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Investigating the Determinants of Banking Coexceedances in Europe in the Summer of 2008.

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Abstract
We examine the nature, extent and possible causes of bank contagion in a high frequency setting. Looking at six major European banks in the summer and autumn of 2008, we model the lower coexceedances of these banks returns. We find that market microstructure, volatility (measured by range based measures) and limited general market conditions are key determinants of these coexceedances. We find some evidence that herding occurred.

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Introduction

The crisis that originated in the subprime mortgage market in the US was strongly felt in all international financial sectors across the globe. While it started in the credit market in summer 2007, its destructive force was not fully sensed until the beginning of the first quarter of 2008. The short respite that emerged in the subsequent quarter was to be followed by strong downward corrections in the summer of the same year. The interchangeable losing and restoring of investors' confidence around the globe was conditioned by the global financial crisis that has already claimed allegedly not-too-big–to-fail Bear Stearns and Lehman Brothers in the US.[1]

In an attempt to avoid similar problems in the European financial system at the beginning of 2008 many banks issued additional share rights to shore up reserves requested for justifying subsequent right-offs or re-intermediation of Residential Mortgaged-Backed Securities (RMBS) and ABS Collateralised Debt Obligation (CDO) originating in the US. Secondly, financial intermediaries became increasingly wary of extending new loans which led to an increase in interest rates and a consequent spill-over of the crisis into the real sector of economies. By end of September 2008, EURIBOR rates had on average increased 17 basis points with respect to the previous month, while the spread between the three-month EURIBOR and overnight lending rates (EONIA), the latter is a good forecast of future European Central Banks' interest rates, doubled from 64 basis points to 125 basis points over the same period. Thirdly, the number of mergers and acquisitions in the banking sector declined in the first half of 2008. In 2007, EU banks recorded not only the highest annual value of M&A deals in a decade, but also the largest spree of acquisitions outside of the USA. By contrast, in 2008 after the exclusion of the acquisition of ABN Amro by a consortium of Halifax Royal Bank of Scotland, Fortis and Santander there was no extensive M&A activity (European Central Bank[b], 2008).

In the environment of distrust and extreme caution the member countries of the European Union in general and the eurozone, in particular, individually decided to shore up ailing banks. The government of Ireland increased the deposit guarantee from €20,000 to €100,000 and subsequently extended an unlimited guarantee to all deposits leading domestic financial institutions. This move was heavily criticised by Eurozone member countries as unfair competition that could have led to an exodus of depositors from countries with less generous protection schemes.[2] To counteract this a chain of similar guarantees was put in place by othe

[1] In June 2007 two hedge funds of Bear Sterns were heavily exposed to the subprime market and ensuing difficulties lead to an increase in credit default swap premia (Cassola *et al.,* 2008)

[2] The Commonwealth of Australia introduced the same plan, but the government's decision has been heavily criticised by opposition leaders and managers whose banks were not included in the scheme. In October 2008, Greece, Denmark, Sweden and Austria decided to support all bank deposits, as well (See Appendix I)

remaining Eurozone members. The Federal Deposit Insurance Corporation (FDIC) increased guarantee from US$100,000 to US$250,000 per depositor until 31 December, 2009, while EU member countries focused on a €100,000 scheme and a rapid process of case resolutions (up to three days). Both decisions were criticised by the European Banking Federation as rather demanding due to the varying financial (fiscal) strength of member states and administrative constraints that could not shorten the current 3-month to a mere 3-day resolution period. Cultural differences among EU countries and incoherent approach to the global crisis reflect difficulties that EU faces in challenging times as these. In addition, in nine out of fifteen euro area countries the level of general government debt is either close to or in excess of the 60% mark of respective GDPs, which limits the amount of extra debt that could be borrowed by national governments.[3] Monetary flexibility is rather limited not only by the strict ECB's policy aimed at stemming inflationary pressures, but also by the non-existence of national monetary policies. The relaxing of fiscal austerity seems to be the only remaining panacea, which will not only reduce the amount of disposable income for taxpayers and further increase government debt levels, but also question the zeal of EU Commission in enforcing its own guidelines that represent the foundation of the euro zone.

In this paper we examine leading banks in the euro area measured by the level of market capitalization in 2008. The largest financial intermediaries have extensive analyst following and in smaller markets they may be the leading companies without comparable substitutes. Therefore, trading patters may reflect the general trading sentiment. In addition, Bonson, Escobar *et al.* (2008) find that the size of European banking institutions and investment firms is positively related to the application of better risk management practices, and assuming that better practices are related to more effective risk management we can reduce the analysis to intraday trading patterns that reflect more a level of sentiment rather than fundementals. Accordingly, the size bias does not seem to enhance the problem of poor risk management.

Contagion and Coexceedances

Over the decade from the Asian crisis of 1997 to the beginning of 2007 a very significant body of research on the interlinked concepts of contagion (excess co movement of assets beyond that which would be expected from fundamentals) and asset interrelationships, spillovers and interdependencies has emerged. These have enhanced both our understanding of the dynamics of contagion and the tools that are available to investigate. As an exemplar, Forbes and Rigobon (2002) *et seq* showed the need for research to move beyond simplistic

[3] Among other 12 non-euroarea countries only Hungary violates the 60% benchmark. However, with the exception of Sweden, Denmark and the UK all other countries sport much lower levels of GDP per capita than the EU average, which questions their ability to support sizeable financial commitments. (European Central Bank[c], 2008)

models based on unconditional correlation matrices. Contagion has thus become seen as a distinct phenomenon from integration and from increased or decreased integration. There has also been an increase in the literature discussing the various approaches taken for defining contagion (See Corsetti, Pericoli et al. (2005) who identify at least five different measures and the first part of Gravelle, Kichian *et al.* (2006)

In this paper we take the notion of contagion as arising from extrema of distributions. The original paper of Bae, Karoli *et al.* (2003) casts contagion as contemporaneous instances of asset prices lying in a particular, negative, portion of the realised distribution. This has the intuitive appeal that it respects the notion that individual assets have greater or lesser inherent volatility. For some assets a fall of 5% may be exceptional while for others a fall of 2% may represent the same degree of "exceptionalness". Their work used multivariate probit analyses to uncover the common factors that drive asset classes returns to lie in the same percentile of their realised distributions.

Contagion studies proper also focus on the behaviour of asset returns during times of crisis. Many of the methodological issues discussed in papers such as Corsetti, Pericoli *et al.* (2005) and Gravelle, Kichian *et al.* (2006) relate to the identification of crises periods, the windows over which analyses should be concluded and the issues in dealing with shifts in regimes as systems move from calm to crisis and back. The advantage of using a coexceedance model such as we deploy here is that it almost by definition is usable only in periods of crisis when assets are falling across the range studied. Defining "shift contagion" in the commonly agreed manner, as a change or break during a crisis period in the transmission mechanisms of how assets are related, coexceedances are a natural measure of this phenomenon. We define contagion here as the existence of a common (unspecified) shock that propagates across the assets in question, which predisposes them to move into a similar position in their distribution, and which shock emerges from a source external to the assets in question. A shock occurs which causes the banks in this analysis to exhibit returns which are extreme in each case.

This definition is essentially that used in the relatively few papers that have used this modelling approach. Groop, LoDuca *et al.* (2006) use a distance to default measure (derived from the BSOPM) to analyse contagion, on a daily frequency, among EU banks over a 9 year period. They concentrate on the 95th percentile coexceedance and find evidence of periods of contagion. This work is similar to that of Hartmann, Straetmans *et al.* (2004) who use extreme value theory to surface US-European contagious episodes. More recently, Baur and Schulze (2005) and Christiansen and Ranaldo (2009) apply a coexceedance model to equity markets, also using a daily approach.

We believe that this present paper advances the literature in several ways. First, we focus on high frequency analyses, using 30-minute data over a 6m period of generally accepted crisis. Second, we focus on a set of assets that are very homogenous, Eurozone large banks. Third, we uncover dynamics not just from the general market but also from other asset markets including the gold market which has been shown in previous work (Baur and Schulze (2005)) to be a safe haven asset in times of market stress. Finally, we employ a non-parametric model of volatility, the Garman-Klass estimator, which belongs to a class of estimators with desirable properties under high frequency data stylised facts.

Methodology

Following the methodology applied by Bae, Karoli *et al.* (2003) we take a look at the 5% percentiles to define extreme negative returns and calculate coexceedances. However, we do not take into account 95% percentiles for positive returns because we are interesting in highlighting the negative impact of the recent crisis on banks' performance. We create the variable that takes into account the number of cases when 30-minute close price changes for a single bank were located in the lowest 5% percentile vis-à-vis the entire period, i.e. 1539 5-minute observations. Thereafter, the variable that sums up all 5% percentile incidences across a single point in time and ranges from 0 to 6 was created to determine the level of coexceedances. If a single bank faces extremely negative price movements in a single period no coexceedance has been registered. However, extreme events for two or more banks in a single period are regarded as a coexceedance. The moderate coexceedance comprises two or three simultaneous banks' price movements, while extreme changes include four or more.

In order to determine the relationship between the number of coexceedances and selected dependent variables we will apply the Multinomial Logit Model (Greene (2000)).[4] As suggested by Groop, LoDuca *et al.* (2006) it is advisable to use either order logit or multinomial (unordered) logit model. The latter model is more appropriate, because it does not assume that the move from 0 or no-coexeedances to 1 or two to three banks with coexeedances is the same as moving from 1 to 2, ie. four or more banks involved in coexeedances.

The proposed model is as follows:

[4] In probit models it is assumed that error terms have joint multivariate normal distribution with 0 mean and arbitrary variance-covariance matrix, which in the case of market microstructure data sets becomes rather difficult to assume. Horowitz (1980) concludes that logit models provide consistent parameter estimates as long as the utility functions are linear.

$$P[Y = j] = \frac{e^{[\beta_j M]}}{\sum_{m=0}^{2} e^{[\beta_m M]}} \qquad (1)$$

where j = 0, 1 and 2, i.e. the indicator whether the case of a) no coexeedance, b) two or three banks or c) more than three banks have coexeedances, respectively exist; M are common shocks, variability measures and commonly accepted market microstructure variables to which companies in the eurozone are exposed, while β_j is a vector of coefficients for variable j. The base category is Y = 0, which helps alleviate the level of indeterminacy in this model.[5] The multinomial logit is calculated in RATS with a significance level of 5 percent.

Data

We collect from Reuters High-Low-Open-Close price data for 6 large European banks in the Eurozone: Banco Santander, BNP Paribas, Societe General, Banco Bilbao, Deutsche Bank and Credit Agricole. For this paper all measures are, except where noted, constructed using close returns. These data are sampled at 30-minute frequencies, from 6 June 2008 to 15 October 2008. The choice of 30-minute frequency , as opposed to the more usual 5m frequency, is dictated by three concerns. First, the range based indicator we use (of which more later) is one that in essence peers "within" the sample frequency to estimate volatility. There is therefore an inherent need for there to be sufficient time elapsed between the endpoints of the sample period for activity to take place. Second recent research on volatility, including range based estimators (see Bandi and Russell (2006), Bandi, Russell et al. (2008) , Schulmeister (2009), De Pooter, Martens et al. (2008), Shu and Zhang (2006)) suggest that a frequency lower than 5m provides more statistically efficient measures. Finally, although we do not decompose the measured volatility into further components, this suggestion to use a frequency greater than 5m is reinforced by Bandi and Russell 2006 in relation to the interval which generates most efficient estimates of high frequency volatility.

A further selection issue arises with regard to the timespan over which we estimate the models. We choose a tight interval, of three months "calm" and two months "crisis" period, for a number of reasons. First, the models are of high frequency banking and other financial data. A significantly longer timeperiod would inevitably lead to a focus on the macrofinanical and macroeconomic effects which the crisis precipitated. While clearly

[5] All coefficients are calculated with respect to 0 as a new base. The normalization process involves the assumption that $\beta_0 = 0$, in which case the equation becomes: $P[Y = j] = \frac{e^{[\beta_j M]}}{1 + \sum_{m=1}^{2} e^{[\beta_m M]}}$ (Greene, 2000).

important, these events were in great part a consequence of the crisis in banking. Thus focusing on the timeframe we do focuses the findings on the crucial point of inflection in the markets. Second, the overall timeframe, although short, provides a very large number of observations. This we believe allows us confidence in the stability and convergence of the models and thus some additional confidence in the findings. Finally, we conceptualise the approach here as akin to an event study. A general observation (see Binder (1998)) is that shorter windows are to be preferred to longer when one is interested in reactions to shocks and "one off" events. Although not perfectly analogous this suggests to us that it is useful in this case to keep shorter than longer timespans under investigation.

In total we have 1540 observations. These banks, at end October 2008, represent 42% of the FTSE Eurotop Banking Index by market capitalization. The choice of banks was dictated by they being in the top ten by market capitalization of the FTSE Eurotop Banking Index, and being denominated in euro. We were unable to obtain accurate information for three banks that met this criterion – Unicredito and SanPaolo and National Bank of Greece. It should be noted that these are smaller than the average, thus to some extent the results here should be taken as representative more of larger banks than average banks. We also collect total volume of shares traded (measured in euro millions) within each thirty minute period. As a control on general stock market as opposed to bank shocks we collect the same information on the DJ EuroSTOXX50 index[6]. This also allows us to capture asset class issues.

To capture possible flight to safety we include data on gold, measured as the London AM Fix. Baur and Lucey (forthcoming) find that in periods of market stress gold becomes n attractive "safe haven" for investors. We also include overnight LIBOR, the London Interbank Offered Rate, as a measure of credit conditions. Both Gold and LIBOR are measured as percentage changes. LIBOR and Gold represent a data problem in that both are fixed at 1100hGMT. We overceme this with an alignment of data ; for each day, when the bank data refer to times pre 1100h we use t-1 LIBOR and Gold data, and from times after 1100h GMT we use that days measures.

To capture volatility effects on coexceedances we use two measures of volatility. We first use a standard conditional volatility measure. Conditional variances were estimated using a ARMA(1,1)-GARCH(1,1) specification with a skewed-t distribution for the errors. We estimate this for the STOXX index and also for each bank. These individual banking measures are then averaged to obtain a composite banking average conditional volatility. We also measure the volatility using the Garman-Klass (Garman and Klass (1980) – hereafter GKe) range based volatility estimator. The novelty of the GKe approach lies in the use of use

6 Note that this index does include in its composition the banks we study here. However, absent an index of non-financial companies in the Eurozone that is also available at 30-minute intervals we are forced to use this as the most general proxy available. The banks we analyse constitute approx 10% of the market value of the STOXX index.

of the open, close, high and low price *within* a particular time interval in its calculation. The GKe therefore provides an alternative, volatility measure to the standard deviation and GARCH approach, which utilises the price change *between* consecutive time intervals The within period focus allows us to peer more deeply into the high frequency dynamics than do other methods. The GKe and other range based volatility measures have been investigated by Shu and Zhang (2006) and Alizadeh, Brandt *et al.* (2002), who conclude that they represent a low-bias and efficient measure of the theoretical volatility and are superior in these respects to the GARCH estimators.

From Garman and Klass (1980), the GKe is:

$$\text{GKe} = \sigma^2 = 0.511\,(H-L)^2 - 0.019\,(C-O)\,(H+L-2C)\,(l-C) - 0.383\,(C-O)^2 \quad (2)$$

where H = log of interval high

L = log of interval low

O = log of interval open

C = log of interval close

Coexceedances are coded 1 where two or three banks exhibit coexceedances, 2 where four or more of the six banks exhibit coexceedances. Two banks exhibit coexceedances when both have returns in that period which are in the lower 5th percentile of their realised distribution.

Finally, we also create indicator variables for a number of microstructure issues. We create dummy variables to indicate if the time is in the early part of the trading day, defined as before 0900h; to indicate if the time overlaps with the opening of the US market; and to control for possible calendar day effects, to indicate that the day is neither a Monday nor a Friday.

Results

In Tables 1 and 2 we have enclosed the descriptive statistics for six selected banks: Banco Santander (Spain), BNP Paribas (France), Banco Bilbao Vizcaya (Spain), Société Générale (France), Deutsche Bank (Germany) and Crédit Agricole (France) in addition to the STOXX 50 Index values. The exclusion of other Eurozone banks such as Unicredito (Italy), SanPaolo (Italy) and National Bank of Greece (Greece) due to the incomplete datasets, does not significantly change the fact that the sample predominantly comprises representatives from the French legal tradition, which in accordance with the La Porta *et al.* (1998) methodology includes Spanish business entities. Even though we cannot examine the difference between companies with German and French legal traditions, respectively, the size of sampled banks and their impact on the capitalization of STOXX 50 index still provides justification for examining contagion effects. The stock prices of all banks, with the exception of Banco Bilbao Vizcaya, are negatively skewed which indicates that means are generally smaller than median values. Kurtosis values clearly indicate that French banks' prices have platykurtic distributions, while all other representatives including the index feature leptokurtic values. Unsurprisingly, the Jarque-Bera tests demonstrate strong divergence from normality for all sampled elements. Even though the STOXX 50 Index demonstrates the lowest level of volatility the banks' prices in our sample are not significantly more volatile with the exception of those of Crédit Agricole. This bank demonstrates the largest relative standard deviation which is accompanied by a significant difference between maximum and minimum values during the sample period.

In Figure 1 are the numbers of banks exhibiting coexceedances over the period. Despite the prominence given to banking stocks in market reports in the September-October period, it is clear that instances where 5 or 6 banks showed declines in the lower 5% of their distributions were also evident in the early summer. However, it is also evident that this severe coexceedance pattern was more frequent in the later part of the summer. Of the 33 instances where 5 or 6 banks exhibit coexceedance we find that slightly more than one third (12) appear before the start of September 2008

Shown in Table 3 are the results of the multinomial logit analyses. A number of points are evident. The coefficient estimate for the constant is mainly insignificant. There is consistent evidence that coexceedances are more likely to occur when the market is in its opening phase. This effect is stronger for the higher coexceedance model. This finding confirms the importance of the opening sessions (see for example Chelley-Steeley (2005)) Contrary to the findings of Groop, LoDuca et al. (2006) and Christiansen and Ranaldo (2009) we find no evidence of significant autoregressive behaviour in the occurrence of sampled banks' coexceedancess. Furthermore, there is no evidence on the impact of overlap with the US market, apart from a weak support for this claim when many coexceedances occur and conditional volatilities are included as independent variables. This limited evidence on the impact of the US market on coexceedances in the European context is in conflict with that found in Christiansen and Ranaldo (2009) for developed markets but is consistent with their findings for accession countries. We also find very little evidence in the data of either a flight to quality or to a safe haven, with gold changes having a marginally positive and negative (for larger coexeedances), but not significant effect on the coexceedances. We do not find evidence of the impact of credit conditions.

Of much more importance in determining the coexceedances is the change in volume traded in STOXX Index, indicating a degree of contagion or spillover from the general market to the financial market: we see a positive relationship here, where increases in the general market are associated with a higher likelihood of a coexceedance in the banking sector. This would accord well with the idea that coexceedances are associated not just with declining prices but with an actual flight from equities; not just are stocks marked down but there is an increased sale of said stocks. For the volume of bank shares traded there is a negative sign in both models, but the coefficient estimates are not statistically significant.

Volatility emerges as the other major determinant of coexceedances. Conditional volatility measures are insignificant. This may reflect an inadequacy of the GARCH model, an inappropriate aggregation of the GARCH volatilities to an overall, or an actual result. If it is an actual result however it demonstrates that the range based approaches, which peer "inside" the period when price is being determined, provide a more refined insight into the impact of volatility on coexceedances. Our results are similar to the findings on volatility as per Bae, Karoli et al. (2003), Groop, LoDuca et al. (2006) and Christiansen and Ranaldo (2009). However, the findings in these papers are for conditional volatility, which we find here to be mainly insignificant. The findings here are more significant for range based estimates. We attribute this difference to the fact that our analyses are conducted on high frequency data, as opposed to the daily and lower frequencies of the other papers which have used this approach.

Our results show reasonable explanatory power. The pseudo-R^2 values are 8.79-11.8% which is higher from that found by Christiansen and Ranaldo (2009) and in line with the findings of Groop, LoDuca et al. (2006). The statistics found here are somewhat closer to the 10% findings in Bae, Karoli et al. (2003).

Conclusions

The banking and financial crisis of 2008 has left a rich field for the analysis of contagion and interrelationships. Based on the multinomial logit model we further discover that the number of coexeedances is more prevalent during the early trading session due to influx of overnight information. There is a week support for the impact of the US market. The change in traded volume in STOXX index demonstrates a positive impact in extreme coexeedances' model. Finally, the conditional volatility seems to have no influence on coexeedance patterns, while the Garman-Klass measure proves to be more statistically powerful.

Table 1. Descriptive statistics for open (O), high (H), low (L) and close (C) share prices of selected banks (Banco Santander, BNP Paribas and Banco Bilbao Vizcaya)

	O_BancoSan	H_BancoSan	L_BancoSan	C_BancoSan	O_BNP	H_BNP	L_BNP	C_BNP	O_BBVA	H_BBVA	L_BBVA	C_BBVA
Mean	2.442	2.443	2.440	2.442	4.117	4.119	4.115	4.117	2.465	2.467	2.464	2.465
Median	2.449	2.451	2.448	2.449	4.115	4.117	4.113	4.116	2.462	2.464	2.461	2.463
Maximum	2.558	2.558	2.558	2.558	4.271	4.275	4.271	4.275	2.635	2.638	2.635	2.638
Minimum	2.207	2.207	2.195	2.195	3.941	3.945	3.940	3.940	2.235	2.235	2.212	2.212
Std. Dev.	0.059	0.059	0.060	0.060	0.059	0.059	0.059	0.059	0.064	0.064	0.065	0.064
Skewness	-0.928	-0.926	-0.949	-0.949	-0.055	-0.035	-0.072	-0.050	0.121	0.128	0.086	0.092
Kurtosis	3.958	3.953	4.036	4.041	2.593	2.596	2.587	2.597	3.812	3.809	3.881	3.881
Jarque-Bera	279.559	278.300	299.717	300.260	11.403	10.773	12.263	11.037	46.069	46.177	51.685	51.955
Probability	0.000	0.000	0.000	0.000	0.003	0.005	0.002	0.004	0.000	0.000	0.000	0.000
Observations	1539	1539	1539	1539	1539	1539	1539	1539	1539	1539	1539	1539

Table 2. Descriptive statistics for open (O), high (H), low (L) and close (C) share prices of selected banks (Societe Generale, Deutsche Bank, Credit Agricole and STOXX)

	O_SocGen	H_SocGen	L_SocGen	C_SocGen	O_DB	H_DB	L_DB	C_DB	O_CA	H_CA	L_CA	C_CA	O_stoxx	H_stoxx	L_stoxx	C_stoxx
Mean	4.091	4.093	4.089	4.091	4.016	4.018	4.014	4.016	1.285	1.286	1.284	1.285	8.088	8.089	8.087	8.088
Median	4.095	4.097	4.092	4.094	4.047	4.048	4.046	4.047	1.316	1.317	1.316	1.316	8.102	8.103	8.102	8.102
Maximum	4.250	4.251	4.249	4.251	4.191	4.191	4.190	4.190	1.464	1.464	1.464	1.464	8.220	8.220	8.220	8.220
Minimum	3.749	3.749	3.749	3.749	3.421	3.433	3.421	3.426	0.830	0.830	0.830	0.830	7.771	7.777	7.771	7.771
Std. Dev.	0.090	0.089	0.090	0.090	0.129	0.128	0.130	0.130	0.122	0.121	0.122	0.122	0.070	0.070	0.071	0.070
Skewness	-0.331	-0.316	-0.331	-0.317	-2.171	-2.166	-2.171	-2.168	-1.713	-1.717	-1.711	-1.714	-1.825	-1.815	-1.828	-1.819
Kurtosis	2.499	2.455	2.500	2.461	8.326	8.306	8.293	8.278	5.583	5.606	5.565	5.588	7.458	7.413	7.432	7.393
Jarque-Bera	44.26	44.7	44.12	44.46	3027.64	3008.60	3005.85	2991.45	1164.63	1175.39	1156.73	1167.32	2129.22	2094.19	2117.25	2086.37
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	1539	1539	1539	1539	1539	1539	1539	1539	1518	1518	1518	1518	1539	1539	1539	1539

Table 3. Multinomial logit analysis

	Two or Three coexceedances				Four or More coexceedances			
Variable	**Coeff**	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**	**Coeff**	**p-value**
CONSTANT	-3.69047	0.210644	-8.90183	0.010153	-4.76483	0.44141	-9.48827	0.089834
COEXCODE1	0.362259	0.220582	0.40928	0.134974	-0.45931	0.410048	-0.42702	0.360888
MIDWEEK	-0.5	0.134016	-0.29506	0.301538	-0.21373	0.6193	0.00312	0.993046
EARLY	1.1895***	0.000608	1.33732***	0.000597	2.419586***	8.5E-07	2.67465***	2E-08
NYSEISOPEN	-0.31396	0.329721	0.23667	0.471781	0.217848	0.743393	0.98199*	0.05123
XSTOXRt-1	0.03476	0.961301	0.45588	0.549985	-1.82811	0.121867	0.56327	0.428221
GOLDFIX	0.000652	0.817111	0.00178	0.489957	-0.0005	0.888502	-0.00043	0.895777
LIBORFIX	-0.15528	0.692918	0.74115	0.198657	-0.00697	0.994878	1.04762	0.267576
CSTOXXRt-1	24.30151	0.276744	8.68202	0.797574	-43.9649	0.216324	-47.4678*	0.090054
VOLSTOXXCHG	0.638713	0.104458	0.73672*	0.052951	1.129103***	0.000677	1.16915***	0.000269
MEANVOLCHG	0.009683	0.964459	-0.04643	0.84077	-0.04371	0.876894	-0.0328	0.885653
GKSTOXXK	-4037.88***	0.000898			-4143.11***	0.003109		
GKSTOXXKt-1	-1681.79**	0.02052			-4766.76***	0.008936		
MEANGKVOLK	79.95933	0.144089			127.3819***	0		
MEANGKVOLKt-1	27.05954*	0.075595			-8.15027	0.795797		
CONDVSTOXX			63.3502	0.991445			-1360.89	0.759921
CONDVSTOXXt-1			-727.599	0.849316			-120.198	0.974155
AVGCONDVOL			-1060.76	0.947986			2738.318	0.890173
AVGCONDVOLt-1			5970.831	0.706348			2634.303	0.892815
Pseudo-R^2	11.8%		8.79%		11.8%		8.79%	

*** p-value < 1%
** p-value < 5%
* p-value < 10%

dependent variable is the number of coexeedances, i.e. 0 for no coexceedance, 1 for two or three banks coexceeding and 2 for four or more banks involved in coexeedances. COEXCODE1 is lagged value of coexeedances; MIDWEEK equals 1 if the days in the week are Tuesday, Wednesday and Thursday; EARLY is a dummy variable denoting that intervals are calculated prior to 9.00am; NYSEISOPEN equals 1 for the trading period when NYSE is open, otherwise it is 0: GOLDFIX is the change in the value of gold based on London AM Fix; LIBORFIX is the change in the value of daily LIBOR rate; XSTOXR1is the number of coexeedances in the STOXX index; CSTOXXR1 is the lagged close return in the STOXX index**;** VOLSTOXXCHG is the change in volume traded in STOXX index; MEANVOLCHG is the average change in the volume of bank shares traded; GKSTOXXK is the value of Garman-Klass range volatility estimator for STOXX; CONDVSTOXX is ARMA(1,1)-GARCH(1,1) conditional volatility measure for STOXX index; MEANGKVOLK is the average value of Garman-Klass range volatility estimator for banks; AVGCONDVOL is average ARMA(1,1)-GARCH(1,1) conditional volatility measure for bank returns;

REFERENCES

Alizadeh, S., M. W. Brandt and F. X. Diebold (2002). "Range-based estimation of stochastic volatility models." Journal of Finance **57**(3): 1047-1091.

Bae, K., A. Karoli and R. Stulz (2003). "A new approach to measuring financial contagion." Review of Financial Studies **16**(3): 717-763.

Bandi, F. M. and J. R. Russell (2006). "Separating microstructure noise from volatility." Journal of Financial Economics **79**(3): 655-692.

Bandi, F. M., J. R. Russell and Y. Zhu (2008). "Using high-frequency data in dynamic portfolio choice." Econometric Reviews **27**(1-3): 163-198.

Baur, D. and B. M. Lucey (forthcoming) "Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold." Financial Review **Volume**, DOI:

Baur, D. and N. Schulze (2005). "Coexceedances in financial markets - a quantile regression analysis of contagion." Emerging Markets Review **6**(1): 21-43.

Binder, J. J. (1998). "The event study methodology since 1969." Review of Quantitative Finance and Accounting **11**(2): 111-137.

Bonson, E., T. Escobar and F. Flores (2008). "Operational risk measurement in banking institutions and investment firms: New European evidences." Financial Markets, Institutions and Instruments **17**(4): 287-307.

Chelley-Steeley, P. (2005). "Explaining volatility and serial correlation in opening and closing returns: A study of the FT-30 components." Global Finance Journal **16**(1): 1-15.

Christiansen, C. and A. Ranaldo (2009). "Extreme coexceedances in new EU member states' stock markets." Journal of Banking and Finance **33**(6): 1048-1057.

Corsetti, G., M. Pericoli and M. Sbracia (2005). "Some contagion, some interdependence': More pitfalls in tests of financial contagion." Journal of International Money and Finance **24**(8): 1177-1199.

De Pooter, M., M. Martens and D. Van Dijk (2008). "Predicting the daily covariance matrix for S and P 100 stocks using intraday data - But which frequency to use?" Econometric Reviews **27**(1-3): 199-229.

Forbes, K. J. and R. Rigobon (2002). "No contagion, only interdependence: Measuring stock market comovements." Journal of Finance **57**(5): 2223-2261.

Garman, M. B. and M. J. Klass (1980). "On the estimation of security price volatilities from historical data." Journal of Business **53**(1): 67-78.

Gravelle, T., M. Kichian and J. Morley (2006). "Detecting shift-contagion in currency and bond markets." Journal of International Economics **68**(2): 409-423.

Greene, W. (2000). Econometric Theory, Upper Saddle River, NJ: Prentice Hall.

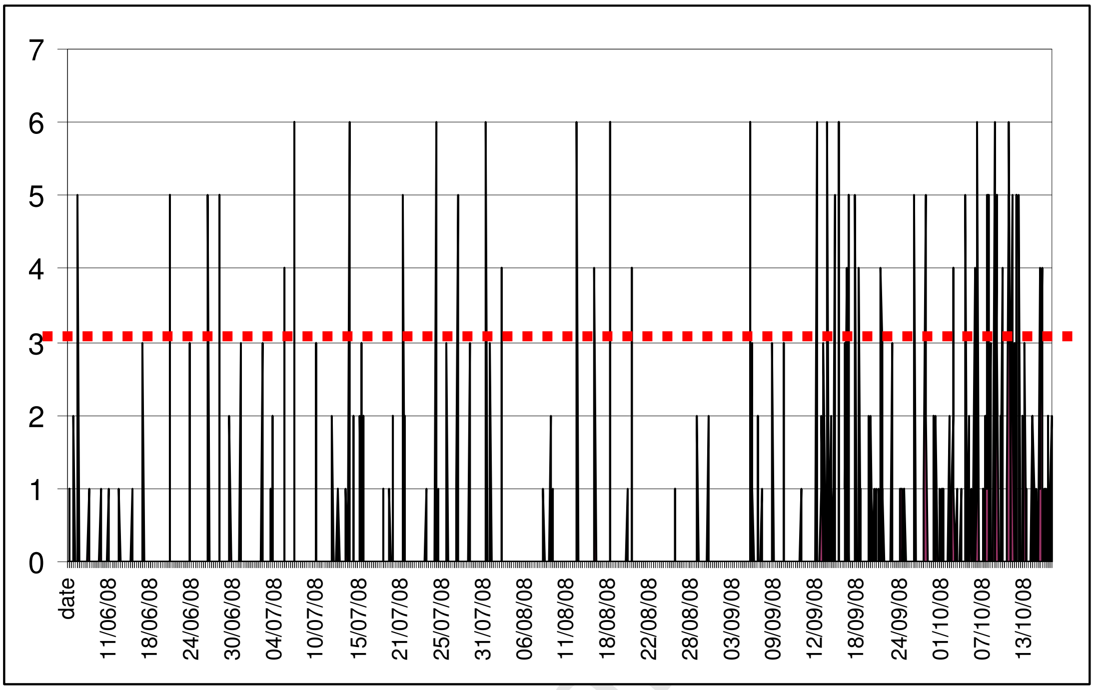
Groop, R., M. LoDuca and J. Cesala. (2006). "Cross Border Bank Contagion in Europe." from ssrn.co/abstract=916997.

Hartmann, P., S. Straetmans and C. G. De Vries (2004). "Asset market linkages in crisis periods." Review of Economics and Statistics **86**(1): 313-326.

Schulmeister, S. (2009). "Profitability of technical stock trading: Has it moved from daily to intraday data?" Review of Financial Economics **18**(4): 190-201.

Shu, J. and J. E. Zhang (2006). "Testing range estimators of historical volatility." Journal of Futures Markets **26**(3): 297-313.

Figure 1 : Number of banks exhibiting lower 5% coexceedances



Appendix I

Timeline of Financial Crisis in Europe

- 13 September 2007 – UK bank Northern Rock applies for emergency funding support by the Bank of England
- 14 September 2007 – Bank run on Northern Rock
- 17 September 2008 – LIBOR reaches a seven-year high
- 18 September 2008 – Central banks provide $180 billion in support of global liquidity
- 19 September 2008 – Thanks to the short-selling ban and US rescue plan announcement FTSE regains 315 point to end the trading day at 5,195.
- 21 September 2008 – The Financial Services Authority involved in talks regarding the potential bail-out of Bradford and Bingley, the banking and financial planning group.
- 25 September 2008 – Ireland is the first country in the eurozone to face recession.
- 28 September 2008 – the governments of the Netherlands, Belgium and Luxembourg buy €11.2 billion of bad assets and assume 49 percent of ownership in Fortis, one of the largest bank and insurance conglomerates in Europe. Spain's Banco de Santander buys 200 branches of Bradford and Bingley and £22 billion savings.
- 29 September 2008 – the federal government in Germany along with selected banks provides a rescue package amounting to €35 billion to support Hypo Real Estate. The British government acquired Bradford and Bingley for €63 billion. The government of Iceland takes up 75 percent stake in the largest local bank, Glitnir, for €0.6 billion.
- 30 September – the Irish government is the first to guarantee all bank deposits over the upcoming two years. Dexia, the municipal lender, seeks for bail-out.
- 1 October 2008 – Fortis abandons its seasoned equity offering plan to raise €3 billion due to the lack of market interest
- 2 October 2008 – Greece secures all deposits in Greek banks
- 3 October 2008 – the UK government increases the compensation for deposits from £35,000 to £50,000. The government of Netherlands purchases the local branch of Fortis for €16.8 billion
- 5 October 2008 – The rescue package for Hypo Real Estate increased from €35 to €50 billion. BNP Paribas acquires Fortis' branches in Belgium and Luxembourg for €14.5 billion.
- 6 October 2008 – the authorities in Denmark, Sweden and Austria secure all bank deposits. In Iceland there is trade suspension at the stock exchange.
- 8 October 2008 – The Icelandic internet bank, Icesave, is in default. UK government declares that they might sue Iceland for losses incurred by British depositors.

- 13 October 2008 – The UK government promises to pay £37 billion to recapitalize the Royal Bank of Scotland, HBOS and Lloyds TSB.
- 14 October 2008 – The Icelandic stock exchange continues trading after a week period. The index declines by 76% after the opening session.
- 16 October 2008 – The Swiss government provides support for UBS, while Credit Suisse manages to raise money from private investors and sovereign investment funds.
- 27 October 2008 - IMF provided £16.5 billion rescue package for mainly Eastern European countries and Turkey. Hungary seeks a €10 billion rescue package, while Ukraine due to political stalemate cannot make a decision about the rescue package.
- 28 October 2008 – Bank of England estimates that due to the recent market correction financial institutions around the globe have lost approximately $2.8 trillion
- 31 October 2008 – Barclays announces the investment of £7.3 billion by Middle Eastern investors who are expected to become owners of one-third of the bank.