Office Market Interconnectedness and Systemic Risk Exposure*

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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 show how systemic risk in the financial sector leads to correlated risk in global financial center office properties.

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

1 Introduction

This paper empirically analyzes the relation between systemic risk in the banking sector and the interconnectedness of commercial real estate markets in international financial centers. As a unique testing ground, office property markets allow us to study how systemic risk in financial markets leads to correlated risk in real asset markets. Because office space in financial centers is used by property-owners and tenants from the financial industry, it links rental values and property returns to price fluctuations in financial markets (see, e.g., Lizieri, Baum, and Scott (2000), Lizieri and Pain (2014)). The stock market performance affects the net worth of financial institutions due to the marked-to-market valuation of their assets. Potential fire-sales during periods of financial distress increase the probability of bank failures (Berger and Bouwman (2013)). Capital shortage, triggered by asset price declines, also lead to job cuts in the financial service sector, which lowers the demand for office space and reduces investors' expectations about future rent cash flows and office market returns. Hence, there exist severe financial and contractual counterparty risks in international office markets that might reinforce periods of distress in the financial sector.

Based on head office locations of financial institutions, we first quantify the aggregated level of systemic risk in financial centers. We use the SRISK of Brownlees and Engle (2017) as a proxy for systemic risk. This measure calculates the expected capital shortfall of financial institutions conditional on a hypothetical price decline in the global asset market. Compared to other systemic risk indicators, such as the marginal expected capital shortfall (MES) of Acharya, Pedersen, Philippon, and Richardson (2017) or ΔCoVaR of Adrian and Brunnermeier (2016), which are highly correlated with the banks' market beta or VaR, the SRISK also includes their leverage and debt side and is therefore more suitable to disentangle systemic from systematic risk (Benoit, Colliard, Hurlin, and Pérignon (2017)). More important, we exploit the hypothetical characteristic of the SRISK measure. The expected capital shortfall should affect the balance sheet of financial institutions only during periods of financial distress. When market prices fall, systemic risk in the banking sector should trigger cross-sectional dependence among commercial real estate. During normal times, balance sheets are not exposed to valuation shocks and the hypothetical undercapitalization in financial centers should not imply return co-movements among related office markets.

In a second step, we then use a large cross-section of city-level office market returns over a long time dimension, which includes several crisis periods to test how systemic risk in the banking sector leads to correlated risk in real estate office markets. 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 non-crisis periods. As financial turmoil times, we consider the dotcom equity bubble burst in 2001/2002 and the recent financial crisis 2007/2008. We then apply a placebo test for cross-sectional dependence among financial center retail markets as a within-city counterfactual. Office and retail markets follow a common city-specific trend; however, their performances should differ during financial turmoil times.

We find empirical evidence of cross-sectional dependence among financial center office market returns during financial turmoil periods that can be related to 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. We also do not find return co-movements among the counterfactual retail markets during crisis periods. Retail markets are not 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.

As an additional robustness test, we find no statistically significant return co-movements among non-financial center office markets. This is corroborated by our finding of a lower level of aggregated expected capital shortfall in non-financial compared to financial centers. To quantify the impact of systemic risk on the return performance in office markets, we then apply a difference-in-difference model. Compared to the within-city counterfactual retail sector, office markets in financial centers are more vulnerable during financial crisis periods. Similarly, we show empirical evidence of a statistically significant decline of office market returns in financial relative to non-financial centers during the aftermath of the recent financial crisis 2007/2008.

In contrast to e.g., Allen et al. (2012); Adrian and Brunnermeier (2016), who show how a shock in one institution affects the entire financial system, we study how synchronous price declines and excess correlations in commercial real estate can reinforce banks' undercapitalization, and thus, global systemic risk. Such a parallel depreciation in international office buildings has an immediate effect on financial covenants, i.e. lower expected cash flows reduce the debt coverage ratio and lower market values lead to higher loan-to-value ratios. We focus on this first-round effect as a source of additional systemic risk rather than the employment and credit channel. However, we also control for alternative transmission channels of cross-sectional dependence among commercial real estate markets, such as global GDP growth (Case, Goetzmann, and Rouwenhorst (2000)) and cycles in credit supply of the banking sector (e.g., Davis and Zhu (2011)). 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)).

This paper contributes to the empirical discussion on the interconnectedness of asset markets during periods of financial distress. Bekaert, Harvey, and Ng (2005) and Bekaert, Ehrmann, Fratzscher, and Mehl (2014) analyze excess return co-movements among global equity markets during financial turmoil periods, which cannot be explained by common risk factors. The literature is mostly silent on co-movements among commercial real estate markets. Exceptions are Case, Goetzmann, and Rouwenhorst (2000) who relate cross-sectional correlations of property markets to changes in global GDP or Stevenson, Akimov, Hutson, and Krystalogianni (2014), finding evidence of synchronized office market cycles. We study the interconnectedness of financial center office markets during periods of financial distress as transmitted through systemic banking sector risk.

We also build on the literature of systemic risk which is based on the correlation of the market price of assets in the balance sheet of financial institutions (e.g., Acharya, Engle, and Richardson (2012), Acharya, Pedersen, Philippon, and Richardson (2017), Brownlees and Engle (2017)). Brunnermeier, Rother, and Schnabel (2017) show the relationship between a higher systemic risk contribution and asset price bubbles prior to their burst. 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 financial sector. Our study shows that systemic risk also leads to price declines and excess correlations in real asset markets.

Our findings help for a better understanding of the fragility of commercial property markets in financial centers, particularly at times when real estate is vulnerable to valuation shocks. Knowledge about how commercial real estate markets are exposed to systemic risk is essential for policy makers and regulatory authorities. In this context, we provide an intuitive tool which similar to a stress test can be used for quantifying and comparing the systemic risk in global financial centers.

We also highlight the importance of our finding for the risk management of investors. Systemic risk as a transmission channel leads to return co-movements among commercial real estate markets and correlated risk with other assets, such as stocks. Consequently, risk diversification strategies among international financial center office markets and across asset classes lose their effectiveness in crisis times when it is most needed.

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

2 Data

This section presents our data. Sub-Section 2.1 discusses our commercial real estate data. We then identify financial centers and compare the performance of international property markets with their corresponding stock market fluctuations. Sub-Section 2.2 describes how we compute the financial center-specific aggregated systemic risk based on the SRISK measure. In Sub-Section 2.3 we then discuss additional control variables which are included in the empirical analysis.

2.1 Commercial Real Estate Data

We use annual commercial real estate prime total market returns reflecting both the rental income and the capital growth component at the city-level. Our sample contains office and retail market returns from 61 cities in 28 countries in the United States, Europe, and Asia-Pacific. The panel ranges from 1995 to 2015. Property Market Analysis (PMA) provides the data. PMA constructs city-level total market returns as a combination of the income and the capital component. These are calculated from observable prime rents per square meter and the observable initial yield taking into account depreciation and management costs. Capital growth is measured as the change in consecutive annual capital components, which are computed from the annual rent divided by the initial yield. Compared to appraisal-based methods, PMA total returns potentially tend to be a more accurate performance measure because of the marked-to-market valuation of commercial real estate. Appraisal-based indices are also difficult to compare internationally because of different valuation techniques. In contrast, our city-level data is based on a homogeneous methodology, which allows an international comparison.

Table 1 presents the summary statistics of the market returns. We pool across all cities and countries over the sample period. Panels A and B split the sample into different sectors (office and retail) and geographic regions (Asia-Pacific, Europe, and the USA), respectively. For instance, the mean annual office market return equals 6%, while the annual retail market performance is on average 10%. Comparing the sector performances with a t-test, the mean difference is statistically significant. Geographically, mean returns only differ by 2%-points (8% in Europe versus 10% in Asia-Pacific and the USA). Compared to e.g., the more established NCREIF data which covers the U.S. market, the large cross-section of our sample allows us to study the dependence among international commercial real estate markets.[1] Our sample also includes the dotcom bubble burst in 2001 and the recent financial crisis period in 2007 which provides sufficient variation over time to analyze how the cross-sectional dependence differs between normal and turmoil times.[2]

In a next step, we distinguish between financial and non-financial centers. Conceptionally, there exists no unique definition of a financial center.[3] We define cities as financial centers if they locate the national stock exchange trading platform. Based on our definition, the sample contains 29 financial centers.[4] Our approach is motivated by

[1] To test the validity of our data, we show the correlation structure between a subset of our U.S. city-level data and the corresponding NCREIF MSA market returns in Table A.1 in the Appendix. For most cities, we find a high correlation between 63 and 89%. Exceptions are the markets of Miami and Houston, for which the correlation only ranges from 47 to 57%.

[2] For example, RCA started their release of international commercial real estate city-level data in 2007 which does not allow the comparison between crisis and non-crisis periods.

[3] 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 often considered as regional financial centers (see Lizieri (2009) for a general discussion). Wójcik (2013), for instance, considers only London and New York as dominant global financial centers. Kindleberger (1974) defines financial centers as a concentration of financial activity where 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 (see also, e.g., Gehrig (2000), Lizieri (2009)).

[4] We list all cities in Table A.2 of the Appendix. Panel A indicates the market coverage of financial centers, whereas Panel B specifies all non-financial centers.

Cetorelli and Peristiani (2013) who highlight the importance of stock exchanges as a proxy for the attractiveness of a financial center. We also rule out offshore financial centers, such as the Cayman Islands, the British Virgin Islands, or Jersey. More important, following this definition, financial centers are predetermined and therefore exogenous for the property market performance. Historically, the financial service industry was built near local stock exchanges to benefit from international capital and from the floor trading access (see, e.g., Lizieri, Baum, and Scott (2000), Wójcik (2013)). In contrast, existing survey-based indices, such as the Global Financial Center Index (GFCI) or the Xinhua/Dow Jones International Financial Centers Development Index, rank financial centers based on several criteria, including infrastructure and business environment. Hence, the exogeneity assumption would be violated when using these indices to identify financial centers, since, in order to measure the attractiveness of a financial center, the criteria include the underlying office market condition.[5] Since we focus our analysis on the cross-sectional dependence among financial and non-financial centers, we briefly discuss their summary statistics in Panel C of Table 1. On average, the return performances are similar (8% for financial compared to 9% for non-financial centers) as are their standard deviations (15% versus 12%).

[INSERT Table 1 HERE]

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. We use the FTSE500 for the London Stock Exchange (LSE), or the Hang Seng Index for the Hong Kong Stock Exchange.[6] We use log-differences of the price index to compute annual

[5]As an additional robustness test, we apply a different approach to distinguish between financial and non-financial centers which is based on the ranking of the aggregated SRISK level of cities. We show that our empirical results also hold when we identify the upper terciles of cities with the highest systemic risk as financial centers.

[6]Table A.2 of the Appendix provides an overview of the listed stock market indices and the corresponding trading platforms.

returns.

We give the reader some intuition of the commercial real estate office and retail market performance. Figure 1 compares their return variation to the stock market behavior from 1995 to 2015. Panels A to C show average market returns pooled across all financial centers for the U.S., Europe, and Asia-Pacific relative to average stock market price index changes. The figures are based on local currencies to illustrate the return performance which is unaffected by local currency movements relative to the USD.[7] Office and retail markets follow a common cyclical pattern with the average stock market. Yet, 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 2001/2002 and the recent financial crisis period in 2007/2008. For instance, in Europe, office and retail market 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]

To further establish the dynamics between stock and office market returns in financial centers, Figure 2 illustrates impulse response functions from a panel vector autoregression (VAR). Local stock market returns tend to positively affect the related office market. We interpret the positive relationship to 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 might lead to job losses and lower demand for office space. We expect a similar relation between the stock market and the retail sector. A poor local

[7] 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.

banking sector performance might imply lower bonus payments for bankers and less income for consumption, which should also reduce the demand on the corresponding retail market. To capture the cyclical effect of the local stock market performance on both commercial real estate sectors within financial centers, we include stock market returns as an additional control variable when we test for the relation between the systemic risk of the banking sector and the office market dependence during financial crisis periods. 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 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]

2.2 Expected Capital Shortfall

We briefly compare the Systemic Risk Measure (SRISK) of Acharya, Engle, and Richardson (2012) and Brownlees and Engle (2017) to other prominent systemic risk measures proposed by the literature, such as the Marginal Expected Shortfall (MES) of Acharya, Pedersen, Philippon, and Richardson (2017) and the Delta Conditional Value-at-Risk (ΔCoVaR) of Adrian and Brunnermeier (2016). The MES measure captures the marginal risk contribution of a financial institution to the overall systemic risk based on its weight on the value-weighted market returns. SRISK not only takes account of the size but also of the liabilities of a financial institution. The ΔCoVaR 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 ΔCoVaR 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.[8]

To compute the aggregated expected capital shortfall in each financial center, we use the Brownlees and Engle (2017) SRISK measure of international financial institutions from 2000 to 2015.[9] SRISK quantifies the dollar-denominated expected capital shortfall of a financial institution i in period t which would occur from a hypothetical decline of the MSCI world equity price index return by 40% or more over the next period of $h = 6$ months:

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

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 $t + h$.[10] 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 is derived from the expected decline in the market value of the assets. We only include financial firms

[8]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 return co-movements are driven by an omitted systematic risk factor and not necessarily by a systemic risk exposure.

[9]The data is provided by the NYU Stern Volatility Lab. Table A.3 of the Appendix provides a snapshot of financial institutions with the highest SRISK level which are measured during our sample period. For instance, the most prominent example for the financial crisis affecting 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.3, 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.

[10]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.

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. Since SRISK values are released each month, we calculate the average SRISK for each financial institution in each year. For each financial center c, we then calculate the sum of the expected capital shortfall, i.e., the individual annual $SRISK$ value, of financial institutions with domestic and foreign head offices (headquarters, branches, or subsidiaries) in the financial 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.[11] 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.[12]

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

[11] 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.

[12] 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).

(2017), our financial center-specific aggregated systemic risk can be interpreted as the required amount of capital that would be needed to bail out the related banking sector during a crisis. 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 in this global financial center. 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 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 and non-financial centers.[13] 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.

[INSERT Figure 5 HERE]

[13] 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.

2.3 Control Variables

We include several risk factors in the model as controls.[14] The data availability of the SRISK measure limits the sample size from 2000 to 2015.

National GDP growth per capita and the inflation rate, measured in log-differences of the consumer price index (CPI), capture the impact of economic business cycle movements on domestic property markets. The empirical analysis is based on USD-denominated returns. To mitigate concerns that office market return co-movements are driven by a common exchange rate component, we control for changes of the local exchange rate relative to the USD. Exchange rate fluctuations also reflect international capital flows as a proxy for the relative attractiveness of a country. At the city-level, population growth controls for systematic differences between cities. Sector-specific construction rates (log-difference in floor space) capture heterogeneity in the supply of building stock between the office and retail.

We test for systemic risk as a channel for correlated risk between financial markets and private commercial real estate. We control for returns of domestic real estate investment trusts (REITs) to rule out that the correlated risk is driven by publicly listed companies which buy and sell properties. We also include dollar-denominated MSCI world equity index returns as a control variable. Since the SRISK measure depends on the performance of the global stock market, we need to rule out that the systemic risk channel is driven by an omitted factor. Based on daily data, we calculate the annual correlation between market returns of the local stock exchange and the global MSCI world index as a proxy for financial market integration. Banks might prefer to locate their branches in more financially integrated cities which could be a potential source for related office market co-movements. We find a positive correlation of 30% between the total SRISK and the related financial integration level of financial centers.

[14]Tables A.4 and A.5 in the Appendix show the descriptive summary and the correlation structure of the control variables.

We also control for the potential impact of a dry-out of funding liquidity on the return dependence among office markets. First, funding liquidity might be provided via structured commercial mortgage backed securities (Levitin and Wachter (2013), Duca and Ling (2018)). Therefore, we include the spread between the yields on the U.S. CMBS index and the long-term government bond as a common risk factor. The spread is larger during periods of financial distress when funding liquidity is restricted because of the higher perceived market risk. Second, we control for the credit supply of the banking sector (e.g., Davis and Zhu (2011)) by including international cross-border claims on each country, which is negatively correlated (−15%) with the total financial center SRISK. This data is provided by the Bank of International Settlement and captures the change in global dollar-denominated amounts outstanding from the national non-bank sector (i.e., bank loans, deposits, and other instruments, such as debt securities).

We also disentangle the systemic risk contribution of financial institutions from their exposure to bank-specific risk factors (e.g., Begenau, Piazzesi, and Schneider (2015)): In addition to the CMBS spread, we include the TED spread, which is computed as the difference between the LIBOR rate and the risk-free U.S. Treasury bill rate (the three month EURIBOR and the EONIA rate for the European area, respectively) as a proxy for global funding liquidity risk (Brunnermeier (2009)). As local risk factor, we use the term spread, defined as the country-specific long-term government bond yield relative to the corresponding short-term interest rate.[15]

[15] Table A.6 of the Appendix shows regression results to check how the aggregated SRISK in financial centers is related to these bank-specific risk factors. Coefficient estimates are statistically significant for the CMBS spread as well as the short- and long-term interest rate, which are explicitly (U.S. CMBS spread) or implicitly (Term Spread, TED Spread) included as controls in our models. However, the explanatory power is rather low, ranging from 0.1 to 6%.

3 Methodology

This section presents our spatial econometric framework. To estimate the cross-sectional dependence between financial center office markets, we specify the following model

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

where we regress annual office market returns in financial center i in year t on the weighted average of contemporaneous office market returns in other financial centers. The weighted average $\sum_{j \neq i} w_{ij,t} r_{jt}$ is defined as the spatially lagged dependent variable. The time-varying weight $w_{ij,t}$ reflects the testable linkage mechanism between office markets i and j. The spatial lag parameter λ measures the degree of cross-sectional dependence from the interconnectedness between the cross-sectional units of the endogenous variable. The set of common risk factors is captured by matrix X_{it}. Parameter η_i defines individual fixed effects.

We apply the Wang and Lee (2013) GMM estimator to account for the endogeneity between cross-sectional units of office market returns and the residuals which arises from the spatial dependence structure. Their approach is flexible enough to estimate the spatial lag model with fixed effects under an unbalanced panel structure. The estimator allows for time-varying spatial weights which are exploited in our identification strategy. 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 to additionally account for the potential cross-sectional correlation of the residuals.

Specification of the Weighting Matrix. We specify the spatial weighting structure to test whether the common systemic banking sector risk between financial centers implies cross-sectional dependence among the underlying office markets. The spatial weight $w_{ij,t}$ between office market i and j is defined as the sum of binary indicator variables for individual financial institutions (l), which equal one if their head offices are located in both financial centers i and j, and zero otherwise. Using the Brownlees and Engle (2017) SRISK measure, we then multiply each indicator variable with the percentage SRISK ($\%SRISK_{l,t}$) of the related financial institution l in year t. The percentage SRISK measures a financial firm's contribution to the overall global systemic risk.[16] Specifically, we compute

$$w_{ij,t} = \sum_{l} \mathbb{1}\big(head\ office_{il} \cap head\ office_{jl}\big) \times \%SRISK_{l,t}. \quad (4)$$

The additional weighting with the $\%SRISK$ gives financial institutions with a higher systemic risk contribution a larger weight in the interconnectedness between both financial centers. A higher common systemic risk contribution between two financial centers, indicated by a larger spatial weight, should imply stronger co-movements between their office markets.[17] We row-normalize the cross-sectional weights to interpret the spatially lagged dependent variable as the weighted average of office markets. As is standard in the spatial econometric literature, 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.

The time-varying weights capture fluctuations in the expected capital shortfall over time. Panels A and B of Figure 6 illustrate the network maps for financial and non-financial centers as implied by the weighting structure for the year 2007. We compare them to highlight the stronger interconnectedness among financial compared to non-financial centers. As indicated in Panel A, the financial center Osaka is only linked to London and Tokyo. The linkage depends on (i) whether financial institutions have head offices located in both financial center (e.g, in Osaka and in Tokyo) and on (ii) their systemic

[16] The percentage SRISK 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 the individual institution.

[17] The importance of the weighting by $\%SRISK$ is also confirmed in Sub-section 4.4, where only financial centers with a banking sector that belongs to the 25% highest (compared to the 25% lowest) expected shortfall show significant declines in office property prices. Hence, we can rule out that our results from spatial regressions are driven by the general structure of the weighting matrix, but the $\%SRISK$-weighting has an additional meaning.

risk contribution. The $\%SRISK$ only includes systemically relevant financial institutions with a positive expected capital shortfall. Hence, potential banks with head offices in Osaka and other financial centers, but with a measured capital surplus, are not included. The network maps look similar for other years of the sample because they are based on the expected capital shortfall given a hypothetical decline in the global stock market. What is essential for our identification strategy is that the linkage mechanism only results in office market dependence during periods of financial distress, when asset price declines lead to an undercapitalization in the balance sheet of banks.

[INSERT Figure 6 HERE]

Identification Strategy. In order to isolate the common systemic banking sector risk as the source of office market co-movements, we apply a double counterfactual approach. Since the systemic risk measure in our research design is based on the expected capital shortfall, we should only observe office market return co-movements during periods of financial distress but not during normal times. As financial turmoil times we define the dotcom bubble burst in 2001/2002 and the financial crisis period 2007/2008. Our chosen crisis periods match with the financial stock market turmoil identified by Brunnermeier, Rother, and Schnabel (2017). They show that the emergence of asset price bubbles leads to a higher systemic risk, which is followed by large financial losses when they burst. Concerns might arise whether both crisis periods can be considered as exogenous events for commercial real estate markets. The stock market bubble prior to its 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)). The recent financial crisis 2007/2008 had its origin in the U.S. residential subprime mortgage market through which it transmitted to the banking sector and then affected the markets for stocks and commercial real estate (see, e.g., Brunnermeier (2009) and Levitin and Wachter (2013)).

We first estimate our spatial lag model for financial center office market returns during the sample period from 2000 to 2015. However, we impose restrictions in the time-varying weighting matrix such that all spatial weights are set equal to zero during normal financial market periods. This model specification allows us to explicitly test for cross-sectional dependence among financial center office markets during periods of financial distress. We then restrict the elements of the weighting matrix to zero during financial turmoil periods and allow for time-varying spatial weights during normal times. We use this specification as a placebo test for office market dependence during normal times.

Second, we test for cross-sectional dependence among financial center retail markets during crisis periods. The retail sector serves as an ideal within-city counterfactual for the office market. Both sectors are driven by the same local market characteristics and follow a common trend. However, the retail market should not be directly exposed to the systemic banking sector risk, particularly when we control for macroeconomic fundamentals. Hence, we should not find any empirical evidence of return co-movements among financial center retail markets. The double counterfactual approach also helps us to further disentangle the systemic risk from omitted common factors as potential transmission channel. Similarities in institutional factors, such as transparency and infrastructure as well as cultural or geographic proximity between financial centers should affect office market return co-movements not only during financial distress, but also during normal times or should also lead to statistically significant dependence among financial center retail markets. Similarly, assuming that international investment flows are more or less equally distributed among both sectors in financial centers, the effect of a liquidity dry-out during crisis periods as a potential source for office market return co-movements might be ruled out, since we should observe a similar effect on the within-city counterfactual retail sector.

Reflection Problem. Spatial models raise potential concerns about the reflection problem (Manski (1993)). The dependence that is captured by the weighted average of the endogenous office market returns might reflect an omitted cross-sectional dependence that arises from explanatory variables.[18] We disentangle both sources of cross-sectional dependence by including the equally-weighted average of country-specific GDP growth as an additional regressor which mirrors the exogenous spatial lag structure. The endogenous spatial lag reflects the common exposure to the systemic banking sector risk as specified by the weighting matrix. The latter factor captures the systematic risk of explanatory variables on contemporaneous, cross-sectional units of the endogenous variable. For instance, the office market return in country i might be affected by GDP growth in country j. In this context, we also control for the common impact of the global GDP trend, proxied by the average of country-specific GDP on international commercial real estate markets (Case, Goetzmann, and Rouwenhorst (2000)).

Fixed Effects. We also include individual fixed effects at the financial center level. This specification removes the omitted variable bias that might explain systematic differences among office markets, e.g., currency zones, gateway cities, quality of life, and local regulation, or the attractiveness of financial centers. These time-invariant factors 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. As imposed by the within-structure of the fixed effects specification, our model explains the variation of office market returns over time within each financial center. Consequently, the spatial lag parameter can be interpreted as a measure for the degree of return co-movements between a certain financial center office market and the weighted average of

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

contemporaneous office markets.[19]

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. In Sub-Section 4.1 we test for the systemic risk in financial centers as a transmission channel for return co-movements among related office markets. Sub-Section 4.2 presents additional robustness tests to support our transmission channel. Sub-Sections 4.3 and 4.4 apply difference-in-difference models to quantify the office market performance during crisis periods relative to the counterfactual retail sector and non-financial center office market returns, respectively.

4.1 Systemic Risk as Transmission Channel

Table 2 shows different model specifications of Equation (5) (Model I as the baseline model and Models II and III for robustness). Following our definition, we include all cities in our sample as financial centers which host a national stock exchange trading platform.[20] 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. International banks are exposed to stock market fluctuations through the marked-to-market value of assets in their balance sheets. A high expected capital shortfall during financial crisis periods leads to an undercapitalization of the banking sector and might

[19]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.

[20]In Table A.8 in the Appendix, we also replicate and confirm our findings, when we rank all cities according to their total systemic risk level and define the top tercile of cities with the highest level of SRISK as financial centers. These cities are listed in Panel A of Figure 4 and are expanded by Brussels, Dublin, Vienna, and Zurich.

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. 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 model specification, we find a statistically and economically significant high degree of cross-sectional dependence as implied by the spatial lag coefficient λ. 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 also 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.[21] 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 within-financial center counter-

[21] 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.2 in the Appendix.

factual. 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 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.[22]

We capture country-specific and local market characteristics as additional controls. Model I includes macroeconomic fundamentals, such as GDP growth, the term spread, the inflation rate, and the local exchange rate relative to the USD. At the city-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 stock market and property market returns and the variable $\Delta Claims$ reflects the potential effect on property markets coming from the international bank lending activity (e.g., Davis and Zhu (2011)). We also find a positive relation between office market returns and the performance of mortgage-backed securities as a source of funding liquidity which is in line with the previous literature (Levitin and Wachter (2013), Duca and Ling (2018)). As an additional control, we include the potential return correlation of the representative national stock market with the MSCI world index as a proxy for the level of financial integration.

The main results are the same, when we include additional control variables. 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 controls for global GDP growth as a potential driver for the correlation among international property markets (Case, Goetzmann, and Rouwenhorst (2000)). Global GDP growth as a common factor tends to positively affect commercial real estate markets. We also check the correlation between global GDP growth and the equally-weighted global property market portfolio for the office (68%) and the

[22] 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 main results are the same.

retail sector (77%). Our findings suggest that GDP growth might capture some of the variation coming from an omitted global CAPM market factor for commercial real estate. However, to fully rule out that our spatial weights reflect the impact of the overall market portfolio, we provide an additional robustness test: We first separately regress office and retail market returns on an intercept and the corresponding global market portfolio (with estimated beta coefficients of 1.15 and 1.17 for the office and retail sector, respectively). In a second step, we then use the residuals to replicate the results of the spatial lag models in Table A.7 in the Appendix. We still find evidence of cross-sectional dependence among financial center office markets during crisis periods, whereas, the spatial lags are statistically insignificant for office markets during normal times and the counterfactual retail sector during the crisis periods. We conclude that our findings cannot be explained by a global market portfolio, but by specific weights based on the common systemic risk and the interconnectedness of the financial system.

4.2 Robustness Tests

Non-Financial Centers. We first 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.[23] These cities are ranked among the top 15 financial centers according to the GFCI but do not host national stock exchanges

[23]Table A.9 in the Appendix shows similar results when we replicate the table based on cities from the bottom tercile with the lowest level of SRISK. For instance, cities like Boston, Chicago, and Washington are included in this bottom tercile.

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 center office 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)).

[INSERT TABLE 5 HERE]

4.3 Evidence from Asset Price Bubble Bursts

Subsection 4.1 shows empirical evidence of cross-sectional dependence among office markets during financial turmoil periods. If this dependence is driven by the common systemic risk in the banking sector, we should observe a significant decline in office market returns relative to the counterfactual retail sector during periods of financial distress, when asset prices fall. In this Sub-Section we compare the return performance of both sectors within financial centers and exploit the recent financial crisis period and the dotcom bubble burst in this quasi-experimental setting. We specify the following linear difference-in-difference model

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

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 data 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 for which we also set the crisis-dummy equal to 1. 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 by setting the crisis-dummy to 1 for the years 2001 and 2002. We restrict the crisis periods to two years to estimate the effect immediately after the bubble burst. Based on the parametric specification, the interaction term assesses the office market performance during the financial market turmoil relative to the counterfactual retail market. Given the within-city comparison between affected and counterfactual property markets, which should be driven by the same factors, we can rule out that the required common trend assumption might be violated.

Model I of Table 6 shows 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 the difference-in-difference setup. Model II also controls for systematic differences in the available supply of floor space between both sectors, which is measured in levels, since this effect would not be captured by its construction rate. 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. Compared to the recent financial crisis, the office market decline is smaller in magnitude; however, the economic interpretation is similar.

[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. Again, we exclude Boston, Chicago, San Francisco, and Washington from our sample to clearly distinguish between both markets. We follow the same methodology as in the previous sub-section and use a difference-in-difference model. However, because of data limitations, we do not have sufficient city-level controls to 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.

Table 7 suggests 12% lower office market returns in financial than in non-financial centers during the recent crisis period 2008/2009. 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 supply of office market floor space and city-level population growth (Model II) and additional country-specific macroeconomic control variables to remove potential differences between financial and non-financial centers located in different countries (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.

[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), conditional on a recent financial crisis dummy. However, Models III to V indicate that the decrease in office market returns during the financial crisis period is stronger in cities with a higher total SRISK.[25]

We distinguish between office markets in the sample for which the aggregated SRISK in the banking sector belongs either to the 25% highest or the 25% lowest each year. We

[24] Note that San Francisco is not included in the sample. Hence, we can rule out any effect that potentially arises from the geographic proximity to Silicon Valley. Many overvalued dotcom companies had their headquarter located there at that time.

[25] We want to analyze the cross-sectional variation of market returns. Hence, we do not include individual fixed effects. Similarly, year fixed effects are also not included. This enables us to assess the impact of the financial crisis dummy on the cross-sectional differences between office markets.

specify dummy variables for both quartiles ($SRISKhigh$ and $SRISKlow$) and interact them with the year dummies of 2008 and 2009 to capture the aftermath effect of the financial crisis. On average, office market returns decrease by 12% in those years (Model IV). In contrast, the magnitude declines 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. However, we find no statistically significant effect for office markets of cities with the lowest 25% expected capital shortfall. We conclude that during normal times the higher expected capital shortfall does not have a significant impact on office market returns. However, a higher potential undercapitalization in the banking sector increases the vulnerability of the underlying office market during periods of financial distress. This effect is the stronger the higher the undercapitalization in a banking sector of a financial center.

[INSERT TABLE 8 HERE]

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 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 of Commercial Real Estate Market Returns

This table contains the descriptive summary for the commercial real estate market returns. Our sample is pooled over a cross-section of 61 cities in 28 countries from 2000 to 2015. We define all cities with a stock exchange trading platform as financial center. Panels A to C separate markets returns based on market sectors, geographic regions, and whether the city is identified as a financial center (i.e. when a representative stock exchange trading platform is located in the city). Returns are calculated as log-differences. The values are measured in decimals.

Panel A: Markets Returns by Sector					
	Mean	**Std.Dev.**	**Min.**	**Max.**	**Obs.**
Office	0.07	0.14	-0.56	0.79	1225
Retail	0.10	0.13	-0.70	0.71	962
Panel B: Markets Returns by Geographic Region					
	Mean	**Std.Dev.**	**Min.**	**Max.**	**Obs.**
Asia-Pacific	0.10	0.18	-0.64	0.71	385
Europe	0.08	0.13	-0.70	0.79	1361
USA	0.10	0.12	-0.52	0.49	441
Panel C: Markets Returns by Center					
	Mean	**Std.Dev.**	**Min.**	**Max.**	**Obs.**
Financial	0.08	0.15	-0.70	0.79	1048
Non-financial	0.09	0.12	-0.44	0.65	1139

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 for *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero for 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 (ΔCPI) proxy expected inflation. Construction (Δ*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. Δ*Population* measures the population growth in the financial center. Δ*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. Δ*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)
ΔGDP 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)
ΔCPI	-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)
ΔFloor 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)
ΔREIT	-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)
ΔPopulation	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)
ΔClaims	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)
ΔExchange 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 for *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero for 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 (ΔCPI) proxy expected inflation. Construction (Δ*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. Δ*Population* measures the population growth in the financial center. Δ*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. Δ*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 for *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero for 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 (ΔCPI) proxy expected inflation. Construction (Δ*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. Δ*Population* measures the population growth in the financial center. Δ*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. Δ*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	**Office**	**Retail**	**Office**	**Office**	**Retail**
	Turmoil	**Normal**	**Turmoil**	**Turmoil**	**Normal**	**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 for *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 (ΔCPI) proxy expected inflation. Construction (Δ*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. Δ*Population* measures the population growth in the financial center. Δ*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. Δ*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. Δ*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)
ΔExchange 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. Δ*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. Δ*Population* measures the population growth in the financial center. Δ*Claims* are international cross-border claims on each country's non-bank sector. Changes in the consumer price index (Δ*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. Δ*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)
ΔExchange 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)
ΔPopulation		0.249**	-0.721		0.611	-0.108
		(0.114)	(0.750)		(0.441)	(0.841)
ΔCPI			-0.991**			-0.143
			(0.443)			(0.550)
Term Spread			-1.197			0.283
			(1.262)			(0.635)
ΔGDP Capita			0.889***			0.648**
			(0.287)			(0.300)
ΔREIT			-0.319			-0.159
			(0.369)			(0.368)
ΔClaims			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: Effect of Financial Center-Specific SRISK on Office Market Returns

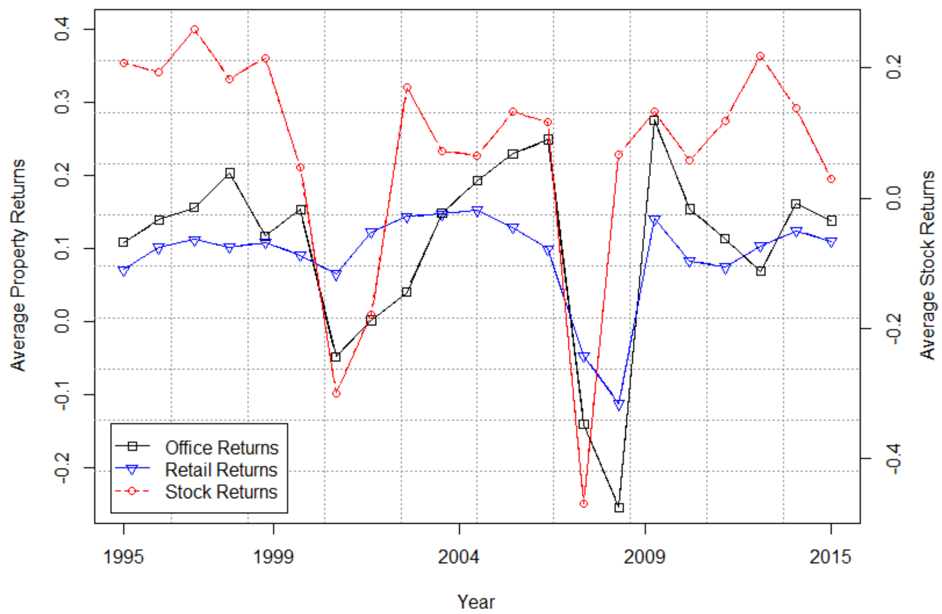
This table shows the effect of the total financial center-specific systemic risk on international office markets. Estimates are based on OLS. *Stock Returns* indicate the log-difference of the national equity market index at the financial center. The financial center-specific *SRISK* exposure is measured 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 (ΔCPI) proxy expected inflation. Construction (Δ*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. Δ*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 financial center-specific systemic risk 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

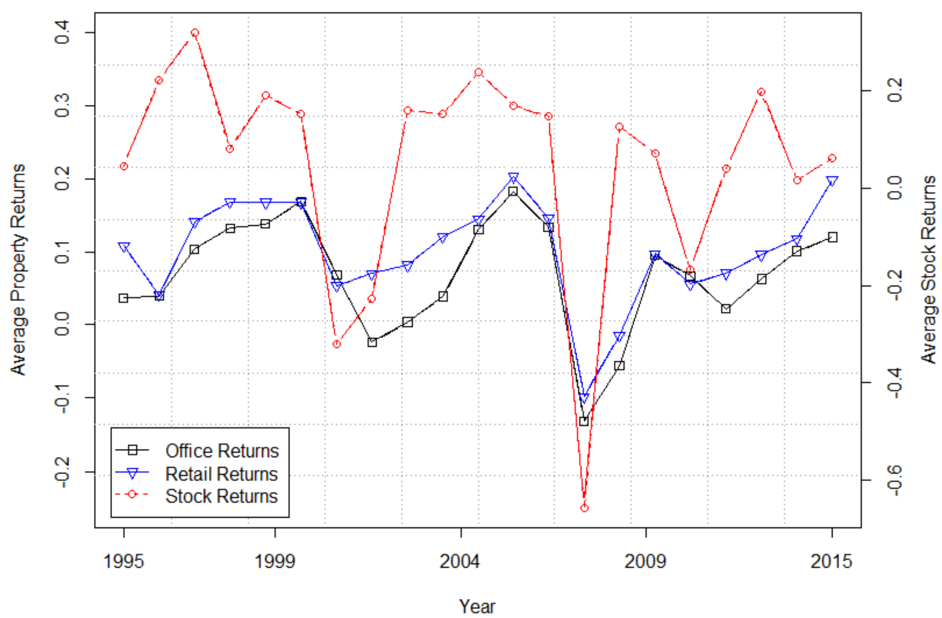


Figure 1 continued.

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

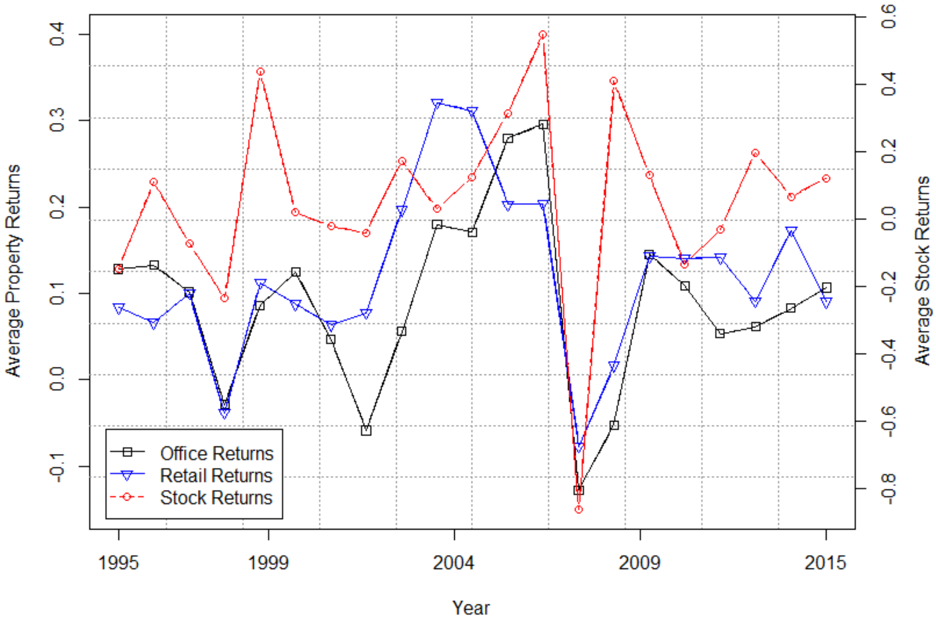


Figure 2: Impulse Response Function

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.

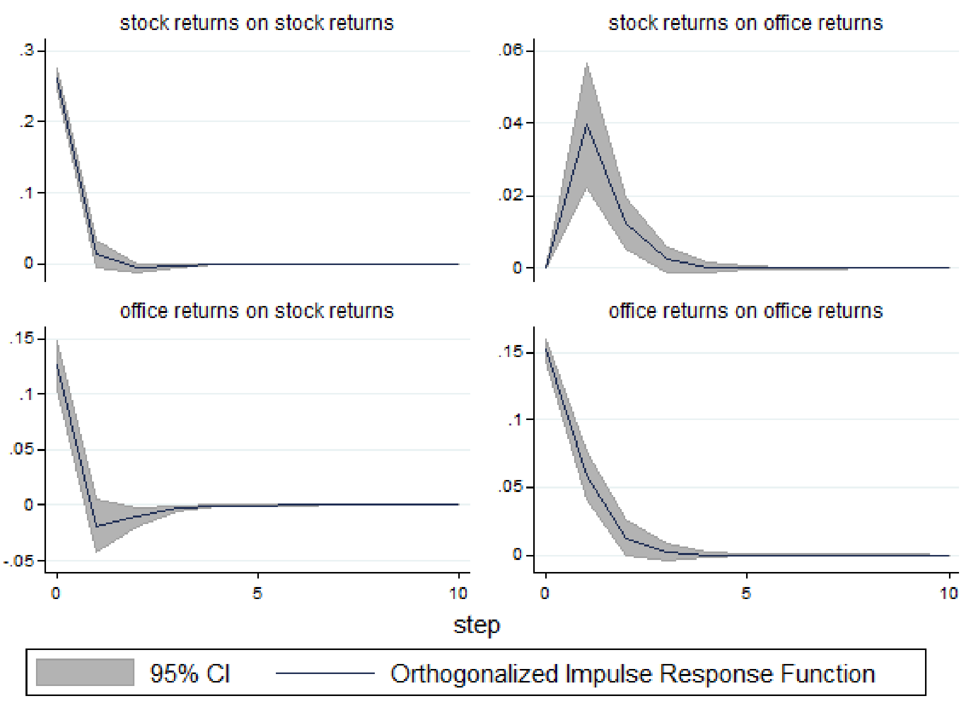


Figure 3: Financial Institutions in International Financial Centers

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.

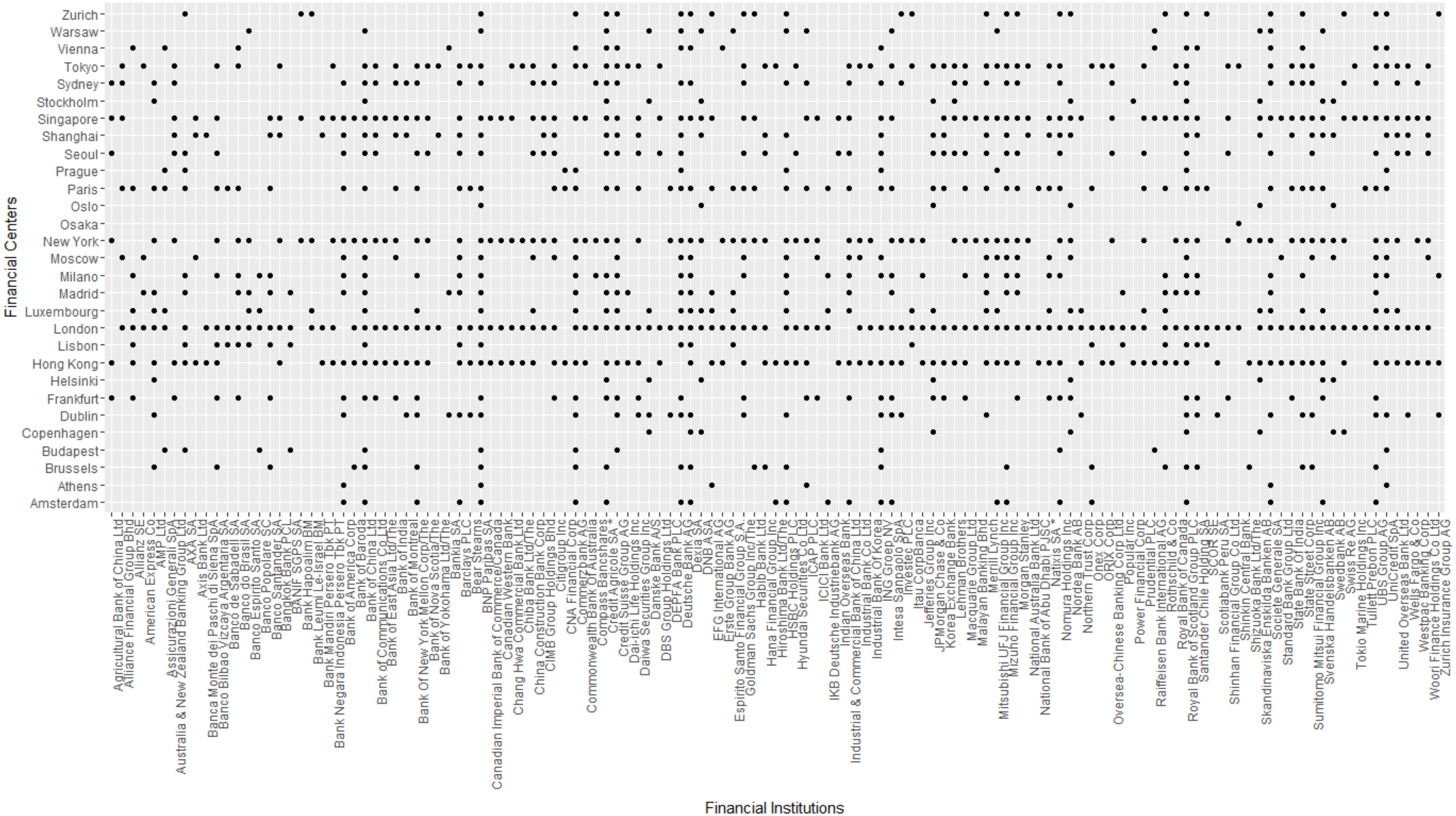
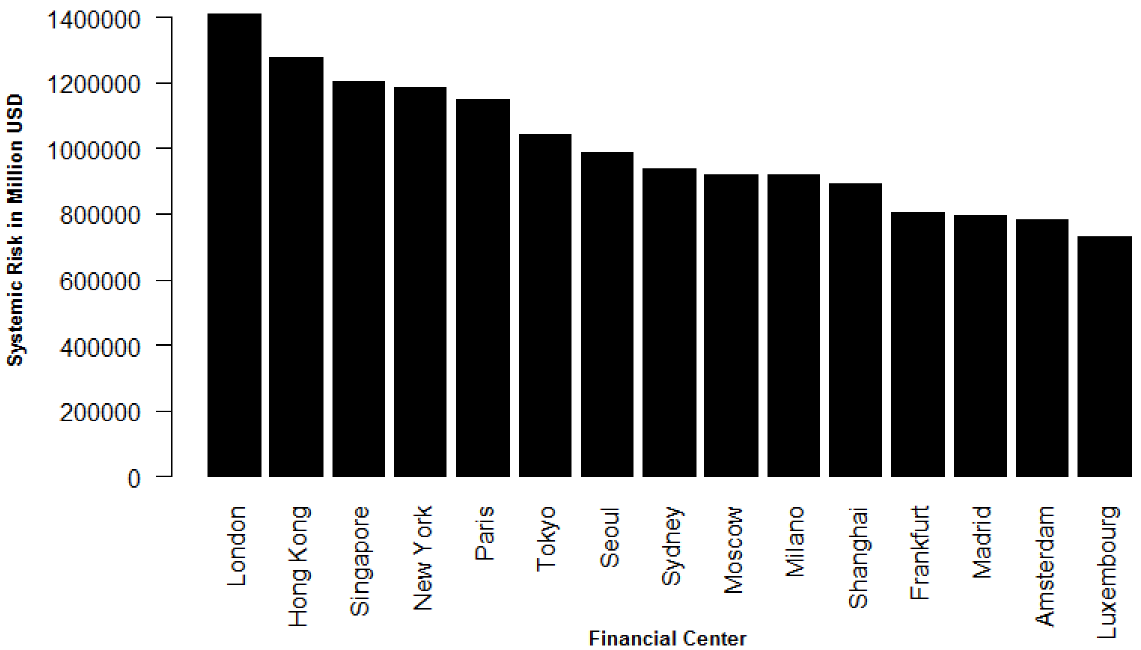


Figure 4: SRISK Ranking of Financial Centers

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

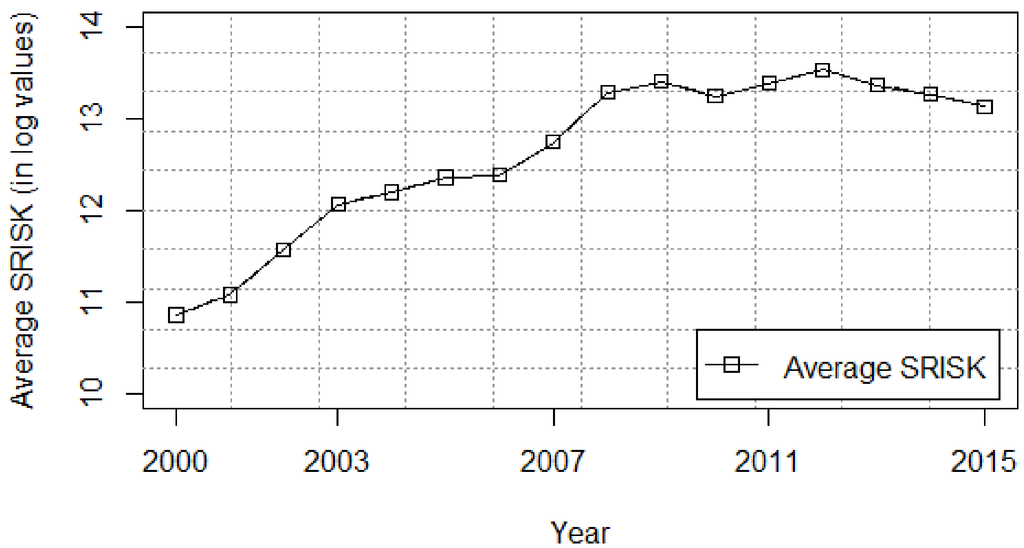


Figure 5: Average SRISK in Financial Centers versus Non-Financial Centers

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.

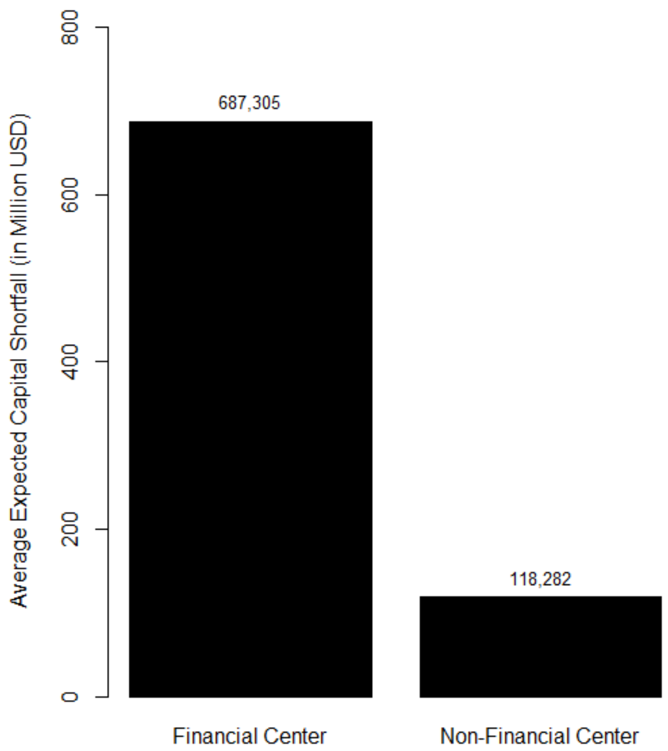
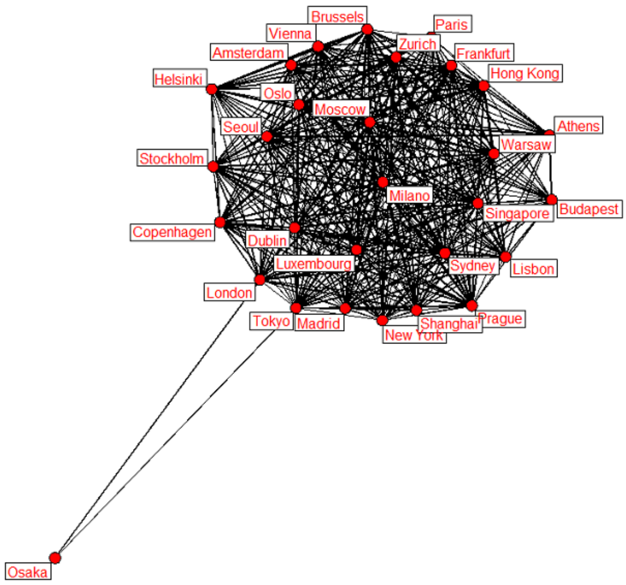


Figure 6: Interconnectedness of Financial and Non-Financial Centers

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

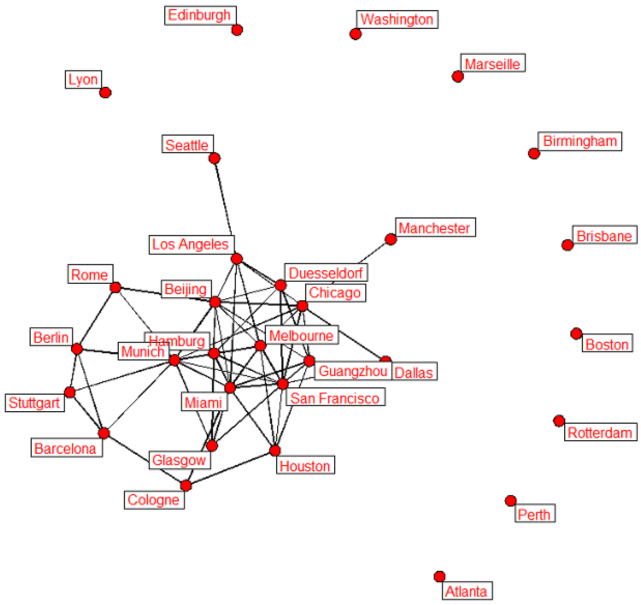


Table A.1: Correlation: PMA data versus NCREIF for U.S

This table depicts the correlation of the city-level market returns based on Property Market Analysis (PMA) with the established NCREIF NPI market returns for the USA (at the MSA level) for the two sectors office and retail from 2000 to 2015.

City	**Office**	**Retail**
Atlanta	0.869	0.886
Boston	0.751	0.751
Chicago	0.646	0.734
Dallas	0.763	0.716
Houston	0.469	0.504
Los Angeles	0.869	0.874
Miami	0.569	0.486
New York	0.645	0.635
Seattle	0.787	-
San Francisco	0.839	0.634
Washington	0.829	0.735

Table A.2: 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.2 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	No
Chicago	USA	Yes	Yes
Cologne	Germany	Yes	Yes
Dallas	USA	Yes	Yes
Dusseldorf	Germany	Yes	No
Edinburgh	United Kingdom	Yes	No
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	No
Perth	Australia	Yes	No
Rome	Italy	Yes	Yes
Rotterdam	Netherlands	Yes	No
San Francisco	USA	Yes	Yes
Seattle	USA	Yes	No
Stuttgart	Germany	Yes	Yes
Washington	USA	Yes	Yes

Table A.3: 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.4: Summary Statistics of Explanatory Variables

This table contains the descriptive summary of the explanatory variables 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. *Stock Returns* measures the performance of the local stock exchange trading platform. The variable *Correlation* is based on daily data and calculates for each year and each local stock exchange trading platform its correlation with the MSCI World equity index performance. ΔGDP Global is computed as the equally-weighted cross-sectional average of all country-specific GDP variables. Returns and growth rates (indicated by Δ) are calculated as log-differences. All values are measured in decimals.

City-Level	**Mean**	**Std.Dev.**	**Min.**	**Max.**	**Obs.**
log(SRISK.total)	12.84	1.28	8.96	14.83	820
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
Correlation	0.51	0.24	-0.12	0.93	435
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.**
ΔGDP Global	0.05	0.07	-0.09	0.16	15
MSCI World Returns	0.02	0.24	-0.63	0.38	15
U.S. CMBS Spread	0.01	0.40	-0.70	1.05	15
TED Spread	0.01	0.01	0.00	0.06	15

Table A.5: Correlation Structure of Explanatory Variables

This table shows the Pravais-Pearson correlation matrix of the explanatory variables.

	log(SRISK.total)	**ΔGDP Capita**	**ΔGDP Global**	**ΔCPI**	**ΔExchange Rate**	**ΔPopulation**	**ΔFloor Space**	**Stock Returns**	**MSCI World Returns**	**ΔREITs**	**Correlation**	**ΔClaims**	**U.S. CMBS Spread**	**TED Spread**	**Term Spread**
log(SRISK.total)	1.00														
ΔGDP Capita	-0.07	1.00													
ΔGDP Global	-0.15	0.73	1.00												
ΔCPI	0.05	0.34	0.21	1.00											
ΔExchange Rate	0.02	0.51	0.16	-0.01	1.00										
ΔPopulation	0.11	0.18	0.08	0.30	-0.03	1.00									
ΔFloor Space	-0.16	0.29	0.08	0.56	0.07	0.25	1.00								
Stock Returns	0.01	-0.02	-0.05	-0.11	-0.11	0.04	-0.02	1.00							
MSCI World Returns	0.01	0.24	0.39	0.09	-0.02	0.01	-0.09	0.10	1.00						
ΔREITs	-0.01	0.78	0.58	0.02	0.84	0.02	0.06	-0.12	0.06	1.00					
Correlation	0.30	-0.17	-0.07	-0.06	-0.03	-0.02	-0.36	-0.13	-0.02	-0.04	1.00				
ΔClaims	-0.15	0.41	0.38	0.16	0.14	0.07	0.19	0.22	0.03	0.27	-0.18	1.00			
U.S. CMBS Spread	0.10	0.05	0.11	0.14	0.03	0.01	-0.10	-0.18	0.32	0.04	0.13	-0.13	1.00		
TED Spread	0.10	-0.07	-0.01	-0.07	-0.06	0.00	-0.08	-0.25	-0.35	-0.01	-0.15	-0.11	-0.01	1.00	
Term Spread	0.06	-0.25	-0.04	-0.38	-0.03	-0.18	-0.37	-0.02	0.02	-0.02	0.14	-0.23	0.10	-0.01	1.00

Table A.6: 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. Δ*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)
ΔMSCI 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

Table A.7: Common Systemic Risk: Conditional on Global CAPM Risk Factor

This table replicates the results of Table 2. As endogenous variable we use residuals from a pooled panel model where office and retail market returns are separately regressed on an intercept and the corresponding equally-weighted global property market portfolio. *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 for *normal* times. To measure dependence during normal times, the weights are restricted to zero for 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 (ΔCPI) proxy expected inflation. Construction (Δ*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. Δ*Population* measures the population growth in the financial center. Δ*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. Δ*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	0.189*	0.248	0.037	0.279**	0.132	0.081	0.229***	0.010	0.024
	(0.099)	(0.164)	(0.082)	(0.131)	(0.301)	(0.080)	(0.082)	(0.328)	(0.076)
Stock Returns	0.347***	0.328***	0.335***	0.279***	0.297***	0.303***	0.338***	0.357***	0.313***
	(0.046)	(0.052)	(0.043)	(0.047)	(0.059)	(0.047)	(0.046)	(0.067)	(0.043)
log(SRISK)	-0.031**	-0.031**	-0.023*	-0.038***	-0.038***	-0.023*	-0.005	-0.006	0.002
	(0.015)	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)	(0.015)	(0.017)	(0.012)
ΔGDP Capita	1.437***	1.209***	1.452***	1.141***	1.111***	1.349***	1.109***	1.133***	1.248***
	(0.244)	(0.229)	(0.279)	(0.238)	(0.249)	(0.280)	(0.246)	(0.257)	(0.275)
Term Spread	-0.248	-0.512	1.306*	0.043	-0.354	1.544**	-0.121	-0.401	0.949
	(0.611)	(0.569)	(0.712)	(0.581)	(0.593)	(0.718)	(0.567)	(0.603)	(0.720)
ΔCPI	-1.010	-0.956	-0.244	-0.752	-0.736	-0.082	-2.352***	-2.339***	-1.437**
	(0.750)	(0.689)	(0.783)	(0.716)	(0.698)	(0.785)	(0.728)	(0.853)	(0.275)
ΔFloor Space	-1.136**	-1.013**	-0.299	-1.225***	-1.194***	-0.305	-0.592	-0.640	-0.085
	(0.485)	(0.444)	(0.237)	(0.454)	(0.449)	(0.235)	(0.432)	(0.448)	(0.206)
ΔREIT	-0.780***	-0.764***	-1.267***	-0.869***	-0.946***	-1.289***	1.190***	1.113**	0.428
	(0.290)	(0.269)	(0.349)	(0.272)	(0.290)	(0.351)	(0.360)	(0.488)	(0.399)
ΔPopulation	0.056	0.031	1.480	0.105	0.064	1.713	0.139	0.115	0.972
	(0.163)	(0.141)	(1.390)	(0.180)	(0.162)	(1.344)	(0.174)	(0.170)	(1.304)
ΔClaims	0.185**	0.219***	0.144*	0.132*	0.180**	0.122	0.139*	0.165**	0.108
	(0.080)	(0.077)	(0.085)	(0.072)	(0.077)	(0.084)	(0.174)	(0.080)	(0.074)
Correlation to MSCI	-0.040	0.077	-0.079	0.0003	0.094	-0.076	-0.043	0.017	-0.076
	(0.113)	(0.102)	(0.087)	(0.104)	(0.113)	(0.088)	(0.106)	(0.136)	(0.076)
ΔExchange Rate	0.789	0.896	0.691	0.985	1.093	0.691	-1.468*	-1.411	-1.362
	(0.831)	(0.802)	(0.972)	(0.805)	(0.825)	(0.970)	(0.082)	(0.895)	(0.993)
U.S. CMBS Spread	0.180***	0.153***	0.046**	0.157***	0.150***	0.037*	0.154***	0.157***	0.031
	(0.022)	(0.027)	(0.022)	(0.020)	(0.039)	(0.021)	(0.019)	(0.043)	(0.019)
TED Spread				-7.372***	-5.889***	-2.394**			
				(1.078)	(1.686)	(0.988)			
$\Delta\overline{GDP}$							2.286**	2.354***	2.087**
							(0.291)	(0.702)	(0.310)
Observations	464	464	368	464	464	368	464	464	368
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pesaran CD	35.97***	28.45***	20.98***	27.10***	26.47***	18.56***	25.15***	25.90***	18.05
Adj.-R^2	0.463	0.501	0.477	0.525	0.528	0.483	0.549	0.542	0.565

Table A.8: Robustness: Common Systemic Risk among Financial Center Office Markets

This table replicates the results of Table 2 with cities as financial centers with the upper tercile of the highest average SRISK level from 2000 to 2015. *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 for *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero for 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 (ΔCPI) proxy expected inflation. Construction (Δ*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. Δ*Population* measures the population growth in the financial center. Δ*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. Δ*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	0.235*	-0.007	0.038	0.317**	-0.095	0.045	0.234*	-0.109	-0.031
	(0.139)	(0.290)	(0.122)	(0.146)	(0.368)	(0.122)	(0.135)	(0.409)	(0.128)
Stock Returns	0.194***	0.230***	0.199***	0.138***	0.190***	0.191***	0.195***	0.237***	0.197***
	(0.044)	(0.049)	(0.044)	(0.050)	(0.051)	(0.050)	(0.044)	(0.054)	(0.045)
log(SRISK)	-0.027*	-0.030*	-0.015	-0.033**	-0.038***	-0.016	-0.019	-0.019	-0.007
	(0.014)	(0.014)	(0.012)	(0.013)	(0.014)	(0.012)	(0.015)	(0.015)	(0.012)
ΔGDP Capita	1.006***	1.067***	0.876***	0.832***	0.949***	0.856***	0.904***	0.969***	0.743***
	(0.188)	(0.191)	(0.212)	(0.197)	(0.203)	(0.223)	(0.190)	(0.199)	(0.230)
Term Spread	-1.090	-1.282	0.953	-0.891	-1.149	1.025	-0.983	-1.141	0.722
	(0.904)	(0.903)	(0.821)	(0.873)	(0.888)	(0.828)	(0.900)	(0.932)	(0.822)
ΔCPI	-0.642	-0.828	0.533	-0.318	-0.522	0.581	-1.052	-1.375*	-0.229
	(0.702)	(0.739)	(0.723)	(0.688)	(0.750)	(0.730)	(0.753)	(0.830)	(0.815)
ΔFloor Space	-0.791	-0.786	0.043	-0.974*	-1.023*	0.041	-0.593	-0.562	0.091
	(0.535)	(0.544)	(0.200)	(0.508)	(0.535)	(0.201)	(0.538)	(0.565)	(0.192)
ΔREIT	-0.068	-0.111	-0.373	-0.227	-0.365	-0.392	0.587	0.735*	0.426
	(0.260)	(0.354)	(0.353)	(0.258)	(0.419)	(0.355)	(0.402)	(0.441)	(0.399)
ΔPopulation	1.978	1.998	0.428	2.269*	2.313*	0.480	2.136	2.239	0.285
	(1.422)	(1.450)	(1.086)	(1.282)	(1.323)	(1.080)	(1.469)	(1.519)	(1.057)
ΔClaims	0.091	0.121	0.055	0.047	0.084	0.050	0.081	0.104	0.052
	(0.077)	(0.085)	(0.084)	(0.072)	(0.083)	(0.084)	(0.077)	(0.084)	(0.081)
Correlation to MSCI	0.130	0.173*	0.075	0.148	0.197**	0.079	0.127	0.156	0.099
	(0.101)	(0.100)	(0.081)	(0.097)	(0.098)	(0.081)	(0.099)	(0.104)	(0.079)
ΔExchange Rate	0.658	0.840	-0.089	0.745	1.054	-0.083	-0.093	-0.147	-0.742
	(0.752)	(0.874)	(0.952)	(0.746)	(0.890)	(0.949)	(0.801)	(0.830)	(0.899)
U.S. CMBS Spread	0.092***	0.102***	0.011	0.076***	0.095***	0.008	0.088***	0.104***	0.003
	(0.021)	(0.029)	(0.018)	(0.020)	(0.032)	(0.019)	(0.020)	(0.034)	(0.019)
TED Spread				-4.204***	-4.404***	-0.575			
				(0.907)	(1.220)	(0.969)			
$\Delta\overline{GDP}$							0.610*	0.864	0.772**
							(0.337)	(0.599)	(0.310)
Observations	320	320	272	320	320	272	320	320	272
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pesaran CD	5.31***	5.39***	2.43**	2.13***	3.41***	2.13**	3.25***	4.08***	0.99
Adj.-R^2	0.418	0.416	0.419	0.457	0.449	0.418	0.425	0.419	0.435

Table A.9: Robustness: Common Systemic Risk among Non-Financial Center Office Markets

This table replicates the results of Table 3 with cities as non-financial centers with the lower tercile of the highest average SRISK level from 2000 to 2015. *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 for *normal* times. To measure dependence during normal times, we restrict the weighting matrix to zero for 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 (ΔCPI) proxy expected inflation. Construction (Δ*Floor Space*) is defined as the log-difference in floor space. $\Delta REIT$ reflects the return in the national REIT index. Δ*Population* measures the population growth in the financial center. Δ*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. Δ*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 erros 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	0.212	-0.138	0.153	0.260	-0.158	0.151	0.198	-0.145	0.149
	(0.157)	(0.212)	(0.188)	(0.164)	(0.208)	(0.189)	(0.155)	(0.211)	(0.181)
Stock Returns	0.194***	0.207***	0.180***	0.137***	0.152***	0.181***	0.189***	0.199***	0.176***
	(0.033)	(0.033)	(0.040)	(0.041)	(0.040)	(0.059)	(0.033)	(0.032)	(0.047)
log(SRISK)	-0.003	-0.002	0.0004	-0.003	-0.002	-0.0001	-0.002	-0.001	-0.0004
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)
ΔGDP Capita	1.105***	1.123***	0.169	1.025***	1.045***	0.161	1.023***	1.012***	0.157
	(0.174)	(0.175)	(0.290)	(0.181)	(0.183)	(0.268)	(0.187)	(0.192)	(0.221)
Term Spread	-1.045*	-1.063*	0.199	-0.510	-0.538	0.200	-1.057*	-1.064*	0.199
	(0.627)	(0.612)	(0.886)	(0.679)	(0.670)	(1.006)	(0.635)	(0.614)	(0.785)
ΔCPI	0.250	0.179	0.160	0.615	0.535	0.147	-0.326	-0.608	0.144
	(0.713)	(0.720)	(0.953)	(0.705)	(0.719)	(0.976)	(0.700)	(0.704)	(1.684)
ΔFloor Space	-1.931***	-1.987***	0.201	-1.793***	-1.852***	0.201	-1.817***	-1.837***	0.199
	(0.496)	(0.506)	(0.360)	(0.466)	(0.476)	(0.338)	(0.490)	(0.497)	(0.306)
ΔREIT	-0.018	-0.081	0.147	-0.057	-0.130	0.128	0.414	0.515	0.140
	(0.198)	(0.204)	(0.254)	(0.191)	(0.199)	(0.260)	(0.363)	(0.385)	(1.403)
ΔPopulation	0.607	0.536	0.198	-0.005	-0.088	0.197	0.670	0.670	0.198
	(0.953)	(0.960)	(1.272)	(0.945)	(0.951)	(1.133)	(0.949)	(0.954)	(1.378)
ΔClaims	0.192***	0.206***	0.184	0.166***	0.182***	0.185	0.176***	0.183***	0.168*
	(0.053)	(0.055)	(0.124)	(0.052)	(0.055)	(0.119)	(0.053)	(0.055)	(0.097)
Correlation to MSCI	-0.075	-0.090	-0.020	-0.091	-0.108	-0.050	-0.052	-0.600	-0.039
	(0.078)	(0.086)	(0.145)	(0.079)	(0.087)	(0.124)	(0.082)	(0.086)	(0.090)
ΔExchange Rate	-2.460	-0.416	0.166	-0.742	-0.564	0.154	-0.746	-0.661	0.153
	(1.464)	(0.873)	(1.223)	(0.846)	(0.843)	(1.544)	(0.906)	(0.909)	(1.599)
U.S. CMBS Spread	0.049***	0.057***	0.018	0.039***	0.048***	0.017	0.047***	0.055***	0.016
	(0.015)	(0.017)	(0.014)	(0.015)	(0.016)	(0.015)	(0.015)	(0.017)	(0.015)
TED Spread				-2.345***	-2.350***	0.194			
				(0.657)	(0.671)	(1.133)			
$\Delta\overline{GDP}$							0.410	0.565	0.176
							(0.271)	(0.309)	(1.206)
Observations	320	320	256	320	320	256	320	320	256
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pesaran CD	7.63***	9.41***	11.81***	4.91***	6.806***	12.06***	4.919***	7.42***	11.14***
Adj.-R^2	0.543	0.532	0.372	0.562	0.550	0.354	0.531	0.536	0.400