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Interconnectedness in Credit Market: An Empirical Investigation Using UK and US CDS Data

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Abstract: The idea that the US and UK credit markets are interrelated is tested in this research using a structural time series technique. The empirical studies span the recent era of financial instability and make use of premium data for credit default swaps (CDS) in the banking industry. The Kalman filter-based approach is resilient when there is little convergence. The findings show a strong long-term steady state convergence in CDS premiums between these two markets. This observation offers recommendations for the efficient functioning of the global financial systems and supports the coordinated regulatory policy actions to address the crisis.

Key words: Banking Sector, CDS, Convergence, Kalman filter

Introduction

Over the last several years, the globe has seen unprecedented levels of financial instability. It was preceded by a protracted era of low interest rates, soaring asset values, and plenty of liquidity. This resulted in a worldwide "search-for-yield," a general underpricing of risk by investors, and the accumulation of global macroeconomic imbalances in the context of international financial integration and innovation. In some instances, regulators assisted, but in others, they did little to address the accumulation of imbalances. Many established and developing nations saw a sharp increase in lending due to the plenty of liquidity. One of the sectors with the fastest growth, both domestically and internationally, was mortgage financing, which fueled a worldwide real estate bubble.

At the same time, financial innovation raised systemic vulnerability in many ways. Both an active secondary market for mortgage-related securities and financial innovation in credit derivatives contributed to the expansion of the mortgage market, particularly in the United States. Furthermore, over-the-counter markets with bilateral clearing and settlement agreements made both regulated and unregulated financial institutions more "interconnected." Financial institutions moved downmarket, lowered credit underwriting standards, engaged in riskier trading activities with maturity mismatches, and over-relied on quantitative risk models due to the favorable macroeconomic environment, increased competition, technological advancements, and rising asset prices.

This paper is motivated to investigate the dynamic behavior of the banking sector indices for the CDS (Credit Default Swaps) spread (expressed in basis points) for two OECD economies, given the role played by financial institutions and the effects of the financial crisis across the advanced economies. It is true that both the US and the UK have sizable banking industries, and their We investigate whether the perceived riskiness of this sector was convergent over time in relation to its relative significance to the individual economies. The market's perception of sector riskiness is measured by the CDS premium.

A CDS index is a standardized, highly liquid credit security with a very narrow bid-ask spread. When processing data on changing risks in the financial industry and the overall economy, CDSs may be effective (see, for example, Norden and Weber, 2004; and Greatrex, 2008). However, CDSs may have contributed to the financial crisis by feeding off unfavorable financial news and encouraging speculation (Stulz, 2010). In times of financial hardship, like the current financial crisis, they could also change the debtor-creditor relationship (Bolton and Oehmke, 2011). They could produce empty creditors—holders of debt and CDS—who have no interest in the debtor's effective continuance and who might force the debtor into ineffective bankruptcy or liquidation. Contrary to what some have claimed, Ashcraft, Joao, and Santos (2009) do not discover evidence that CDS trading reduces the typical borrower's

cost of debt financing. As a result, a lot of politicians and experts want these CDS contracts to be standardized internationally, trade on organized exchanges, and pass through the standard clearinghouses.

A widening of the CDS spread in response to specific credit events indicates an increase in the level of credit risk in the relevant economic sector, whereas a narrowing of the spread would indicate the opposite. This is because the size of the financial credit spreads measures the default risk exposure of the institutions that comprise the financial sectors.

The literature also makes clear that the CDS spreads include a number of elements pertaining to default risk, projected loss, and liquidity premium. On the other hand, bond spreads are dependent on non-default factors (see, for example, Ericsson, Reneby, and Wang, 2006). The sensitivity of the CDS spreads for the banking sector to default risk, banking risk premium, and banking liquidity premium is hence another reason this study is prompted by the recent increases in risks. Therefore, parallelism in the components of these risk premia of the two countries would be shown by the interconnection of the banking sector CDS spreads.

Banks take deposits and focus on lending money. Both of these economies have a similar fundamental basis. The perceived riskiness of this industry would be shown via the buying and selling activity in the CDS market. Certain banks link the costs of their corporate syndicated loans to the CDS spreads of the borrowers. Increasing CDS spreads should encourage risk to migrate to safer contracts and support the trend of economic sectors moving toward greater risk. All of the CDS spreads together assess the state of the economy.

The comovement of risks during the 2009 financial crisis has just recently come into emphasis in the research. Additionally, it's too soon to conclude that the literature has sufficiently examined the effects of recent quantitative easing (QE) on migration and risk elevation, but our analysis has. This study vacuum in the literature on the connections between the same economic sectors tied by several similarities is another reason for the article.

The paper's main goal is to determine if the two nations' overall banking sector riskiness was convergent throughout the time of the global financial crisis. For traders and hedgers who could be involved in both of these markets, the findings should be useful in offering strategy implications. The outcomes need to have policy as well.

consequences for regulatory bodies with a focus on the contagion effect, especially the shocks coming from the financial industry. Such an investigation may also look at CDS data from other sectors. But the reason for the emphasis on the banking industry is that it is the source of the financial crisis.

Some of the biggest and most reputable banks, investment firms, and insurance corporations have either filed for bankruptcy or required financial rescue as a consequence of the crisis. Almost every developed nation declared plans for banking sector rescue and/or economic stimulus. As a last option, a number of nations borrowed money from the International Monetary Fund. The crisis has shown basic flaws in global financial institutions, shown how intertwined and linked economies are now, and created difficult policy conundrums.

Countries all across the world have responded to the crisis by implementing financial system reforms and government action to lower risk and avert repeat disasters. The need for a strong financial infrastructure, including sound accounting and auditing standards, efficient collateral registration and enforcement systems, efficient payment and settlement systems, and well-designed corporate governance structures, has been reinforced by the crisis. In addition, the crisis is causing several aspects of financial sector policies, such as regulation and supervision, to be reexamined (Nanto, 2009). To prevent businesses and transactions from migrating to less regulated markets, the planned regulatory reforms will need to be coordinated across countries. Business and transactions may shift to other markets if rules in certain countries are unusual or noticeably more "burdensome" than those in other developed countries.

In this article, we demonstrate that the implementation of a uniform finance architecture governed by global policy frameworks is necessary for the sustainability and efficacy of the global economy because of the relatively substantial interconnection of the banking sector in the US and the UK. The comment that "On a country-by-country basis, U.K.-owned banks' biggest exposures are to the United States" on page 8 of the IMF study (Chan-Lau, Mitra, and Ong, 2007) is the source of the attention on these two markets. Additionally, these two mature financial sectors would be appropriate candidates for an exploratory investigation because of their historical and cultural ties. Nonetheless, we acknowledge the distinctiveness of economies and the importance of local market expertise, and we recommend that sovereign governments implement the suggested global policy initiatives at

Literature Review

Over the last three decades, financial academics have thoroughly examined the subject of financial markets integration. Although this area of interest has been studied using a variety of datasets and approaches, most have adopted the common strategy of modeling return series from comparable asset markets and analyzing feedback mechanisms using the first or second moments of the distributions. Malliaris and Urrutia (1992, 1997) demonstrate that certain worldwide occurrences

likely to influence national stock markets simultaneously. Another excellent summary of the research on stock market links is given by McCarthy and Najand (1995).

An alternate method for analyzing the stock market risk premium is based on Merton (1980). A risk-averse investor requests a risk premium to offset market risk, as shown by Merton's model of intertemporal capital asset pricing. This risk premium is proportionate to the market return, assuming that the variation of the market return is an adequate statistic for the market risk. This proportionality constant also equals the investor's relative risk aversion in the case of a representative investor. By giving the unit price of risk, this multiplier may also be used to quantify risk. The unit price of risk should not change over time, according to any evidence. This is really the method used by Jochum (1999), who demonstrates that an unobserved component model may be used to estimate the temporal variation in the price of risk.

By no means is the concept of temporal variation of the unit price of risk restricted to the previously mentioned framework. Another possible source of information for determining the temporal variation of the market price of risk is the derivative contracts signed on the market indices of several nations. The idea is ingrained in the sophisticated theory of derivatives pricing, which necessitates a relationship between historical probability distributions and risk-neutrality. Bhar et al. (2004) show how the model may be configured in the state space framework to effectively infer the temporal fluctuation of the market price of risk.

The aforementioned tactics have to do with calculating the price of risk in the stock market. On the other hand, we want to concentrate on risk pricing in the credit market. Monitoring variations in corporate bond spreads is the conventional method of assessing shifts in the markets' projected credit outlook for businesses. These are often calculated as the difference between risk-free interest rates, which are typically approximated by government bond yields, and the returns given on businesses' corporate debt instruments. The risk premium that companies pay investors to offset a variety of hazards related to corporate debt is known as corporate bond spreads.

Additionally, researchers and policymakers now have additional tools to quantify the perceived credit risk of enterprises thanks to recent financial developments like credit derivatives. Credit default swaps quantify credit risk in a manner similar to corporate bond spreads. Under a CDS deal, the seller of the default swap receives monthly or upfront payments from the buyer of protection against default. In the event of a default on a reference obligation, which is often a bond or a loan, the seller of protection guarantees to pay. The default swap spread is another name for the default swap premium.

The long-term link between the two markets and the propensity of CDS markets to outperform corporate bond markets in terms of price discovery are confirmed by Alexopoulou, Andersson, and Georgescu (2009). They discover that the start of the financial crisis in the summer of 2007 caused a significant rise in risk aversion and a change in credit risk pricing, with cash bond markets pricing in more information about liquidity and idiosyncratic risk and CDS markets becoming more sensitive to systematic risk. Additionally, the substantial shift in the lead-lag relationship brought about by the financial instability resulted in a systematic separation between the two markets, with CDS markets consistently outperforming cash bond prices.

markets. In this case, we examine convergence in the two OECD credit markets using CDS market data. The phrases convergence and interconnectivity will be used interchangeably.

Numerous approaches have been put out to assess and quantify the convergence of economic series in addition to integration studies. The following summarizes the key findings from some earlier research. When determining whether a collection of more than two series is convergent, several techniques make use of cross-sectional data. Examples include the estimate of Markov transition matrices, random field regressions, "initial value" or "Barro" regressions and their derivations, and time series analysis of a dispersion measure (St. Aubyn, 1999). One recurrent problem with these approaches is that it becomes difficult to account for the potential for restricted convergence. Only a subset of series—such as the GDPs of nations—converge to a single leading series, which is known as

restricted convergence. There are several leading series when there are multiple such groupings, and each of the remaining series is drawn to only one of them. The approaches put forward by Durlauf and Johnson (1992) and Quah (1996) are specifically developed to deal with this problem. However, a high degree of correlation within the categories is necessary for their efficacy. St. Aubyn (1995) uses the Monte Carlo technique to illustrate this.

Pure time series tests for convergence often examine the characteristics of the difference between two series. They have one thing in common, according to St. Aubyn (1999): they enable restricted convergence or convergence clubs. For instance, just check for convergence of series A to B if you assume that nation A and country B are members of the same club. Testing this difference for stationarity using a Dickey-Fuller statistic, for instance, is the most widely used time series method to convergence. This method is not entirely suitable since convergence does not always imply stationarity of the differences according to the definitions from the preceding section. For instance, two series are totally independent of one another and eventually become precisely equal, according to Hall, Roberston, and Wickens (1992). Although these series would converge, the stationarity condition would not be passed. Hall, Roberston, and Wickens (1992) suggest using the Kalman Filter to enable a convergence process that begins after the start of the period under consideration. Evidence that this approach is more effective than Dickey-Fuller's when there is a structural break in the convergence process is reported by St. Aubyn (1999).

This study employs a sophisticated empirical technique to utilize banking sector CDS indexes to quantify the interdependence of the US and UK credit markets. Naturally, the global financial crisis era is included in the data, which spans the years 2004 to 2010. We leverage data directly from the credit derivative market, going beyond the traditional usage of first and second moments of equity return time series. The riskiness of these two credit markets would converge if they were financially connected. The convergence in the CDS time series would not be seen if these two markets were separated. More precisely, we assess the interdependence of these nations' credit sectors by applying the Kalman filter convergence tests to the daily CDS index prices.

The remainder of the work is structured as follows: the empirical model is covered in section 3, the data is covered in section 4, the empirical findings are presented in section 5, and the conclusion is covered in section 6.

Expirical model

Defining Convergence

The meaning of convergence may be clarified before we proceed into testing for it. We are considering two economic series of interest to us. For example, these could be GDPs per head of any two countries. These two are said to converge to each other if their difference becomes stationary in the long term. In more formal terms, consider two economic series and . These two may represent GDPs per head or any other two series we are interested in. These two series converge if:

$\square X_t \square Y_t \square \square \square_t$ ^{P} as t $\square \square$ (1)

where ε_t is a random variable obeying the following conditions:

$$E(\varepsilon_t) = 0, \quad Var(\varepsilon_t) = \sigma^2 < \infty \qquad (2)$$

Equations (1) and (2) mean that the difference $y_t - x_t$ between the two series converges in probability to a third series that is stationary, having a constant mean μ_{XY} and a finite constant variance σ^2.

To turn this definition into one compatible with the definitions presented elsewhere (e.g. Barro and Sala-i-Martin, 1995), we could define economic convergence as:

Point wise, if $\sigma^2 = 0$;

Unconditional, if $\mu_{XY} = 0$;

Conditional, if $\mu_{XY} \neq 0$.

Thus, the above definitions encompass the "beta-convergence" concept proposed by Barro and Sala-i-Martin (1995). In their study, series are supposed to converge to their steady-state level at an annual constant rate. If steady-states are the same, "beta-convergence" is unconditional. If they are different but grow at the same rate, "beta-convergence" is conditional. Definitions presented in (1) and (2) are more general because they do not imply a constant rate of convergence and therefore differences between series are not necessarily stationary from the beginning.

Bernard and Durlauf (1995) propose a related definition: series and converge if the long run forecasts for both series are equal at time t:In some sense, the definition in (3) is more stringent: Bernard and Durlauf actually allows for the difference between series to be a random walk. The definition in (4) and (5) prevents this possibility by imposing a restriction on the variance.

Testing for Convergence

Testing Convergence – Dickey-Fuller

Dickey-Fuller convergence tests are stationarity tests for the differences between the two economic series. Equation (4) can be estimated using OLS and d_t is the difference between the two series being discussed.

$$\Delta d_t = \alpha_1 + \beta d_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta d_{t-j} + \varepsilon_t \qquad (4)$$

The number of lags denoted by is chosen so that the residuals would not display significant autocorrelation or non-normality. The standard tests for autocorrelation and normality could be implemented for this purpose.

The statistic of concern is the t-statistic for the coefficient. Under the null hypothesis of non-stationary, this statistic is not normally distributed. The relevant critical values are available from MacKinnon (1991).

Testing Convergence – Kalman Filter

Here is the brief description of the method and the detailed description can be found in St. Aubyn (1995). In this approach the difference between the two series, d_t, is modeled as,

$$d_t = \alpha_t + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma^2_{\varepsilon}) \qquad (5)$$

$$t \quad t\square 1 \quad t \quad t \quad t \quad t \quad t\square 1 \tag{6}$$

and $\square^2$ is the assumed initial value of the variance of $\square$.

The difference between the two series is modeled as a random walk plus noise. Although the noise variance σ^2 is constant through time, the variance of ε_t is potentially time varying and given by λ^2. If λ is less than 1, this variance tends to 0 in the long run, meaning that the two series are converging. Their difference becoming a stationary variable: the random walk component vanishes eventually and the noise becomes the only stochastic disturbance.

The model in (5) and (6) is written in state-space form equation where the first equation is the measurement equation and the second is the state equation. The likelihood function can be constructed using the Kalman Filter as discussed in chapter 8 of Bhar and Hamori (2005). The maximum likelihood estimates for the parameters are obtained by maximizing it.

The null hypothesis of no convergence implies that $\phi = 1$. Therefore, the proper test for convergence is: H_0: $\phi = 1$ against H_1: $\phi < 1$. The implementation of this test requires the distribution of ϕ under the null. St. Aubyn (1995) shows via simulation the critical values that are applicable for this hypothesis test. The test is based on the quantity,

$$t\left(\hat{\phi}\right) = \frac{\hat{\phi} - 1}{\sqrt{h^{-1}}} \quad (7)$$

where $\hat{\phi}$ is the estimated maximum likelihood value of ϕ and h^{-1} is the inverse of the diagonal element of the Hessian matrix corresponding to ϕ.

The test described above using Kalman Filter can be easily extended to accommodate differences in steady state values reached by the economic time series being investigated. Finally, the hypothesis that there are differences in the convergence process across the candidate series is addressed. That is to say that even if all series are converging towards the same attracting economy, it may well be the case that they are doing it at different speeds and towards different steady-states.

Consider the following set up,

$$d_t = d_{SS} + b_t (d_{t-1} - d_{SS}) + \varepsilon_t \quad (8)$$

$$b_t = b + a_1 (b_{t-1} - b) + \eta_t, \; -1 < a_1 < 1 \quad (9)$$

Here, ε_t and η_t are i.i.d. normally distributed. b_t is a time-varying speed of convergence. Since a_1 is bounded within the unit circle, b_t tends to return to its "long run" value, given by b. This is a case of a "return to normality" model. If b_t is smaller than one, the difference between the two series converges to the steady-state value given by d_{SS}.

Equations (8) and (9) express the measurement and transition equations in a state-space representation of the return to normality model. The concentrated log-likelihood can be written, as discussed in chapter 8 of Bhar and Hamori (2005), as an implicit function of the relevant parameters and maximized using numerical methods.

Data

The model is applied to the banking sector daily CDS quotes for UK and the USA. The period covers beginning January 2004 to end December 2010. This gives us 1827 observations. The

banking-sector five year CDS premium (mid quote) are obtained from Datastream. The specific Datastream variables used are USBANCD and UKBANCD. The summary statistics for the data used are presented in Table 1.

Summary Statistics

	Mean	Std Dev	Max	Min	Skewness	Kurtosis
UK	69.18	66.61	235.21	4.63	0.4733	1.6766
USA	87.39	86.22	595.99	10.20	1.4265	5.3467

Table 1: Summary Statistics

In order to get a visual appreciation of the variability of the CDS indexes over the sample period, we include the following plot.

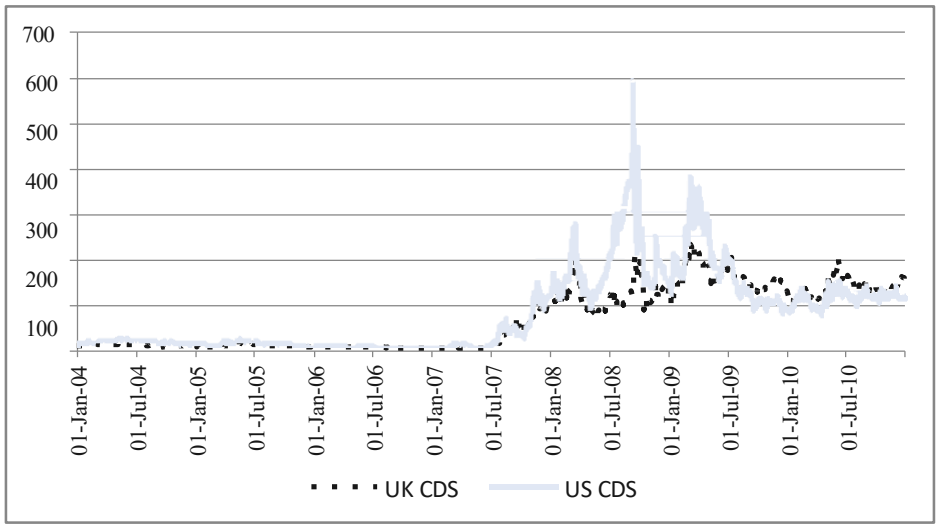


Figure 1: Basic Plot of CDS Indexes

The huge difference between the maximum and the minimum of the variables is clearly attributable to the financial crisis period starting in 2007. It may also indicate heavy tailed distribution. The basic profile of the graphs tends to indicate high correlations between these the CDS markets as well. The following Table 2 gives the correlation measures of these two CDS indexes.

Table 2:Correlation Measures

Correlation Measures

	Pearson Correlation	Kendall's Tau	Spearman's Rho
UK - USA	0.8539^{***}	0.7664^{***}	0.9230^{***}

Pearson correlation is a linear-based measurement of dependence. The nonparametric rank correlations, Kendall's tau and Spearman's rho, are useful for the observations in the tails. Moreover, Kendall's tau and Spearman's rho are associated with copula functions (not studied here). 1% level of significance is indicated by ***.

All the correlation measures are positive indicating that the increase US CDS premium is associated with an increase in the UK CDS premium. The Kendall tau is significantly positive, showing that the probability of concordance is significantly higher than the probability of discordance. The Spearman rho is also significantly positive, indicating obvious rank correlations. The values of Kendall's tau and Spearman's rho are consistent with each other and the linear correlation.

Table 3:Convergence in CDS Indexes (UK and USA)

Test of Convergence in CDS Indexes (UK and USA)

Relevant t-Stat.	d_{ss}	$\bar{b}$	a_1	σ_η^2
-46.16***	0.34896***	0.99301***	-0.11562	0.00336***
	(0.06110)	(0.00348)	(0.12493)	(0.00064)

Relevant t-statistic $t_{\bar{b}=1} = (\bar{b}-1)/\sqrt{h^{-1}}$ is described in the text. Asterisk indicates the hypothesis of No Interconnectedness is rejected at the 1% level of significance. Critical values are obtained from St. Aubyn (1999). Other parameters relate to steady state property of convergence as described in the text. The numbers in the parentheses below the parameters are the appropriate standard errors.

The steady state coefficient d_{ss} is derived as a difference between the US banking sector CDS premium and that of the UK banking sector. The coefficient is positive and significant implying that the aggregate premium charged for the US banking sector is higher than that of UK. This is consistent with the plot in Figure 1. a_1 is the short-run speed of convergence of the banking sector CDS premium between these two countries and it is not statistically significant.

It is also evident from the results in Table 3 that the variance σ_η^2 is significant, which implies that the speed of convergence or interconnectedness for the two CDS premium series is time varying. The parameter representing the long-run value of the time-varying speed of convergence $\bar{b}$, is significant though. It is slightly lower than 1 and this implies that the difference between the banking sector CDS premium eventually will converge to the steady state value given by financial crisis in each country.

In summary, there is no statistically significant evidence of short-run time-varying banking sector interconnectedness between the two markets, the steady state long term interconnectedness is evident. The presence of interconnectedness may be reflective of the common sector response to government intervention programs in the wake of the financial crisis. Similar to the US, the UK government intervened quickly with financial institutions bailouts, guaranteed bank deposits, stimulus packages encouraging consumer spending and investments in infrastructure projects. This longer term steady state interconnectedness of the two markets might indicate greater operational and structural alignment of financial institutions operating in these countries and similarity in investor behaviour and broader market conditions. Besides, many of the large banking institutions operate in both these countries and would have similar regulatory expectations.

Sheard (2009) argues that an important transmission channel of policy is its effect on private sector beliefs and expectations about the future. In banking crises, depressions or deflations, economies can be viewed as suffering from a coordination failure, which might have strong negative effects on consumer and business confidence and market sentiment. Governments and central banks need to show a strong and timely commitment to achieving their policy goals and then take forceful action consistent with those goals. Along these lines, the International Monetary Fund attributes the improved financial conditions of late across the globe to 'cuts in policy interest rates, continued provision of ample liquidity, credit easing, public guarantees, and bank recapitalization which have appreciably lowered concerns about systemic failure and have supported intermediation' (IMF, 2009).

Figure 2 depicts the consumer sentiment index in the two countries covering the period of financial crisis. As expected, both the markets show fall in the sentiment index roughly coinciding with the period of financial crisis. Although, the UK market show bigger drop in sentiment, its pick up tends to match with that of the US. In line with the remarks above, it appears that the policymakers in both these countries are successful, most of the time, in communicating a timely and committed approach to responding to the financial crisis. Most importantly, the US policymakers have said that they will do "whatever it takes" to overcome the current problems, which has sent a strong message to the national and international public, backed up with consistent policy action.

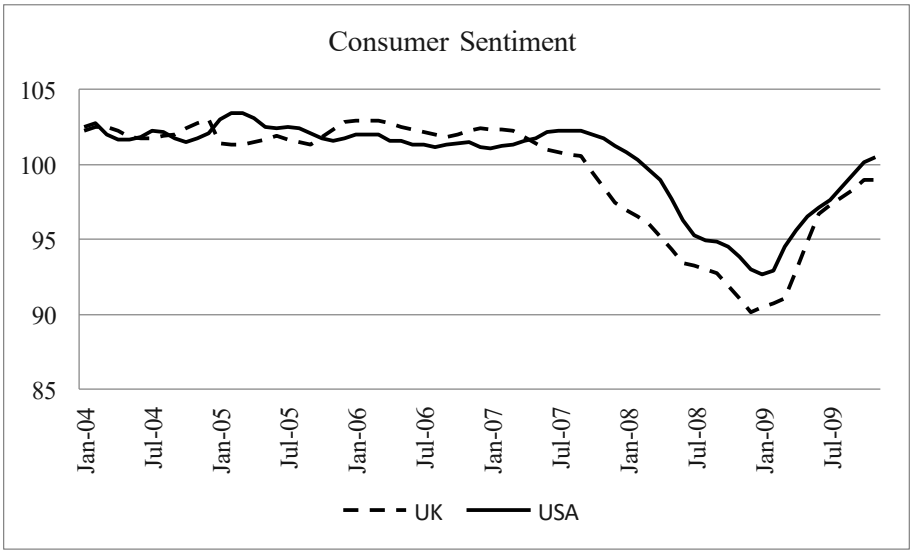


Figure 2: Consumer Sentiment (January 2004 – December 2009)

Conclusion

When analyzing the impact of policy actions, especially during times of crisis, the idea of two markets being interrelated is crucial. We have the chance to look at how two large economies with sizable banking sectors fared when their respective central banks interfered in the recent global financial crisis.

The short-run time-varying banking sector interconnectivity between the two markets in the US and the UK is not supported, according to the measure of convergence utilizing the Kalman filter tests. However, there is unquestionably long-term, steady state connectivity between these two economies. This could be a reflection of how the general public responded to government intervention initiatives during the financial crisis. There are some similarities between these two economies' banking sector rules, both historically and recently. The convergence tests are most likely emphasizing this. These results lead us to the conclusion that the ideal financial markets regulatory framework for the future is a coordinated global financial regulatory policy with discretionary interventionary fund allocation and execution plan at the country level.

It would be beneficial to concentrate on additional sectors and the relevant aggregate CDS data as part of the continuing study.

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