000, we would have to remove several countries from our sample which would potentially lead to a too small sample size.

[24]San Francisco is not included in the sample to rule out any effect that could arise from the geographic proximity to Silicon Valley. Many overvalued dotcom companies had their headquarter located there at that time.

[INSERT TABLE 7 HERE]

Motivated by the results of Table 7, we extend our analysis on office market returns during the aftermath of the recent financial crisis in the years 2008 and 2009. From Figure 5, we conclude that the total SRISK is systematically higher in financial than in non-financial centers. Table 8 shows that office market returns are not significantly lower in cities with a higher expected capital shortfall, both in terms of a level effect (Model I) as well as its growth rate (Model II), when we control for the recent financial crisis. However, Models III to V indicate that the decrease in office market returns because of the financial crisis is stronger in cities with a larger total SRISK in the banking sector.[25] We distinguish between office markets in the sample for which the aggregated expected capital shortfall in the banking sector belongs either to the 25% largest or the 25% lowest each year. We specify dummy variables for both quartiles ($SRISKhigh$ and $SRISKlow$) and interact them with the year dummies of 2008 and 2009 to capture the effect of the aftermath of the financial crisis. On average, office market returns decrease by 12% in those years (Model IV). In contrast, the magnitude decreases by 10.2%-points to -22% for office markets in cities with a banking sector that belongs to the group with the 25% highest expected capital shortfall. In contrast, we find no statistically significant effect for office markets of cities with the lowest 25% expected capital shortfall. This supports our intuition: During normal times, the higher expected capital shortfall does not have a significant impact on office market returns. However, a higher potential undercapitalization of the local banking sector makes the underlying office market more vulnerable during financial crisis periods.

[INSERT TABLE 8 HERE]

[25] We do not include individual fixed effects, which allows us to analyze the cross-sectional variation of market returns. Year fixed effects are also not included to assess the impact of the financial crisis dummy on the cross-sectional differences between office markets.

## 5 Conclusion

This paper tests for the common systemic risk contribution of financial firms between local banking sectors as a source of return co-movements among international financial center office markets. The systemic banking sector risk reflects the potential undercapitalization of financial institutions given a hypothetical decline in the performance of global equity markets. Hence, we test for cross-sectional dependence among financial center office markets during financial turmoil periods, when stock market prices fall, and therefore, affect the balance sheet of financial firms. As crisis periods we exploit the dotcom bubble burst in 2001/2002 and the recent financial crisis in 2007/2008. Our identification strategy is based on a double counterfactual approach. We apply placebo tests for spatial dependence among financial center office markets during normal times and among the counterfactual retail markets during crisis periods.

We find empirical evidence of return co-movements among financial center office markets during financial crisis periods which can be related to the common systemic banking sector risk. As expected, the return dependence among office markets cannot be observed during normal times. Our findings suggest no evidence of co-movements among financial center retail market returns. Additionally, we find no evidence of return co-movements among non-financial center office markets. We also compare the return performance of office markets between financial and non-financial centers during the aftermath of the recent financial crisis. The results indicate a negative impact on the return performance, which is stronger for financial center office markets. This is in line with our economic intuition: the total expected capital shortfall is significantly larger in financial than in non-financial centers, which increases the fragility of the related office markets during periods of financial distress.

Our findings reveal new insights into the vulnerability of international commercial real estate markets in financial centers that can be related to the systemic risk of the banking sector. Even more important, we provide important implications for international investors with respect to diversification potentials and the related risk management of their portfolio. The correlated risk between financial center office market co-movements and the stock markets performance during financial turmoil reduces diversification potentials both within international financial center office markets and across office and stock markets.

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## Table 1: Summary Statistics

This table contains the descriptive summary of the data used in our sample. Each variable is pooled over the cross-section of 61 cities in 28 countries from 2000 to 2015. Representative trading platforms are located in 29 cities. Returns and growth rates (indicated by Δ) are calculated as log-differences. The values are measured in decimals.

| **City-Level** | **Mean** | **Std.Dev.** | **Min.** | **Max.** | **Obs.** |
|---|---|---|---|---|---|
| Office Returns | 0.06 | 0.15 | -0.56 | 0.79 | 899 |
| Retail Returns | 0.09 | 0.13 | -0.70 | 0.71 | 711 |
| ΔFloor Space Office | 0.02 | 0.04 | -0.04 | 0.42 | 914 |
| ΔFloor Space Retail | 0.03 | 0.05 | -0.02 | 0.68 | 720 |
| Stock Returns | 0.02 | 0.30 | -1.24 | 1.17 | 435 |
| SRISK | 435,398 | 557,111 | 21 | 2,745,599 | 820 |
| ΔPopulation | 0.01 | 0.03 | -0.66 | 0.18 | 911 |
| **Country-Level** | **Mean** | **Std.Dev.** | **Min.** | **Max.** | **Obs.** |
| ΔGDP capita | 0.05 | 0.10 | -0.26 | 0.27 | 420 |
| Term Spread | 0.01 | 0.02 | -0.07 | 0.22 | 420 |
| ΔCPI | 0.02 | 0.02 | -0.05 | 0.19 | 420 |
| ΔREITs | 0.00 | 0.05 | -0.29 | 0.13 | 420 |
| ΔExchange Rate | 0.00 | 0.09 | -0.46 | 0.19 | 420 |
| ΔClaims | 0.08 | 0.18 | -0.49 | 0.67 | 420 |
| **Global Level** | **Mean** | **Std.Dev.** | **Min.** | **Max.** | **Obs.** |
| U.S. CMBS Spread | 0.01 | 0.40 | -0.70 | 1.05 | 15 |
| TED Spread | 0.01 | 0.01 | 0.00 | 0.06 | 15 |
| MSCI World Returns | 0.02 | 0.24 | -0.63 | 0.38 | 15 |

Table 2: Common Systemic Risk among Financial Center Office Markets

This table shows the results of spatial models for office and retail markets in 29 financial centers from 2000 to 2015. Estimates are based on GMM. *Turmoil* periods are the dotcom bubble burst 2001/2002 and the financial crisis period 2007/2008. To measure spatial dependence during turmoil periods, the elements of the weighting matrix are restricted to zero during *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero during the crisis periods. *Stock Returns* indicate the log-difference of the national equity market index at the financial center. The financial center-specific total *SRISK* is measured in logs. The country-specific *GDP growth* is measured per capita. The *Term Spread* reflects the difference between long-term government bond yields and short-term interbank rates. Changes in the consumer price index ($\Delta CPI$) proxy expected inflation. Construction ($\Delta$*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. $\Delta$*Population* measures the population growth in the financial center. $\Delta$*Claims* are international cross-border claims on each country's non-bank sector. The *Correlation to MSCI* is a proxy for the stock market integration of the representative stock market indices of the financial centers. $\Delta$*Exchange Rate* measures the change of the local currency relative to the USD. The *U.S. CMBS Spread* is the difference between the yield on U.S. CMBS index and the long-term government bond. The *TED Spread* is defined as the difference between the annualized three-month LIBOR rate and the corresponding three-month U.S. Treasury Bill rate. For the European area, we use the difference between the three-month EURIBOR and the three-month EONIA rate. $\Delta\overline{GDP}$ measures the average GDP growth. The Pesaran (2004) CD test shows $t$-statistics of the null hypothesis of residual independence. Spatial HAC-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | Model I | | | Model II | | | Model III | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Office** | **Office** | **Retail** | **Office** | **Office** | **Retail** | **Office** | **Office** | **Retail** |
| | **Turmoil** | **Normal** | **Turmoil** | **Turmoil** | **Normal** | **Turmoil** | **Turmoil** | **Normal** | **Turmoil** |
| Spatial Lag | 0.316*** | -0.058 | -0.015 | 0.327*** | -0.121 | 0.004 | 0.312*** | -0.322 | -0.053 |
| | (0.116) | (0.271) | (0.114) | (0.122) | (0.383) | (0.112) | (0.112) | (0.545) | (0.116) |
| Stock Returns | 0.154*** | 0.201*** | 0.186*** | 0.124*** | 0.173*** | 0.176*** | 0.154*** | 0.217*** | 0.182*** |
| | (0.033) | (0.039) | (0.035) | (0.035) | (0.041) | (0.039) | (0.033) | (0.050) | (0.035) |
| log(SRISK) | -0.015 | -0.019* | -0.012 | -0.019* | -0.023** | -0.012 | -0.009 | -0.009 | -0.005 |
| | (0.011) | (0.011) | (0.010) | (0.010) | (0.010) | (0.010) | (0.011) | (0.012) | (0.010) |
| $\Delta$GDP Capita | 0.880*** | 0.940*** | 1.035*** | 0.744*** | 0.817*** | 1.000*** | 0.803*** | 0.909*** | 0.975*** |
| | (0.192) | (0.194) | (0.215) | (0.194) | (0.201) | (0.221) | (0.191) | (0.203) | (0.219) |
| Term Spread | -0.379 | -0.476 | 0.887 | -0.289 | -0.368 | 0.964 | -0.361 | -0.406 | 0.759 |
| | (0.442) | (0.469) | (0.589) | (0.430) | (0.469) | (0.593) | (0.437) | (0.509) | (0.583) |
| $\Delta$CPI | -0.706 | -0.843 | -0.110 | -0.566 | -0.672 | -0.060 | -1.030* | -1.444** | -0.476 |
| | (0.544) | (0.570) | (0.554) | (0.531) | (0.564) | (0.559) | (0.574) | (0.688) | (0.561) |
| $\Delta$Floor Space | -0.600* | -0.671* | -0.101 | -0.656* | -0.765** | -0.104 | -0.473 | -0.527 | -0.039 |
| | (0.358) | (0.364) | (0.172) | (0.347) | (0.358) | (0.172) | (0.351) | (0.376) | (0.171) |
| $\Delta$REIT | -0.021 | -0.130 | -0.467* | -0.089 | -0.251 | -0.474* | 0.450* | 0.655** | 0.031 |
| | (0.196) | (0.242) | (0.278) | (0.191) | (0.282) | (0.279) | (0.236) | (0.303) | (0.285) |
| $\Delta$Population | 0.091 | 0.076 | 0.744 | 0.111 | 0.098 | 0.822 | 0.110 | 0.116 | 0.597 |
| | (0.124) | (0.125) | (1.051) | (0.131) | (0.135) | (1.037) | (0.126) | (0.138) | (1.027) |
| $\Delta$Claims | 0.093* | 0.126** | 0.077 | 0.071 | 0.101* | 0.071 | 0.084 | 0.101 | 0.069 |
| | (0.056) | (0.063) | (0.068) | (0.052) | (0.060) | (0.067) | (0.055) | (0.064) | (0.064) |
| Correlation to MSCI | 0.012 | 0.045 | 0.039 | 0.041 | 0.071 | 0.041 | 0.015 | 0.013 | 0.046 |
| | (0.073) | (0.081) | (0.062) | (0.069) | (0.083) | (0.063) | (0.072) | (0.110) | (0.061) |
| $\Delta$Exchange Rate | 0.682 | 0.908 | 0.491 | 0.795 | 1.072 | 0.496 | 0.141 | -0.040 | -0.101 |
| | (0.612) | (0.726) | (0.734) | (0.603) | (0.742) | (0.733) | (0.628) | (0.684) | (0.738) |
| U.S. CMBS Spread | 0.081*** | 0.097*** | 0.013 | 0.070*** | 0.089*** | 0.011 | 0.075*** | 0.103*** | 0.008 |
| | (0.016) | (0.026) | (0.016) | (0.015) | (0.032) | (0.017) | (0.015) | (0.040) | (0.017) |
| TED Spread | | | | -3.579*** | -4.100*** | -0.805 | | | |
| | | | | (0.775) | (1.029) | (0.822) | | | |
| $\Delta\overline{GDP}$ | | | | | | | 0.554** | 1.119* | 0.623** |
| | | | | | | | (0.224) | (0.614) | (0.250) |
| Observations | 464 | 464 | 368 | 464 | 464 | 368 | 464 | 464 | 368 |
| Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pesaran CD | 12.78*** | 14.06*** | 6.02*** | 8.15*** | 10.63*** | 5.22*** | 9.86*** | 15.56*** | 5.29*** |
| Adj.-$R^2$ | 0.447 | 0.439 | 0.458 | 0.479 | 0.470 | 0.458 | 0.457 | 0.434 | 0.471 |

# Table 3: Common Systemic Risk among Non-Financial Center Office Markets

This table shows the results of spatial models for office and retail markets in non-financial centers of our sample from 2000 to 2015. Estimates are based on GMM. *Turmoil* periods are the dotcom bubble burst 2001/2002 and the financial crisis period 2007/2008. To measure spatial dependence during turmoil periods, the elements of the weighting matrix are restricted to zero during *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero during the crisis periods. *Stock Returns* indicate the log-difference of the national equity market index at the financial center. The financial center-specific total *SRISK* is measured in logs. The country-specific *GDP growth* is measured per capita. The *Term Spread* reflects the difference between long-term government bond yields and short-term interbank rates. Changes in the consumer price index ($\Delta CPI$) proxy expected inflation. Construction ($\Delta$*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. $\Delta$*Population* measures the population growth in the financial center. $\Delta$*Claims* are international cross-border claims on each country's non-bank sector. The *Correlation to MSCI* is a proxy for the stock market integration of the representative stock market indices of the financial centers. $\Delta$*Exchange Rate* measures the change of the local currency relative to the USD. The *U.S. CMBS Spread* is the difference between the yield on U.S. CMBS index and the long-term government bond. The *TED Spread* is defined as the difference between the annualized three-month LIBOR rate and the corresponding three-month U.S. Treasury Bill rate. For the European area, we use the difference between the three-month EURIBOR and the three-month EONIA rate. $\Delta\overline{GDP}$ measures the average GDP growth. The Pesaran (2004) CD test shows $t$-statistics of the null hypothesis of residual independence. Spatial HAC-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | Model I | | | Model II | | | Model III | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Office** | **Office** | **Retail** | **Office** | **Office** | **Retail** | **Office** | **Office** | **Retail** |
| | **Turmoil** | **Normal** | **Turmoil** | **Turmoil** | **Normal** | **Turmoil** | **Turmoil** | **Normal** | **Turmoil** |
| Spatial Lag | 0.064 | 0.084 | -0.033 | 0.141 | 0.037 | 0.050 | 0.056 | 0.082 | -0.082 |
| | (0.153) | (0.104) | (0.127) | (0.150) | (0.113) | (0.133) | (0.153) | (0.104) | (0.124) |
| Stock Returns | 0.154*** | 0.152*** | 0.126*** | 0.125*** | 0.135*** | 0.109*** | 0.152*** | 0.150*** | 0.110*** |
| | (0.026) | (0.027) | (0.025) | (0.030) | (0.029) | (0.028) | (0.026) | (0.027) | (0.025) |
| log(SRISK) | -0.002 | -0.003 | -0.004 | -0.003 | -0.003 | -0.004 | -0.002 | -0.002 | -0.001 |
| | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) | (0.003) |
| ΔGDP Capita | 1.125*** | 1.104*** | 0.461*** | 1.086*** | 1.091*** | 0.436*** | 1.107*** | 1.089*** | 0.343** |
| | (0.153) | (0.149) | (0.157) | (0.156) | (0.152) | (0.160) | (0.161) | (0.158) | (0.160) |
| Term Spread | -1.223** | -1.316*** | 0.152 | -0.837 | -1.037* | 0.405 | -1.250** | -1.332*** | -0.127 |
| | (0.483) | (0.495) | (0.467) | (0.514) | (0.540) | (0.457) | (0.498) | (0.505) | (0.480) |
| ΔCPI | 0.116 | 0.068 | -0.090 | 0.430 | 0.395 | 0.116 | -0.045 | -0.068 | -1.253 |
| | (0.669) | (0.666) | (0.724) | (0.674) | (0.688) | (0.716) | (0.667) | (0.654) | (0.787) |
| ΔFloor Space | -1.227*** | -1.191*** | -0.204 | -1.120*** | -1.102*** | -0.188 | -1.227*** | -1.194*** | -0.228 |
| | (0.238) | (0.238) | (0.229) | (0.232) | (0.236) | (0.222) | (0.238) | (0.238) | (0.229) |
| ΔREIT | 0.174 | 0.184 | 0.228 | 0.155 | 0.158 | 0.209 | 0.304 | 0.293 | 1.117*** |
| | (0.185) | (0.183) | (0.174) | (0.181) | (0.184) | (0.176) | (0.339) | (0.335) | (0.321) |
| ΔPopulation | 1.512** | 1.511** | 1.429** | 1.425** | 1.437** | 1.432** | 1.559** | 1.550** | 1.690** |
| | (0.707) | (0.703) | (0.713) | (0.704) | (0.707) | (0.704) | (0.723) | (0.718) | (0.708) |
| ΔClaims | 0.193*** | 0.194*** | 0.182*** | 0.166*** | 0.172*** | 0.164*** | 0.191*** | 0.193*** | 0.170*** |
| | (0.045) | (0.043) | (0.049) | (0.047) | (0.045) | (0.051) | (0.045) | (0.044) | (0.048) |
| Correlation to MSCI | -0.718 | -0.688 | 0.141 | -0.938 | -0.928 | -0.004 | -0.791 | -0.748 | -0.249 |
| | (0.810) | (0.790) | (0.879) | (0.799) | (0.791) | (0.861) | (0.850) | (0.834) | (0.863) |
| ΔExchange Rate | -3.119 | -2.922 | -1.565 | -4.095 | -3.941 | -2.490 | -3.120 | -2.923 | -1.521 |
| | (2.469) | (2.483) | (2.890) | (2.492) | (2.544) | (2.916) | (2.464) | (2.478) | (2.809) |
| U.S. CMBS Spread | 0.058*** | 0.053*** | 0.025** | 0.050*** | 0.050*** | 0.020* | 0.058*** | 0.053*** | 0.022* |
| | (0.013) | (0.014) | (0.012) | (0.014) | (0.014) | (0.117) | (0.013) | (0.014) | (0.011) |
| TED Spread | | | | -1.656*** | -1.414** | -1.101** | | | |
| | | | | (0.624) | (0.652) | (0.464) | | | |
| $\Delta\overline{GDP}$ | | | | | | | 0.147 | 0.123 | 1.054*** |
| | | | | | | | (0.284) | (0.290) | (0.294) |
| Observations | 416 | 416 | 304 | 416 | 416 | 304 | 416 | 416 | 304 |
| Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pesaran CD | 5.03*** | 4.13*** | 6.14*** | 3.14*** | 3.25*** | 4.16*** | 4.919*** | 4.07*** | 5.62*** |
| Adj.-$R^2$ | 0.532 | 0.538 | 0.508 | 0.541 | 0.541 | 0.512 | 0.531 | 0.537 | 0.528 |

## Table 4: Common Systemic Risk: Conditional on MSCI World Index

This table shows the results of spatial models for office and retail markets in 29 financial centers from 2000 to 2015. Estimates are based on GMM. *Turmoil* periods are the dotcom bubble burst 2001/2002 and the financial crisis period 2007/2008. To measure spatial dependence during turmoil periods, the elements of the weighting matrix are restricted to zero during *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero during the crisis periods. *Stock Returns* indicate the log-difference of the national equity market index at the financial center. The financial center-specific total *SRISK* is measured in logs. The country-specific *GDP growth* is measured per capita. The *Term Spread* reflects the difference between long-term government bond yields and short-term interbank rates. Changes in the consumer price index ($\Delta CPI$) proxy expected inflation. Construction ($\Delta Floor\ Space$) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. $\Delta Population$ measures the population growth in the financial center. $\Delta Claims$ are international cross-border claims on each country's non-bank sector. The *Correlation to MSCI* is a proxy for the stock market integration of the representative stock market indices of the financial centers. $\Delta Exchange\ Rate$ measures the change of the local currency relative to the USD. The *U.S. CMBS Spread* is the difference between the yield on U.S. CMBS index and the long-term government bond. The *TED Spread* is defined as the difference between the annualized three-month LIBOR rate and the corresponding three-month U.S. Treasury Bill rate. For the European area, we use the difference between the three-month EURIBOR and the three-month EONIA rate. $\Delta\overline{GDP}$ measures the average GDP growth. The Pesaran (2004) CD test shows $t$-statistics of the null hypothesis of residual independence. Spatial HAC-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | **Financial Centers** | | | **Non-Financial Centers** | | |
|---|---|---|---|---|---|---|
| | **Office Turmoil** | **Office Normal** | **Retail Turmoil** | **Office Turmoil** | **Office Normal** | **Retail Turmoil** |
| Spatial Lag | 0.290** | -0.256 | -0.240 | 0.065 | -0.046 | 0.009 |
| | (0.125) | (0.199) | (0.226) | (0.195) | (0.113) | (0.137) |
| log(SRISK) | -0.017* | -0.023** | -0.007 | -0.001 | -0.001 | -0.001 |
| | (0.009) | (0.010) | (0.011) | (0.002) | (0.002) | (0.003) |
| ΔGDP Capita | 0.540*** | 0.574*** | 0.897*** | 1.006*** | 1.019*** | 0.341** |
| | (0.206) | (0.213) | (0.256) | (0.172) | (0.171) | (0.157) |
| Term Spread | -0.150 | -0.125 | 1.436** | -0.410 | -0.435 | 0.704 |
| | (0.389) | (0.412) | (0.653) | (0.516) | (0.540) | (0.477) |
| ΔCPI | -1.374** | -1.700*** | -1.211** | -1.533*** | -1.570*** | -1.672** |
| | (0.546) | (0.578) | (0.563) | (0.575) | (0.571) | (0.652) |
| ΔFloor Space | -0.433 | -0.525 | 0.096 | -1.102*** | -1.098*** | -0.229 |
| | (0.345) | (0.353) | (0.175) | (0.308) | (0.317) | (0.213) |
| ΔREIT | 0.136 | -0.034 | -0.388 | 0.240 | 0.230 | 0.251 |
| | (0.183) | (0.194) | (0.260) | (0.172) | (0.174) | (0.168) |
| ΔPopulation | 0.134 | 0.138 | 0.747 | 1.890*** | 1.915*** | 1.712** |
| | (0.118) | (0.122) | (0.941) | (0.657) | (0.655) | (0.737) |
| ΔClaims | 0.184*** | 0.243*** | 0.231*** | 0.306*** | 0.310*** | 0.288*** |
| | (0.048) | (0.055) | (0.061) | (0.044) | (0.043) | (0.050) |
| Correlation to MSCI | -0.001 | -0.005 | -0.018 | 1.003 | 1.059 | 1.828** |
| | (0.054) | (0.060) | (0.076) | (0.699) | (0.696) | (0.763) |
| ΔExchange Rate | 1.480** | 2.078*** | 1.675** | 0.001 | 0.001 | 0.002 |
| | (0.581) | (0.683) | (0.725) | (0.003) | (0.003) | (0.003) |
| U.S. CMBS Spread | 0.028* | 0.037** | -0.025 | 0.034** | 0.036*** | 0.001 |
| | (0.016) | (0.019) | (0.020) | (0.014) | (0.014) | (0.011) |
| ΔMSCI World | 0.248*** | 0.34*** | 0.166*** | 0.167*** | 0.174*** | 0.163*** |
| | (0.034) | (0.072) | (0.031) | (0.025) | (0.033) | (0.021) |
| Observations | 464 | 464 | 368 | 416 | 416 | 304 |
| Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Pesaran CD | 12.15*** | 21.30*** | 9.11*** | 8.15*** | 5.99*** | 5.22*** |
| Adj.-$R^2$ | 0.464 | 0.443 | 0.432 | 0.479 | 0.534 | 0.458 |

## Table 5: Euro Sovereign Debt Crisis

This table shows the results of spatial models for office and retail markets in 29 financial centers from 2000 to 2015. Estimates are based on GMM. The *turmoil* period is defined as the European sovereign debt crisis of 2010/2011. To measure spatial dependence during turmoil periods, the elements of the weighting matrix are restricted to zero during *normal* times. *Stock Returns* indicate the log-difference of the national equity market index at the financial center. The financial center-specific total *SRISK* is measured in logs. The country-specific *GDP growth* is measured per capita. The *Term Spread* reflects the difference between long-term government bond yields and short-term interbank rates. Changes in the consumer price index ($\Delta CPI$) proxy expected inflation. Construction ($\Delta$*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. $\Delta$*Population* measures the population growth in the financial center. $\Delta$*Claims* are international cross-border claims on each country's non-bank sector. The *Correlation to MSCI* is a proxy for the stock market integration of the representative stock market indices of the financial centers. $\Delta$*Exchange Rate* measures the change of the local currency relative to the USD. The *U.S. CMBS Spread* is the difference between the yield on U.S. CMBS index and the long-term government bond. The *TED Spread* is defined as the difference between the annualized three-month LIBOR rate and the corresponding three-month U.S. Treasury Bill rate. For the European area, we use the difference between the three-month EURIBOR and the three-month EONIA rate. $\Delta\overline{GDP}$ measures the average GDP growth. The Pesaran (2004) CD test shows $t$-statistics of the null hypothesis of residual independence. Spatial HAC-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | **Model I** | | **Model II** | | **Model III** | |
|---|---|---|---|---|---|---|
| | **Office** | **Retail** | **Office** | **Retail** | **Office** | **Retail** |
| Spatial Lag | 0.026 | -0.130 | -0.198 | -0.190 | -0.137 | -0.208 |
| | (0.227) | (0.166) | (0.233) | (0.174) | (0.252) | (0.171) |
| Stock Returns | 0.196*** | 0.187*** | 0.169*** | 0.177*** | 0.198*** | 0.180*** |
| | (0.032) | (0.036) | (0.033) | (0.040) | (0.033) | (0.037) |
| log(SRISK) | -0.018* | -0.011 | -0.020** | -0.011 | -0.009 | -0.002 |
| | (0.010) | (0.010) | (0.010) | (0.010) | (0.011) | (0.010) |
| ΔGDP Capita | 0.909*** | 1.050*** | 0.793*** | 1.017*** | 0.838*** | 0.997*** |
| | (0.194) | (0.219) | (0.195) | (0.222) | (0.194) | (0.223) |
| Term Spread | -0.494 | 0.973 | -0.306 | 1.082* | -0.402 | 0.915 |
| | (0.468) | (0.611) | (0.459) | (0.620) | (0.461) | (0.601) |
| ΔCPI | -0.852 | -0.102 | -0.726 | -0.049 | -1.242** | -0.460 |
| | (0.569) | (0.551) | (0.557) | (0.557) | (0.608) | (0.555) |
| ΔFloor Space | -0.652* | -0.095 | -0.676* | -0.097 | -0.475 | -0.025 |
| | (0.372) | (0.170) | (0.365) | (0.171) | (0.373) | (0.169) |
| ΔREIT | -0.094 | -0.470* | -0.180 | -0.488* | 0.448* | 0.044 |
| | (0.198) | (0.276) | (0.193) | (0.277) | (0.244) | (0.284) |
| ΔPopulation | 0.077 | 0.717 | 0.090 | 0.801 | 0.094 | 0.545 |
| | (0.124) | (1.045) | (0.127) | (1.030) | (0.123) | (1.020) |
| ΔClaims | 0.128** | 0.073 | 0.100 | 0.065 | 0.112* | 0.059 |
| | (0.062) | (0.067) | (0.059) | (0.066) | (0.061) | (0.064) |
| Correlation to MSCI | 0.050 | 0.047 | 0.104 | 0.060 | 0.068 | 0.054 |
| | (0.079) | (0.064) | (0.076) | (0.064) | (0.079) | (0.063) |
| ΔExchange Rate | 0.876 | 0.479 | 1.023 | 0.500 | 0.260 | -0.153 |
| | (0.651) | (0.723) | (0.646) | (0.723) | (0.650) | (0.734) |
| U.S. CMBS Spread | 0.091*** | 0.022 | 0.094*** | 0.023 | 0.094*** | 0.023 |
| | (0.024) | (0.019) | (0.023) | (0.019) | (0.025) | (0.019) |
| TED Spread | | | -3.820*** | -0.945 | | |
| | | | (0.810) | (0.850) | | |
| $\Delta\overline{GDP}$ | | | | | 0.645*** | 0.636** |
| | | | | | (0.243) | (0.248) |
| Observations | 464 | 368 | 464 | 368 | 464 | 368 |
| Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Pesaran CD | 12.59*** | 5.98*** | 9.01*** | 5.00*** | 10.19*** | 5.15*** |
| Adj.-$R^2$ | 0.443 | 0.458 | 0.473 | 0.460 | 0.451 | 0.472 |

## Table 6: Difference-in-Difference Model: Office versus Retail

This table shows the regression result for the difference-in-difference model. We regress property market returns $r_{it}$ on the dummy variables for the financial crisis period, $D_{Crisis}$, the office market dummy, $D_{Office}$, and their interaction term. We include the sector-specific level of lagged floor space (construction level in log-values) as a control variable. Based on the common trend assumption we use retail markets in the same city as the counterfactual. City-specific market characteristics are removed by the difference-in-difference structure. $\Delta$*Exchange Rate* measures the change of the local currency relative to the USD. As sector-specific control variable we include the level of *Floor Space*, measured in logs, from the construction sector. For the financial crisis, we use a sample from 2005 to 2009 with the years 2008 and 2009 defined as aftermath of the recent financial crisis (dummy variable $D_{Crisis}$ equals one). For the dotcom bubble burst, we use a sample from 1995 to 2002, with 2001 and 2002 defined as the turmoil period. The estimation is based on OLS. Cluster-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | **Financial Crisis 2008-2009** | | **Dotcom Bubble Burst 2001-2002** | |
|---|---|---|---|---|
| | **Model I** | **Model II** | **Model I** | **Model II** |
| constant | 0.207*** | 0.249*** | 0.101*** | 0.129* |
| | (0.017) | (0.040) | (0.023) | (0.069) |
| $D_{Crisis}$ | -0.279*** | -0.279*** | -0.041 | -0.048 |
| | (0.039) | (0.039) | (0.029) | (0.047) |
| $D_{Office}$ | 0.022 | 0.024 | -0.016 | 0.001 |
| | (0.026) | (0.025) | (0.027) | (0.042) |
| $D_{Crisis} \times D_{Office}$ | -0.110** | -0.111** | -0.081** | -0.098* |
| | (0.051) | (0.051) | (0.039) | (0.054) |
| $\Delta$Exchange Rate | 0.510*** | 0.494*** | 1.017*** | 1.112*** |
| | (0.171) | (0.171) | (0.151) | (0.229) |
| log(Floor Space) | | -0.005 | | -0.002 |
| | | (0.004) | | (0.006) |
| Observations | 175 | 175 | 225 | 170 |
| Adj.-$R^2$ | 0.584 | 0.583 | 0.237 | 0.222 |

Table 7: Office Market Returns in Financial Center versus Non-Financial Center

This table shows the regression result of the difference-in-difference model. We regress office market returns $r_{it}$ on the dummy variables for the financial crisis period, $D_{Crisis}$, the financial center dummy, $D_{Center}$, and their interaction term. We include a set of additional control variables in the model. For the financial crisis, we use a sample from 2005 to 2009 with the years 2008 and 2009 defined as the aftermath of the recent financial crisis (dummy variable $D_{Crisis}$ equals one). For the dotcom bubble burst, we use a sample from 1995 to 2002, with 2001 and 2002 defined as the turmoil period. $\Delta$*Exchange Rate* measures the change of the local currency relative to the USD. As sector-specific control variable we include the level of *Floor Space*, measured in logs. $\Delta$*Population* measures the population growth in the financial center. $\Delta$*Claims* are international cross-border claims on each country's non-bank sector. Changes in the consumer price index ($\Delta$*CPI*) proxy expected inflation. The *Term Spread* reflects the difference between long-term government bond yields and short-term interbank rates. The country-specific *GDP growth* is measured per capita. $\Delta$*REIT* reflects the return in the national REIT index. The estimation is based on OLS. Cluster-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | **Financial Crisis 2008-2009** | | | **Dotcom Bubble Burst 2001-2002** | | |
|---|---|---|---|---|---|---|
| | **Model I** | **Model II** | **Model III** | **Model I** | **Model II** | **Model III** |
| constant | 0.155*** | 0.198** | -0.038 | 0.095*** | 0.171** | 0.154* |
| | (0.018) | (0.086) | (0.093) | (0.012) | (0.082) | (0.091) |
| $D_{Crisis}$ | -0.227*** | -0.227*** | -0.165*** | -0.066*** | -0.095*** | -0.100*** |
| | (0.032) | (0.032) | (0.025) | (0.019) | (0.025) | (0.025) |
| $D_{Center}$ | 0.042 | 0.041 | 0.037 | -0.003 | -0.010 | -0.021 |
| | (0.026) | (0.025) | (0.025) | (0.019) | (0.028) | (0.028) |
| $D_{Crisis} \times D_{Center}$ | -0.130** | -0.130** | -0.118** | -0.041 | -0.038 | -0.027 |
| | (0.052) | (0.052) | (0.047) | (0.030) | (0.040) | (0.042) |
| $\Delta$Exchange Rate | | -0.005 | 0.340 | 0.935*** | 1.079*** | 0.901 |
| | | (0.009) | (0.950) | (0.072) | (0.115) | (0.551) |
| log(Floor Space) | | -0.005 | 0.018* | | -0.006 | -0.006 |
| | | (0.009) | (0.010) | | (0.009) | (0.010) |
| $\Delta$Population | | 0.249** | -0.721 | | 0.611 | -0.108 |
| | | (0.114) | (0.750) | | (0.441) | (0.841) |
| $\Delta$CPI | | | -0.991** | | | -0.143 |
| | | | (0.443) | | | (0.550) |
| Term Spread | | | -1.197 | | | 0.283 |
| | | | (1.262) | | | (0.635) |
| $\Delta$GDP Capita | | | 0.889*** | | | 0.648** |
| | | | (0.287) | | | (0.300) |
| $\Delta$REIT | | | -0.319 | | | -0.159 |
| | | | (0.369) | | | (0.368) |
| $\Delta$Claims | | | 0.235*** | | | |
| | | | (0.068) | | | |
| Observations | 275 | 275 | 275 | 398 | 290 | 279 |
| Adj.-$R^2$ | 0.510 | 0.508 | 0.638 | 0.322 | 0.408 | 0.334 |

Table 8: Cross-Sectional Comparison of SRISK Exposure on Office Returns

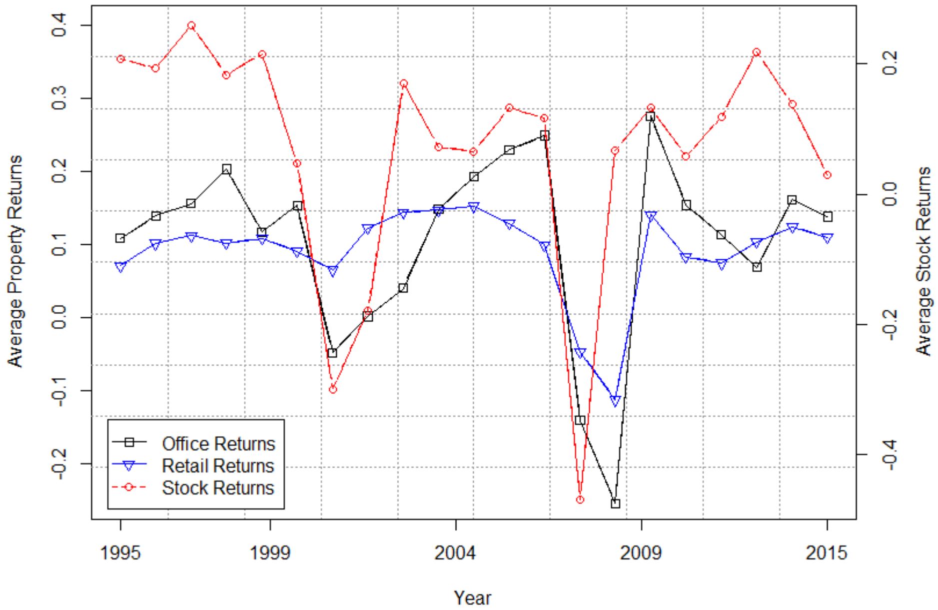
This table shows the effect of the systemic risk exposure on international office markets. Estimates are based on OLS. *Stock Returns* indicate the log-difference of the national equity market index at the financial center. The financial center-specific *SRISK* exposure is measured in logs. $\Delta$*SRISK* measures the changes in log-difference. The country-specific *GDP growth* is measured per capita. The *Term Spread* reflects the difference between long-term government bond yields and short-term interbank rates. Changes in the consumer price index ($\Delta$*CPI*) proxy expected inflation. Construction ($\Delta$*Floor Space*) is defined as the log-difference in floor space. $\Delta$*Claims* are international cross-border claims on each country's non-bank sector. $\Delta$*Exchange Rate* measures the change of the local currency relative to the USD. *SRISK high* and *SRISK low* capture office markets with the 25% highest and 25% lowest aggregated systemic risk exposure per year. The *Financial Crisis* dummy is equal to one for the years 2008 and 2009. $\times SRISKhigh$ and $\times SRISKlow$ define the interaction of both variables with the Financial Crisis-dummy, respectively. Cluster-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | **Model I** | **Model II** | **Model III** | **Model IV** | **Model V** |
|---|---|---|---|---|---|
| Stock Returns | 0.122*** | 0.122*** | 0.124*** | 0.125*** | 0.124*** |
| | (0.023) | (0.024) | (0.021) | (0.021) | (0.021) |
| log(SRISK) | -0.001 | | | | |
| | (0.001) | | | | |
| ΔSRISK | | -0.007 | | | |
| | | (0.004) | | | |
| ΔGDP Capita | 0.841*** | 0.896*** | 0.833*** | 0.812*** | 0.847*** |
| | (0.214) | (0.248) | (0.196) | (0.197) | (0.194) |
| Term Spread | -0.635*** | -0.565** | -0.743*** | -0.776*** | -0.871*** |
| | (0.215) | (0.241) | (0.219) | (0.219) | (0.197) |
| ΔCPI | 0.044 | 0.177 | 0.113 | 0.144 | 0.113 |
| | (0.288) | (0.312) | (0.267) | (0.272) | (0.270) |
| ΔFloor Space | -0.759*** | -0.848*** | -0.808*** | -0.791*** | -0.751*** |
| | (0.220) | (0.255) | (0.211) | (0.217) | (0.216) |
| ΔClaims | 0.073** | 0.090*** | 0.080*** | 0.073** | -0.079 |
| | (0.033) | (0.033) | (0.028) | (0.029) | (0.340) |
| ΔExchange Rate | -0.032 | -0.223 | -0.113 | -0.124 | -0.079 |
| | (0.334) | (0.394) | (0.307) | (0.309) | (0.340) |
| SRISK high | | | -0.004 | 0.010 | -0.003 |
| | | | (0.008) | (0.011) | (0.008) |
| SRISK low | | | 0.001 | 0.0004 | 0.001 |
| | | | (0.009) | (0.009) | (0.010) |
| Financial Crisis | -0.145*** | -0.139*** | -0.142*** | -0.118*** | -0.150*** |
| | (0.019) | (0.018) | (0.017) | (0.015) | (0.021) |
| $\times SRISKhigh$ | | | | -0.102** | |
| | | | | (0.045) | |
| $\times SRISKlow$ | | | | | 0.0001 |
| | | | | | (0.032) |
| Observations | 830 | 787 | 946 | 946 | 946 |
| Adj.-$R^2$ | 0.496 | 0.504 | 0.497 | 0.505 | 0.497 |

Figure 1: Performance of Commercial Real Estate and Stock Market Returns

This figure illustrates the performance of the commercial real estate (office and retail) and stock market returns from 1995 to 2015. We compute cross-sectional average returns for the United States, Europe, and Asia-Pacific. Returns are measured in decimals.

Panel A: Commercial Real Estate and Stock Market Returns in USA




Panel B: Commercial Real Estate and Stock Market Returns in Europe

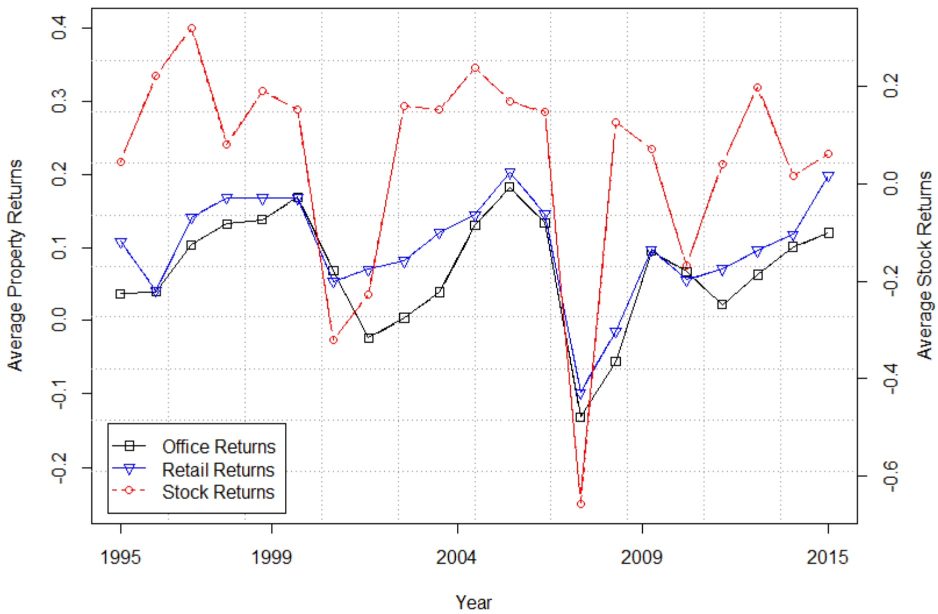


*Figure 1 continued.*

Panel C: Commercial Real Estate and Stock Market Returns in Asia-Pacific

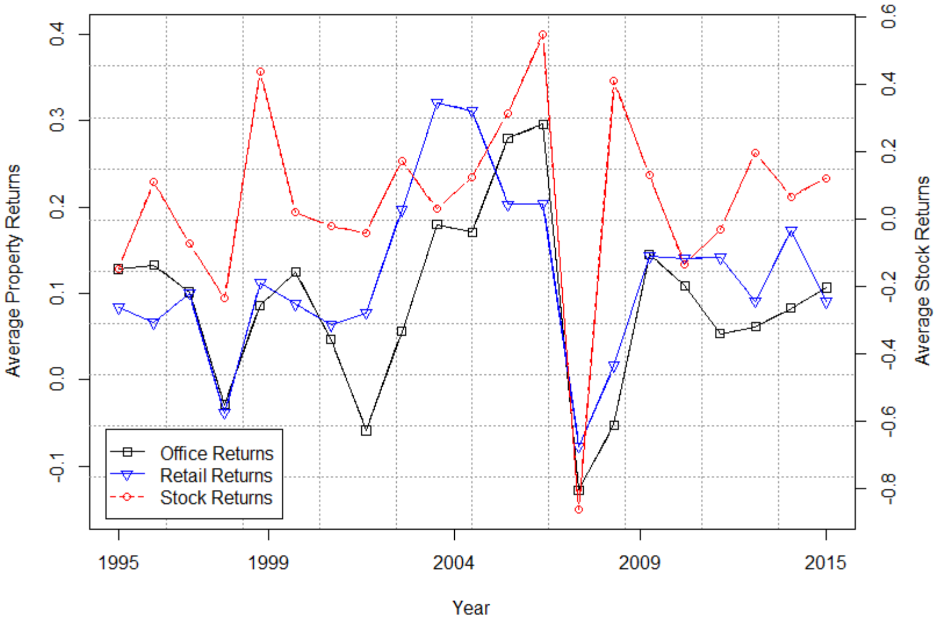
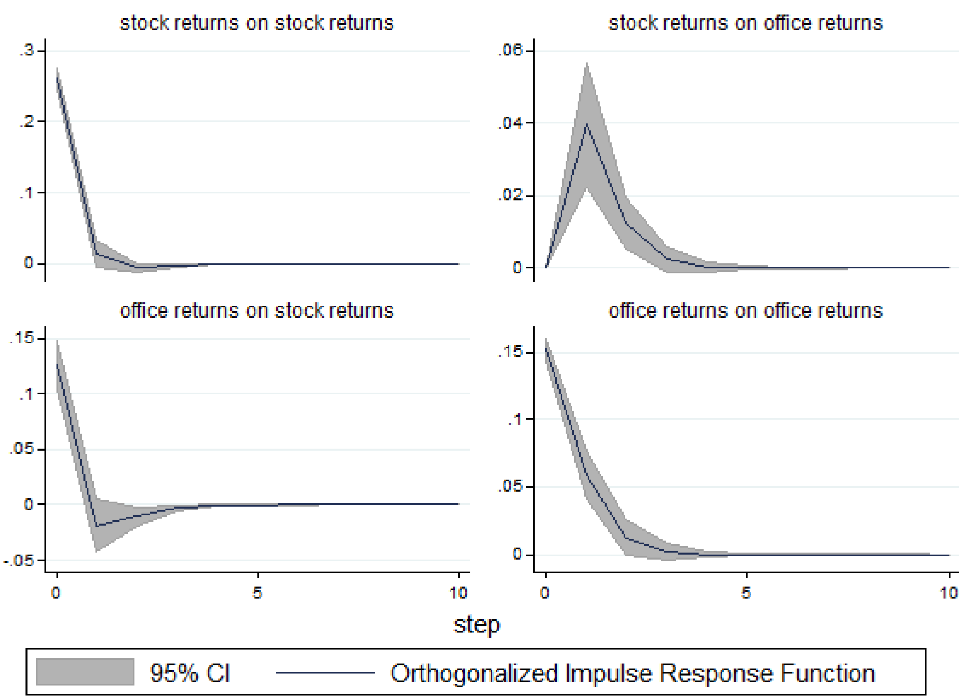


Figure 2: Impulse Response Function

This figure illustrates the impulse response functions of a positive shock of stock returns (top) and office returns (bottom) on stock returns and office returns, respectively. The GMM system is estimated using the forward-orthogonal transformation (Arellano and Bover (1995)). A two-way fixed effects specification resembles a common factor representation to account for the cross-sectional dependence across the endogenous variables (Sarafidis and Wansbeek (2012)). The impulse response functions are orthogonalized based on the Cholesky decomposition of the covariance matrix. The Hannan-Quinn (HQ) and Bayesian information criteria suggest an optimal lag length of order one. The confidence intervals are based on 200 Monte Carlo simulations.



# Figure 3: Financial Institutions in International Financial Centers

This figure illustrates the distribution of domestic and foreign head office locations of financial institutions across international financial centers. We include only financial institutions with head offices in at least two financial centers.

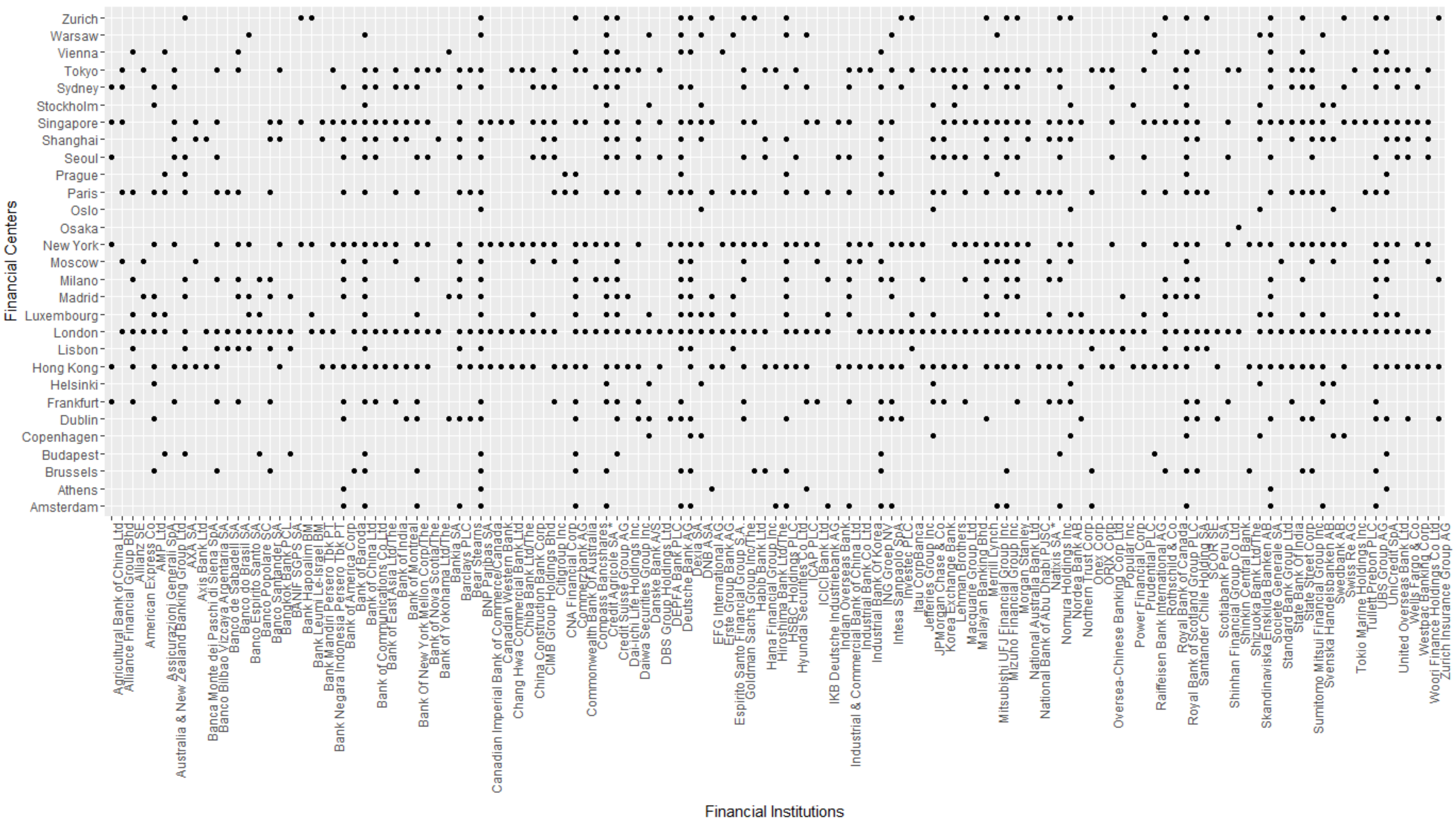
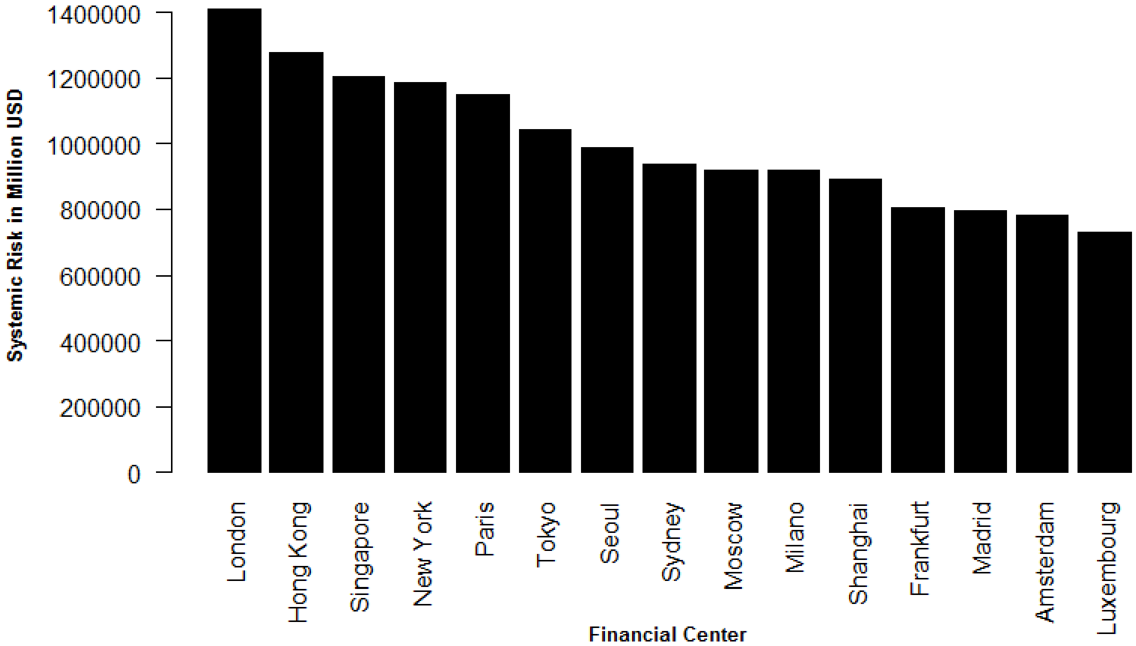


Figure 4: SRISK Ranking of Financial Centers

This figure shows the cross-sectional and time-series variation of the financial center-specific systemic risk exposure. Panel A ranks the 15 financial centers with the highest systemic risk exposure. Panel B shows the time-variation of the average systemic risk exposure of all financial centers.

Panel A: SRISK Ranking of Financial Centers




Panel B: Average SRISK Exposure of Office Markets over Time

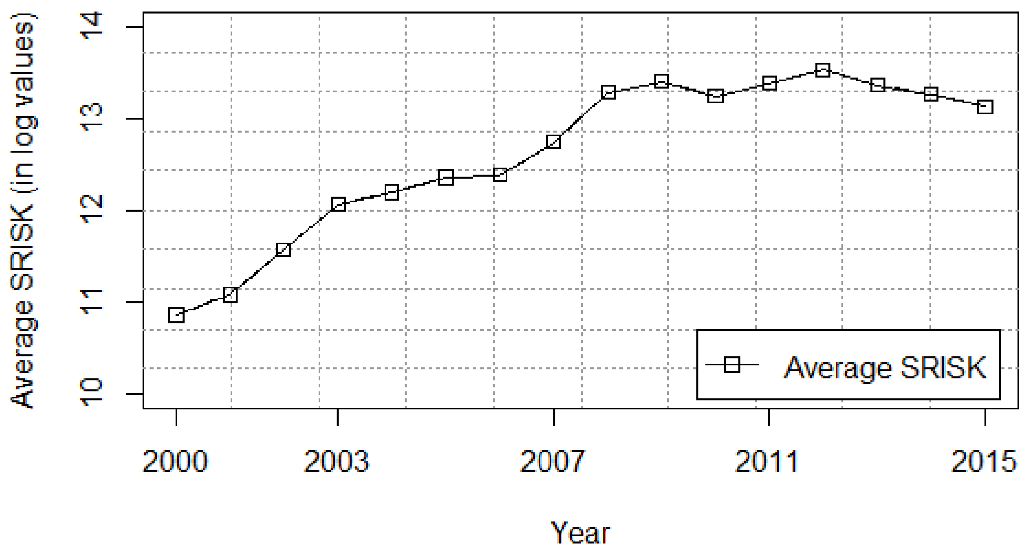


Figure 5: Average SRISK in Financial Centers versus Non-Financial Centers

This figure illustrates the mean difference between office markets in financial centers and non-financial centers during the sample period from 2000 to 2015. Financial centers include all cities in our sample that host the national stock exchange trading platform. We exclude Boston, Chicago, San Francisco, and Washington from the sample of non-financial centers. Based on our definition they would be classified as non-financial centers, while they are ranked as top financial centers by the Global Financial Center Index (GFCI) and the Xinhua/Dow Jones International Financial Centers Development Index.

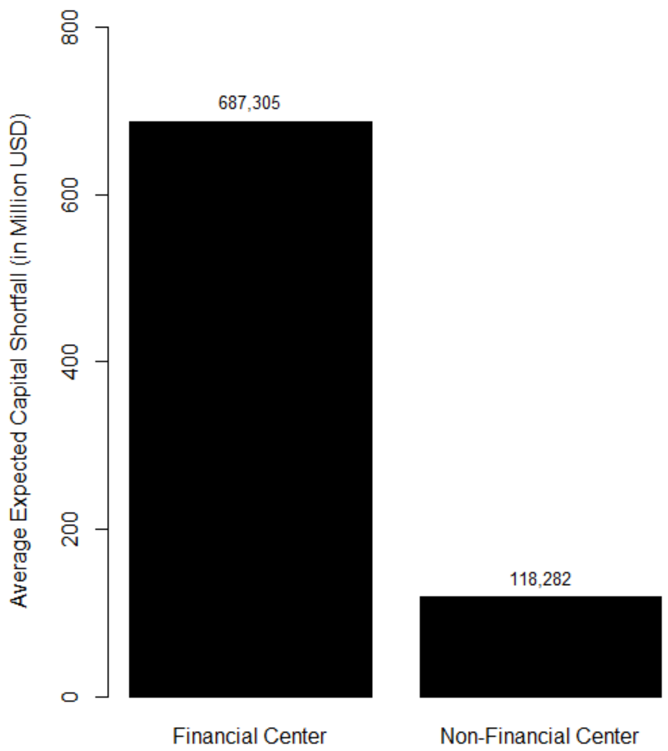
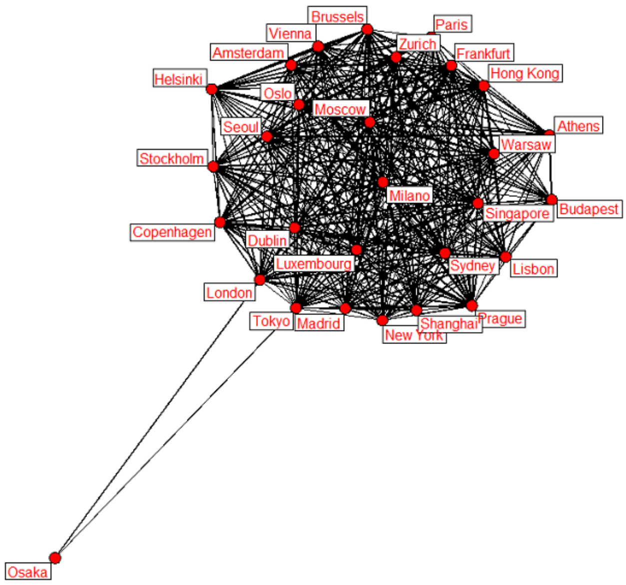


Figure 6: Interconnectedness of Financial and Non-Financial Centers

Panels A and B of the figure illustrate the linkage among financial and non-financial centers as implied by the corresponding weighting matrices. We show the interconnectedness representative for the year 2007.

Panel A: Financial Centers




Panel B: Non-Financial Centers

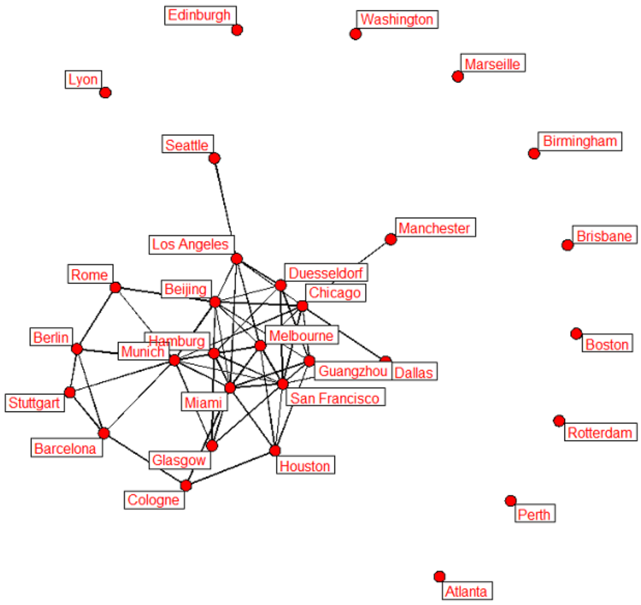


Table A.1: Commercial Real Estate Market Coverage

This table contains the market coverage of our sample. We show the data availability for commercial real estate office and retail markets for each city in our sample. In Panel A, we list all available markets in financial centers with a stock exchange. We also list the corresponding trading platform and the national stock market index that is used in our sample. In Panel B, we list all available commercial real estate office and retail markets of all non-financial centers in our sample.

| **Panel A: Financial Centers** | | | | | |
|---|---|---|---|---|---|
| **City** | **Country** | **Office** | **Retail** | **Trading Platform** | **Stock Index** |
| Amsterdam | Netherlands | Yes | Yes | Euronext | AEX |
| Athens | Greece | Yes | No | Athen Stock Exchange | ATHEX Composite |
| Brussels | Belgium | Yes | Yes | Euronext | Bel20 |
| Budapest | Hungary | Yes | Yes | Budapest Stock Exchange | BUX |
| Copenhagen | Denmark | Yes | Yes | OMX Nordic Exchange | OMXC20 |
| Dublin | Ireland | Yes | Yes | Irish Stock Exchange | ISEQ |
| Frankfurt | Germany | Yes | Yes | Deutsche Börse | DAX30 |
| Helsinki | Finland | Yes | No | OMX Nordic Exchange | OMXH25 |
| Hong Kong | Hong Kong | Yes | Yes | Hong Kong Stock Exchange | Hang Seng Index |
| Lisbon | Portugal | Yes | Yes | Euronext | PSI20 |
| London | United Kingdom | Yes | Yes | London Stock Exchange | FTSE100 |
| Luxembourg | Luxembourg | Yes | No | Luxembourg Stock Exchange | LUX SE General |
| Madrid | Spain | Yes | Yes | BME Spanish Exchange | IBEX35 |
| Milan | Italy | Yes | Yes | Borsa Italia | FTSE MIB |
| Moscow | Russia | Yes | No | Moscow Exchange | MICEX Index |
| New York | USA | Yes | Yes | New York Stock Exchange | SNP500 |
| Osaka | Japan | Yes | Yes | Japan Exchange Group | NIKKEI Futures |
| Oslo | Norway | Yes | No | Oslo Bors | OBX |
| Paris | France | Yes | Yes | Euronext | CAC40 |
| Prague | Czech Republic | Yes | Yes | Prague Stock Exchange | PX50 |
| Seoul | South Korea | Yes | Yes | Korea Exchange | KOSPI |
| Shanghai | China | Yes | Yes | Shanghai Stock Exchange | SE A SPI |
| Singapore | Singapore | Yes | Yes | Singapore Exchange | Straits Time Index |
| Stockholm | Sweden | Yes | Yes | OMX Nordic Exchange | OMXS30 |
| Sydney | Australia | Yes | Yes | Australian Sec. Exchange | ASX |
| Tokyo | Japan | Yes | Yes | Japan Exchange Group | NIKKEI25 |
| Vienna | Austria | Yes | Yes | Wiener Börse | ATX |
| Warsaw | Poland | Yes | Yes | Warsaw Stock Exchange | WIG |
| Zurich | Switzerland | Yes | No | SIX Swiss Exchange | SSMI |

*Table A.1 continued.*

| **Panel B: Non-financial Centers** | | | |
|---|---|---|---|
| **City** | **Country** | **Office** | **Retail** |
| Atlanta | USA | Yes | Yes |
| Barcelona | Spain | Yes | Yes |
| Beijing | China | Yes | Yes |
| Berlin | Germany | Yes | Yes |
| Birmingham | United Kingdom | Yes | Yes |
| Boston | USA | Yes | Yes |
| Brisbane | Australia | Yes | Yes |
| Chicago | USA | Yes | Yes |
| Cologne | Germany | Yes | Yes |
| Dallas | USA | Yes | Yes |
| Dusseldorf | Germany | Yes | Yes |
| Edinburgh | United Kingdom | Yes | Yes |
| Glasgow | United Kingdom | Yes | Yes |
| Guangzhou | China | Yes | Yes |
| Hamburg | Germany | Yes | Yes |
| Houston | USA | Yes | Yes |
| Lille | France | Yes | Yes |
| Los Angeles | USA | Yes | Yes |
| Lyon | France | Yes | Yes |
| Manchester | United Kingdom | Yes | Yes |
| Marseille | France | Yes | Yes |
| Melbourne | Australia | Yes | Yes |
| Miami | USA | Yes | Yes |
| Munich | Germany | Yes | Yes |
| Nagoya | Japan | Yes | Yes |
| Perth | Australia | Yes | Yes |
| Rome | Italy | Yes | Yes |
| Rotterdam | Netherlands | Yes | Yes |
| San Francisco | USA | Yes | Yes |
| Seattle | USA | Yes | Yes |
| Stuttgart | Germany | Yes | Yes |
| Washington | USA | Yes | Yes |

Table A.2: List of Financial Institution with highest SRISK

This table contains a ranking of the 40 financial institutions with the highest SRISK, denominated in million USD, that is observed in any month during the sample period from 2000 to 2015. The SRISK measure is calculated as the expected capital shortfall given a 40% decline in the MSCI world equity index over the next 6 months. The data are provided by the NYU Stern Volatility Lab.

| **Institution** | **SRISK** | **Month** | **Year** | **Headquarter** | **Country** |
|---|---|---|---|---|---|
| Royal Bank of Scotland Group PLC | 186,877 | 11 | 2008 | Edinburgh | United Kingdom |
| Mitsubishi UFJ Financial Group Inc | 177,001 | 1 | 2012 | Tokyo | Japan |
| Deutsche Bank AG | 170,167 | 3 | 2008 | Frankfurt | Germany |
| Barclays PLC | 157,427 | 1 | 2009 | London | United Kingdom |
| Bank of America Corp | 154,312 | 4 | 2009 | Charlotte, NC | USA |
| Citigroup Inc | 141,770 | 2 | 2009 | New York | USA |
| BNP Paribas SA | 140,504 | 1 | 2009 | Paris | France |
| Mizuho Financial Group Inc | 140,389 | 11 | 2012 | Tokyo | Japan |
| JPMorgan Chase & Co | 126,504 | 2 | 2009 | New York | USA |
| Credit Agricole SA | 126,388 | 11 | 2012 | Montrouge | France |
| Sumitomo Mitsui Financial Group Inc | 107,646 | 11 | 2012 | Tokyo | Japan |
| HSBC Holdings PLC | 99,166 | 3 | 2009 | London | United Kingdom |
| ING Groep NV | 94,726 | 1 | 2009 | Amsterdam | Netherlands |
| Bank of China Ltd | 91,706 | 8 | 2013 | Beijing | China |
| UBS Group AG | 90,748 | 5 | 2008 | Basel | Switzerland |
| China Construction Bank Corp | 86,169 | 6 | 2013 | Beijing | China |
| Societe Generale SA | 84,762 | 1 | 2012 | Paris | France |
| Lloyds Banking Group PLC | 77,239 | 6 | 2009 | London | United Kingdom |
| Agricultural Bank of China Ltd | 75,497 | 7 | 2013 | Beijing | China |
| Wells Fargo & Co | 75,119 | 2 | 2009 | San Francisco | USA |
| American International Group Inc | 74,333 | 9 | 2008 | New York | USA |
| UniCredit SpA | 70,577 | 11 | 2008 | Milano | Italy |
| Commerzbank AG | 70,531 | 3 | 2009 | Frankfurt | Germany |
| HBOS PLC | 70,123 | 9 | 2008 | Edinburgh | United Kingdom |
| Morgan Stanley | 69,571 | 9 | 2008 | New York | USA |
| Freddie Mac | 68,939 | 8 | 2008 | Tysons Corner | USA |
| Fannie Mae | 66,701 | 8 | 2008 | Washington | USA |
| Banco Santander SA | 66,636 | 5 | 2012 | Madrid | Spain |
| Merrill Lynch | 66,088 | 3 | 2008 | New York | USA |
| Goldman Sachs Group Inc | 62,491 | 10 | 2008 | New York | USA |
| Ind. & Commercial Bank of China Ltd | 59,517 | 12 | 2013 | Beijing | China |
| Lehman Brothers | 57,692 | 3 | 2008 | New York | USA |
| Wachovia Bank | 55,795 | 9 | 2008 | Charlotte, NY | USA |
| Allianz SE | 55,310 | 2 | 2009 | Munich | Germany |
| Credit Suisse Group AG | 51,613 | 1 | 2012 | Zurich | Switzerland |
| Dexia SA | 48,036 | 7 | 2008 | Brussels | Belgium |
| MetLife Inc | 47,263 | 11 | 2012 | New York | USA |
| London Stock Exchange Group PLC | 46,337 | 12 | 2013 | London | United Kingdom |
| AXA SA | 42,536 | 12 | 2011 | Paris | France |

Table A.3: Exposure to Systematic Banking Market Risk

This table shows the correlation between the aggregated expected capital shortfall (measured in log-values) in financial and non-financial centers and systematic risk factors of local banking markets. The sample ranges from 2000 to 2015. Estimates are based on OLS. We use systematic risk factors related to credit risk and interest rate risk. The *U.S. CMBS Spread* is the difference between the yield on U.S. CMBS index and the long-term government bond. The *TED Spread* is defined as the difference between the annualized three-month LIBOR rate and the corresponding three-month U.S. Treasury Bill rate. For the European area, we use the difference between the three-month EURIBOR and the three-month EONIA rate. $\Delta$*MSCI World* measures the global stock market performance. The *Term Spread* reflects the difference between long-term government bond yields and short-term interbank rates as a local risk factor. *Long-Term Interest* reflects the local interest rate risk. We use the U.S. long-term government bond yield (*U.S. Long-Term Interest*) and the U.S. 3-month Treasury Bill rate (*U.S. Short-Term Interest*) as proxies for global interest rate risk. Cluster-robust standard errors are given in parenthesis. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | **Model I** | **Model II** | **Model III** | **Model IV** |
|---|---|---|---|---|
| U.S. CMBS Spread | 0.198** | 0.185** | -0.071 | -0.049 |
| | (0.081) | (0.093) | (0.077) | (0.079) |
| TED Spread | -12.084 | -12.589 | -8.050 | -12.169 |
| | (14.156) | (14.143) | (14.433) | (14.229) |
| $\Delta$MSCI World | -0.281 | -0.307 | -0.205 | 0.036 |
| | (0.280) | (0.282) | (0.285) | (0.288) |
| Term Spread | -5.160 | | | |
| | (0.215) | | | |
| Long-Term Interest | | -10.119 | | |
| | | (9.183) | | |
| U.S. Long-Term Interest | | | -52.424*** | |
| | | | (8.978) | |
| U.S. Short-Term Interest | | | | -21.460*** |
| | | | | (3.544) |
| Observations | 849 | 849 | 854 | 854 |
| Adj.-$R^2$ | 0.002 | 0.010 | 0.060 | 0.036 |