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基於跨期違約相關性描述下信用衍生性商品之評價
研究成果報告(精簡版)

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I. Research background

Most credit derivative products possess an underlying reference pool of credit entities with multiple asset classes. The valuation of such products entails careful assessments of the likelihood of defaults and the inter-dependent relationship among them. Recent trends in the development of credit-related products, such as forward-starting CDO tranches, option on CDO tranches, and reset tranches are basket-typed securities with fexible timing features embeded. The factor copulae formalism of Li(2000), Laurent and Gregory (2003), Andersen et al. (2003) and Hull and White (2004) that generates conditional portfolio-loss distributions on single fixed maturity dates are inadequate under an inter-temporal setting, and has since triggered research efforts to consider inter-temporal default inter-dependencies.

A forward-starting CDO (FCDO) is a forward contract which allows investors to buy or sell a specific tranche on a pre-specified date. The premium for the protection sellers is preset at the beginning of the contract, and they are responsible for the future losses of the reference pool should any default event takes place during the contract period. As a protection measure for the protection sellers, the protection buyers of FCDOs are solely responsible for the losses of any underlying credit entities prior to the pre-determined contractual date. Upon entering the contract, the underlying credit entities that have defaulted are then excluded from the reference pool.

Although the contract of a FCDO only becomes effective after the contractual date, the changes in the default probabilities of the underlying reference pool shall still affect the value of the contract. When the average credit spread of the reference pool increases by one basis point, the credit spread of each tranche will decrease. Thus, in order to hedge the market-wide spread-risk upon entering into long positions in a FCDO contract, investors should in fact consider taking specific short positions (buy protection) in the CDS index.

The valuation and hedging of these instruments require a dynamic description of portfolio losses, and therefore, of the correlated nature of defaults that would result in such losses. A consistent pricing framework under such dynamic description presents a real challenge to both academic researchers and practitioners, and the existing literature on this subject is surprisingly scarce. In this research, we explore the feasibility of modeling the correlated nature of defaults in an inter-temporal setting, and we consider the valuation of options on forward-starting CDO tranches under such framework.

As for the valuation of options on forward-starting CDO tranches, the decision to buy or sell protection at a forward time T depends on if the losses due to defaults events that took place prior to the exercise date remain below the tranches detachment point. A dynamic description of losses are therefore of absolute necessity in determining the probability of the option being “in-the-money”, and this in turn calls for an adequate modeling of default events which are inter-temporally dependent. In contrast to Jackson and Zhang (2007), this research adapts the inter-temporal factor copulae model of Andersen (2006) in order to calculate the expected losses of forward-starting CDO tranches. Under the inter-temporal framework, we derive the relevant tranche spreads of forward-starting CDOs. In addition, we allow the systematic and idiosyncratic risk factors and the factor loadings to be inter-related across time horizons, in order to properly characterize the inter-temporal feature of the forward-starting CDO tranches.

Subsequent parts of this report are organized as follows. Section 2 presents the methodology that introduced the inter-temporal factor for pricing the FCDO tranches. Section 3 analyzes the numerical results. Section 4 concludes.

II. Methdology

II.1 Inter-temporal Correlation:

We begin with only two dates $\{T_j\}_{j=1}^{2}$. As to the asset value, we define as follows:

$$X_i^{(1)} = \sqrt{a_i(T_1)}M^{(1)} + \sqrt{1 - a_i(T_1)}e_i^{(1)} \qquad \text{at } T_1$$
$$X_i^{(2)} = \sqrt{a_i(T_2)}M^{(2)} + \sqrt{1 - a_i(T_2)}e_i^{(2)} \qquad \text{at } T_2 \quad i = 1,2,\dots,N$$

where $X_i^{(j)}$ is asset i's value. Also $M^{(j)}$ and $e_i^{(j)}$ are systematic and idiosyncratic risk factor respectively. The density of $M^{(j)}$ is $\varphi_M^{(j)}(m)$, j=1,2 and the joint density of $M^{(1)}$ and $M^{(2)}$ is $\varphi_M^{(j)}(m_1, m_2)$.

Let $F_i^{(j)}(e)$ denote the cumulative distribution function for $e_i^{(j)}$, j=1,2, and let $F_i^{(1,2)}(e_1, e_2)$ be the joint cumulative distribution function for $e_i^{(1)}$ and $e_i^{(2)}$. With the barrier variable $H_i(t)$, we would lead to conditional survival probabilities:

$$\Pr(\tau_i > t) = \Pr\left(\sqrt{a_i(T_1)}M^{(1)} + \sqrt{1 - a_i(T_1)}e_i^{(1)} > H_i(t)\right), t \in [0, T_1]$$

$$\Pr(T_1 < \tau_i \le t) = \Pr\left(\sqrt{a_i(T_1)}M^{(1)} + \sqrt{1 - a_i(T_1)}e_i^{(1)} > H_i(T_1), \sqrt{a_i(T_2)}M^{(2)} + \sqrt{1 - a_i(T_2)}e_i^{(2)} \le H_i(t)\right)$$

where $t \in (T_1, T_2]$.

Setting our total systematic factor vector to $M = \left(M^{(1)}, M^{(2)}\right) = (m_1, m_2)$, we can get the following results:

$$\Pr\left(\sqrt{a_i(T_1)}M^{(1)} + \sqrt{1 - a_i(T_1)}e_i^{(1)} > H_i(T_1), \sqrt{a_i(T_2)}M^{(2)} + \sqrt{1 - a_i(T_2)}e_i^{(2)} \le H_i(t)\right)$$
$$= F_i^{(2)}\left(\frac{H_i(t) - \sqrt{a_i(T_2)}m_2}{\sqrt{1 - a_i(T_2)}}\right)$$
$$- F_i^{(1,2)}\left(\frac{H_i(T_1) - \sqrt{a_i(T_1)}m_1}{\sqrt{1 - a_i(T_1)}}, \frac{H_i(t) - \sqrt{a_i(T_2)}m_2}{\sqrt{1 - a_i(T_2)}}\right)$$

where $t \in (T_1, T_2]$.

We use the fact that:

$$\Pr\left(e_i^{(1)} > e_1, e_i^{(2)} \le e_2\right) + \Pr\left(e_i^{(1)} \le e_1, e_i^{(2)} \le e_2\right) = \Pr\left(e_i^{(2)} \le e_2\right)$$

to rewrite the equation and lead to conditional survival probabilities:

$$q_i(t, m_1, m_2) = 1 - F_i^{(1)}\left(\frac{H_i(t) - \sqrt{a_i(T_1)}m_1}{\sqrt{1 - a_i(T_1)}}\right), t \in [0, T_1]$$

$$q_i(t, m_1, m_2) = q_i(T_1, m_1, m_2) - F_i^{(2)}\left(\frac{H_i(t) - \sqrt{a_i(T_2)}m_2}{\sqrt{1 - a_i(T_2)}}\right)$$

$$+ F_i^{(1,2)}\left(\frac{H_i(T_1) - \sqrt{a_i(T_1)}m_1}{\sqrt{1 - a_i(T_1)}}, \frac{H_i(t) - \sqrt{a_i(T_2)}m_2}{\sqrt{1 - a_i(T_2)}}\right), t \in (T_1, T_2]$$

Since we consider a Gaussian copula where M and Z are standard normal distribution, that is, we write:

$$q_i(t, m_1, m_2) = 1 - \emptyset\left(\frac{H_i(t) - \sqrt{a^{(1)}}m_1}{\sqrt{1 - a^{(1)}}}\right), t \in [0, T_1]$$

$$q_i(t, m_1, m_2) = 1 - \emptyset\left(\frac{H_i(t) - \sqrt{a^{(1)}}m_1}{\sqrt{1 - a^{(1)}}}\right) - \emptyset\left(\frac{H_i(t) - \sqrt{a^{(2)}}m_2}{\sqrt{1 - a^{(2)}}}\right)$$

$$+ \emptyset_2\left(\frac{H_i(T_1) - \sqrt{a^{(1)}}m_1}{\sqrt{1 - a^{(1)}}}, \frac{H_i(t) - \sqrt{a^{(2)}}m_2}{\sqrt{1 - a^{(2)}}}; \rho_e\right), t \in (T_1, T_2]$$

Calibration of $H_i(t)$ is accomplished from the equation:

$$\Pr(\tau_i > t) = \int_M q_i(t, m_1, m_2)\emptyset_M^{(1,2)}(m_1, m_2)dm_1dm_2$$

A FCDO have an effective date T^* preset in the beginning of contract and the terminal maturity denoted by T. If defaults take place before the effective which is time interval between $[0, T^*]$, the investors need not count in these default when determining the cumulative losses in a given tranche. To obtain the entire loss distribution between $[T^*, T]$. we substitute primary default probability $\Pr(\tau_i \le t)$ to $\Pr(T^* \le \tau_i \le t)$.

II.2 Constructing the Loss Distribution

Assume that nominal principal and recovery rate for each asset are the same, we can calculate the survival probability $S_i(t|M)$ and the default probability $Q_i(t|M)$ in order to construct the loss distribution. In other words, given that $\pi_T(t|M)$ is the probability that exactly k defaults occur from time zero to time T , and systematic risk factor is known, then we get:

$$\pi_T(0|M) = \prod_{i=1}^{N} S_i(T|M)$$

Similarly, by replacing survival probability to default probability, we can prove:

$$\pi_T(1|M) = \left[\prod_{i=1}^{N} S_i(T|M)\right] * \sum_{i=1}^{N} \frac{1 - S_i(T|M)}{S_i(T|M)} = \pi_T(0|M) * \sum_{i=1}^{N} \frac{1 - S_i(T|M)}{S_i(T|M)}$$

Define $w_i = \frac{1-S_i(T|M)}{S_i(T|M)}$, then the above equation can be renewed to:

$$\pi_T(k|M) = \pi_T(0|M) * \sum_{i=1}^{j} w_{z(1)} w_{z(2)} \ldots w_{z(k)}, j = C_k^N$$

where $z(1), z(2), \ldots, z(k)$ is a set of k assets selected from N assets.
To know the relationship of $U_k, U_{k-1}, \ldots, U_1$, we also define:

$$U_k = \sum_{i=1}^{j} w_{z(1)} w_{z(2)} \ldots w_{z(k)}, j = C_k^N$$

Hull & White show that if a variable can be described as:

$$V_k = \sum_{i=1}^{N} w_i^k$$

then there exist the relationship as follow:

$$U_1 = V_1$$

$$2U_2 = V_1 U_1 - V_2$$

$$3U_3 = V_1 U_2 - V_2 U_1 + V_3$$

$$\vdots$$

$$kU_k = V_1 U_{k-1} - V_2 U_{k-2} + \cdots + (-1)^k V_{k-1} U_1 + (-1)^{k+1} V_k$$

Based on the above procedure, one can calculate the $\pi_T(k|M)$ by finding $U_1, U_2, \ldots U_k$. In addition, it is easy to compute the loss distribution by integrating over the M. However, this recurrence method cannot be used in the non-standard products. Also, the loss distribution cannot be constructed when the number of underlying asset pools is too large.

III. Numerical results

First, we construct and price two FCDOs based on methodology as described in section 2. Second, we examine the impact of each parameter to the credit spreads and what makes the credit spreads changed. Finally, we use the hedging parameter delta to explore the FCDO hedging issues.

We consider FCDO pricing on a CDX-like portfolio with 125 names, with average 5-year spread of 75bps. The effective date of the FCDO is T^*, and the maturity is T. We let the contract period $T - T^* = 5$ and consider two trades $T^* = 2$ and $T^* = 5$. The tranches are

0-3%, 3%-7%, 7%-10%, 10%-15% and 15%-30%. For simplicity, we let the risk-free rate be constant of 5%, recovery rate be 0 and factor loadings $a_1 = a_2$.

Based on the methodology described in section 2, we then examine the impact of the inter-temporal factors of the system risk and idiosyncratic risk on the credit spreads of the FCDO tranches.

III.1 The Impact of ρ_M

In a Gaussian model, we assume that the systematic risk factor loading $\sqrt{a} = \sqrt{2}$ and the inter-temporal correlation of the idiosyncratic $\rho_e = 0$. We consider four cases of the inter-temporal correlation of the systematic risk ρ_M, which are $\left\{1, \sqrt{T^*/T}, 0, -1\right\}$. The numerical results are shown as follows.

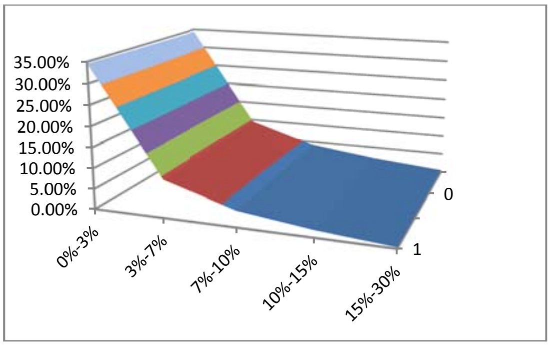

Figure 1 $T^* = 2, a_1 = a_2 = 0.2, \rho_e = 0$, Gaussian model

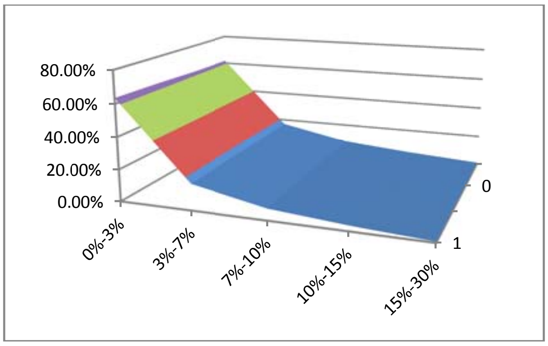

Figure 2 $T^* = 5, a_1 = a_2 = 0.2, \rho_e = 0$, Gaussian model

From Figure 1 and 2, we can observe that in all cases of $T - T^* = 5$ years, the credit spreads of the FCDO are higher than the regular synthetic CDO tranches, especially, the later of the FCDO contract effective date is, the higher the credit spreads are. This shows that if default intensity is constant, the default probability will increase as time goes on. In general, the senior and subordinated tranche are hard to default in the first or second year, so the investors usually can receive the fixed payoff in every interest payment date. As to the FCDO, it does not need to pay these premiums before the effective date and cause the effect of deferred payment. However, it should give more risk premiums to attract more investors.

In addition, as the inter-temporal correlation factor ρ_M getting small will decrease the credit spreads of the equity tranche and increase the credit spreads of the senior tranche. We begin with inspect the loss situation of senior tranche. Let the contract period $[0, T]$ be divided into two periods $[0, T^*]$ and $[T^*, T]$.

Since the inter-temporal correlation ρ_M is higher, and with a well market environment in the first period, there is a decreased likelihood to crash to the second period. Therefore the senior tranche has less possibility to suffer loss. On the country, as the ρ_M get close to -1, the environment of the second period will be inversed. As a result, there may be few defaults in $[0, T^*]$ and caused a sufficient amount of defaults located inside $[T^*, T]$ that lead senior tranche under less protection during effective period. It implies senior tranche take more risks.

On the other hand, if the economic environment of the first period is bad, there may be large number of defaults to concentrate in $[0, T^*]$ and leaving a few underlying assets still in the portfolio. Even the remain part of the underlying assets to default in the $[T^*, T]$, the losses will be absorb by equity and subordinated tranche, and cause the investors of the senior tranche to take less risks. The smaller the value of ρ_M is, the better the market environment is in the second period, still makes investor of the senior tranche having less probability to get losses. Briefly, as the inter-temporal correlation is lowered, there may be a sufficient amount of defaults located inside $[T^*, T]$ to cause loss in the senior tranche and raise the credit spreads of it.

For the equity investor, things work the opposite way than for the senior investor. Under the well environment in the first period and inter-temporal correlation factor ρ_M is higher, there is very few defaults take place in $[0, T^*]$, and some poor foundational assets still in the portfolio that cause the equity tranche more risky. When the economic environment is bad in the first period and the value of ρ_M is getting closer to -1, that means the large amount of defaults clustered in $[0, T^*]$, and also include the pool foundational ones, this will decrease the equity tranche risky. In other words, lowering inter-temporal correlation will make the equity tranche less risky.

III.2 The Impact of ρ_e

See the examples of ρ_M given above, we come to observe the other timing variable ρ_e. Using the Gaussian Factor Copula environment with $\sqrt{a} = \sqrt{0.2}$ and $\rho_M = 0$, the impact of $\rho_e = 1, \sqrt{T^*/T}, 0, -1$ can be showed as Figure 3 and 4.

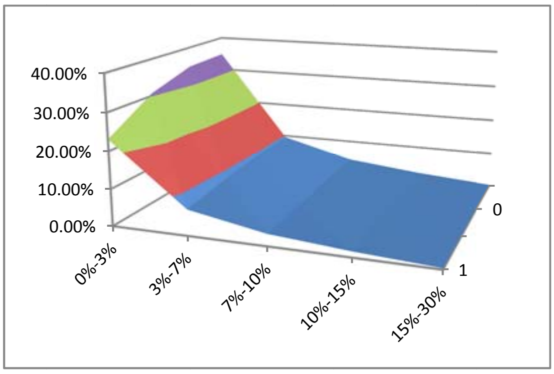

Figure 3 $T^* = 2, a_1 = a_2 = 0.2, \rho_M = 0$, Gaussian model

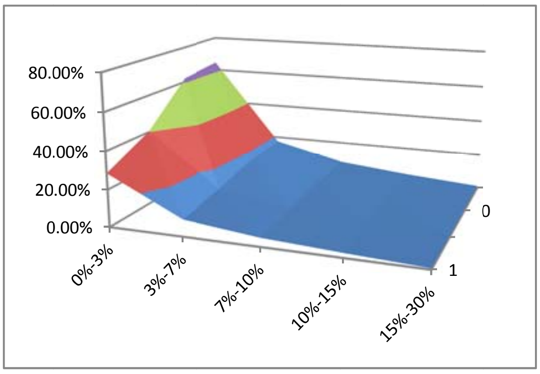

Figure 4 $T^* = 5, a_1 = a_2 = 0.2, \rho_M = 0$, Gaussian model

As the results of Figure 3 and 4, the little ρ_e has more CDO spreads for all tranche and bigger loss probability. (see Figure 4.1) This phenomenon is due to the investors of FCDO only response the loss during [T*,T], that is, the investors only consider the assets that survive during [T*,T] and react without default asset. The assets that survive during [T*,T] are well enough to having bigger e. In other words, the smaller the ρ_e and e are, the larger the default risk is. And this phenomenon does not only appear in equity tranche investors. When all assets that survive during first period [T*,T] but there has individual firm becoming physical deterioration in the second period [T*,T], the investors of senior or highest tranches may have the loss. Thus, all the spreads of credit tranches will be bigger when the ρ_e is smaller.

III.3 The Impact of a

Above study is assumed in a=0.2, and then we come to observe the impact of credit spreads when the system load factor $\sqrt{a}$ increase to $\sqrt{a} = \sqrt{0.2}$.

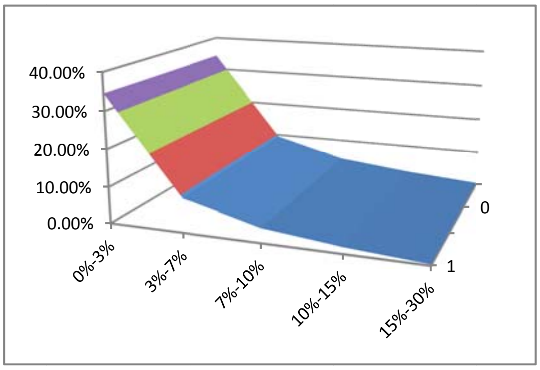

Figure 5 $T^* = 2, a = 0.2, \rho_e = 0$, Gaussian model

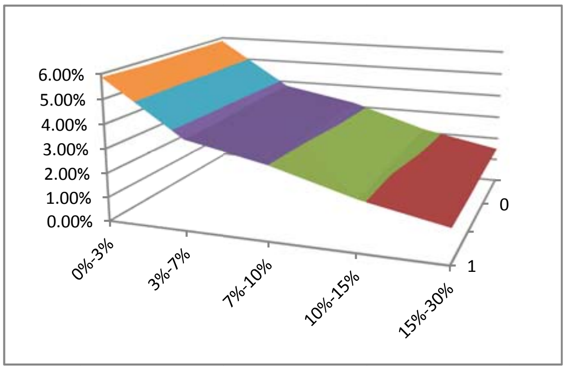

Figure 6 $T^* = 2, a = 0.8, \rho_e = 0$, Gaussian model

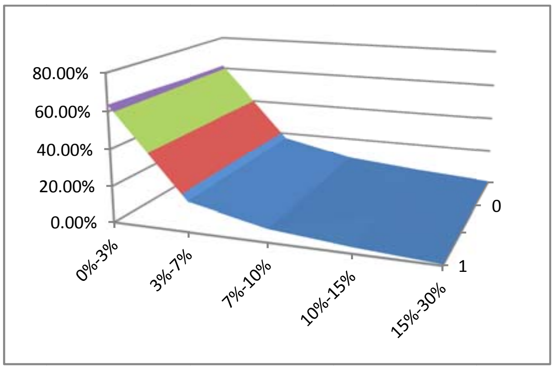

Figure 7 $T^* = 5, a = 0.2, \rho_e = 0$, Gaussian model

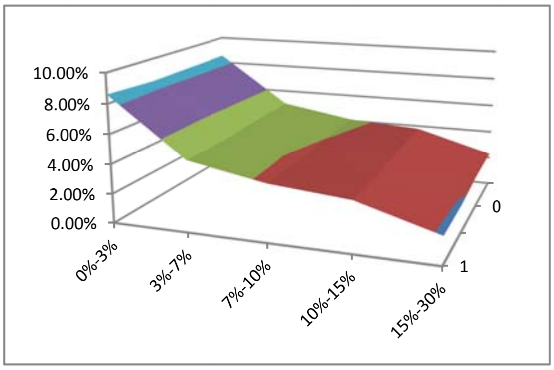

Figure 8 $T^* = 5, a = 0.8, \rho_e = 0$, Gaussian model

From Figure 5 to 8 show the different impact of ρ_M to different credit tranche spreads when $\rho_e = 0$. We find that the loading of systematic risk factor $\sqrt{a}$ less sensitiveness when ρ_M is small. This is the same conclusion of Hull & White (2004).

Next, we can observe that the credit spreads does not change larger as ρ_M becoming small. This is because that the risk characteristics are the same with the senior tranches when the systematic loading risk factor coefficient is larger. The results of increasing a=0.8 is showing from Figure 9 to 12.

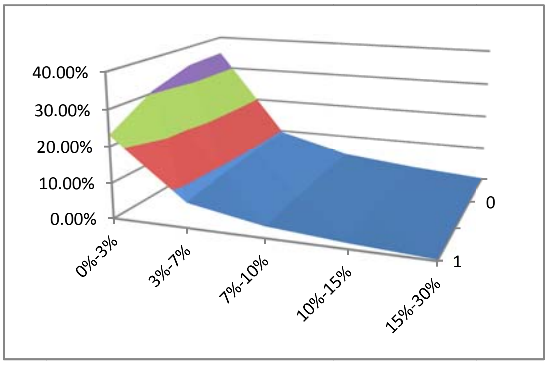

Figure 9 $T^* = 2, a = 0.2, \rho_M = 0$, Gaussian model

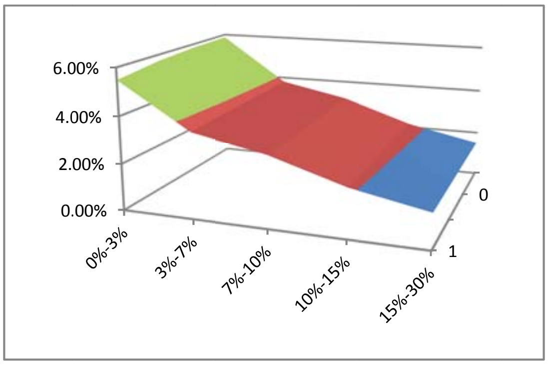

Figure 10 $T^* = 2, a = 0.8, \rho_M = 0$, Gaussian model

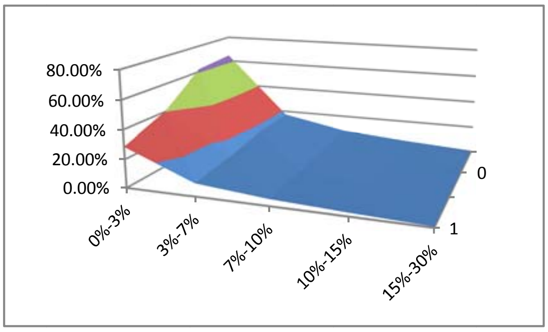

Figure 11 $T^* = 5, a = 0.2, \rho_M = 0$, Gaussian model

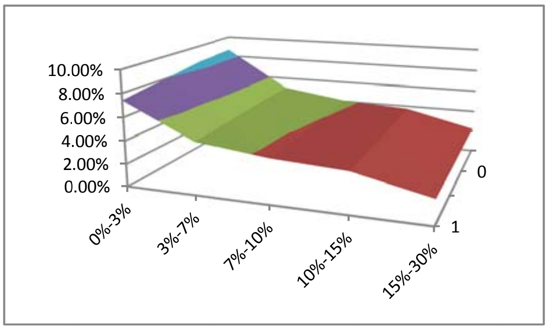

Figure 12 $T^* = 5, a = 0.8, \rho_M = 0$, Gaussian model

III.4 Hedging of FCDO

The CDS index is the most often seen instrument to hedge the price risk of a synthetic CDO. The CDS index is a standardize contract and has high trading volumes and great liquidity. Therefore, it is convenient to hedge the market-wide credit spread risk with the CDS index. The composition of a CDS index is not always the same with the portfolio of a synthetic CDO. Hence, it is necessary to compute the hedging parameters, and measure the capability of a hedging strategy.

Although the contract of a FCDO becomes effective after the effective date, the changes in default probabilities of the underlying asset pool still affect the value of the contract. If the average credit spread of the underlying asset pool increases by 1bp, the values of each tranche will decrease. Thus, when investors enter into a long position in a FCDO contract, a short position (buy protection) in CDS index should be constructed to hedge the market-wide credit risk. For simplicity, we assume that $a = a1 = a2,\ r = \rho_m = \rho_e$.

In Figure 13 to 16, we show that when the loading of systematic risk factor ‘a’ decreases, the dispersion in delta of each tranche increases. When the credit spreads of underlying asset pool increase, the equity tranche of the FCDO suffers the greatest negative impact. On the other hand, when the loading of systematic risk factor increases, the dispersion in delta of each tranche decreases. Moreover, delta of the equity tranche becomes smaller and delta of the highest rated tranche becomes bigger. Also in these figure, we can see that when $r = \rho_m = \rho_e$ decreases, delta of the highest rated tranche increases.

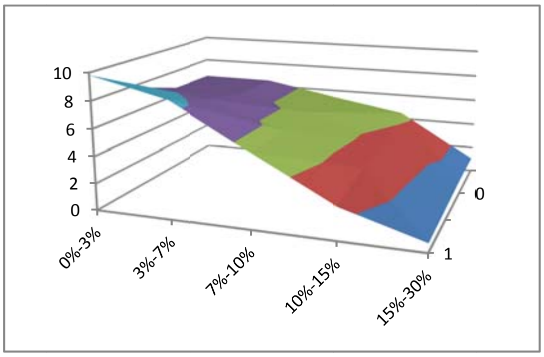

Figure 13 $T^* = 2, T = 7, a = 0.2$, Gaussian model

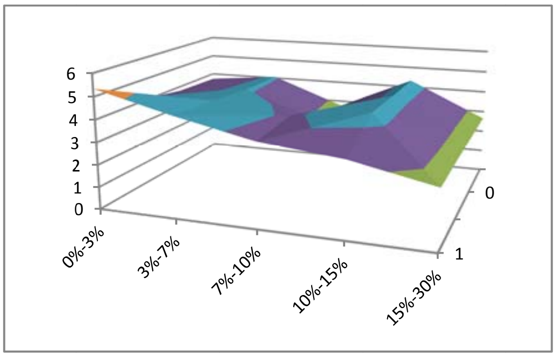

Figure 14 $T^* = 5, T = 7, a = 0.8$, Gaussian model

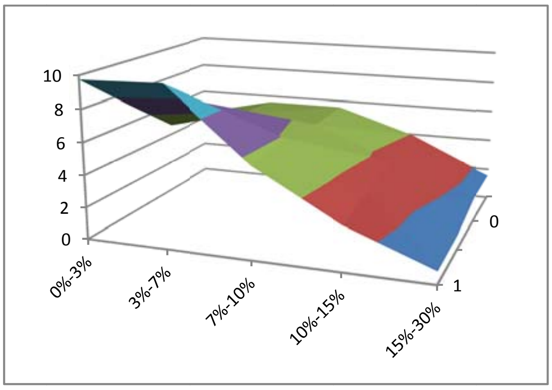

Figure 15 $T^* = 5, T = 10, a = 0.2$, Gaussian model

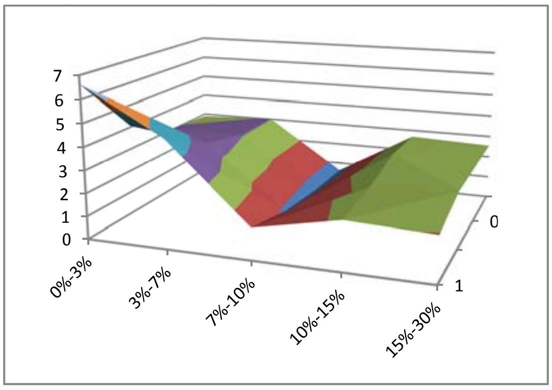

Figure 16 $T^* = 5, T = 10, a = 0.8$, Gaussian model

Next, we consider the feasibility of the hedging strategy. We take the equity tranche as an example, under the assumption of $a = 0.2, T^* = 2$, and $r = 1$, delta of this tranche is -9.8248. Therefore, to fully hedge the price risk due to the changes in the credit spreads of underlying asset pool, one should sell the CDX index contract and its total amount must equal to 9.8248 times the total principal of the investment on equity tranche. When the credit spreads of underlying asset pool change by 1bp in average, the value of the equity tranche will decrease by -12300. Meanwhile, the value of hedging position will gain 12300 therefore offset the decrease in value of the equity tranche position. However, for the FCDO holder, the premium of 2371bps is received after the effective date, but the hedging cost of 9.8248*75bps is paid before this date. Before effective date, the investor must pay 184.215bps in every quarter. After the second year, the investor has the net income of 408.535bps. Therefore, the equity tranche investor must receive the premium at least for one year, or the hedging cost will be greater than the premium.

Then, we consider the hedging feasibility of 7%~10% tranche investors. Under the assumption of $a = 0.2, T^* = 2, r = 1$, delta of this tranche is -5.3843. The total principal of this tranche is 3.75 million dollar, hence, the investors must sell 36.843 million to construct a fully hedge strategy. Yet the premium of 209bps will be received after effective date. Before the effective date, investors must pay 5.3843*75bps for the hedging position. After second year, investors have net income of 108.23bps in each quarter. Therefore, the investors should

receive the premium for at least 2.25 years or the hedging cost is too high to be offset.
For the highest rated tranche, under the same assumption of a, T*, and r, delta is -0.6621. Before the effective date of the FCDO, the investors have to pay 0.6621*75bps for hedging cost. After that, the investors have net premium of 5.6bps. The total hedging cost is more than total income of the investors, thus, hedging strategies using delta are not feasible for the investors of the highest rated tranche.

Then we change the effective date to examine the impact on the effectiveness of the hedging strategy. Under the assumption of $a = 0.2, T^* = 5,$ and $r = 1$, delta of equity tranche is -9.7619. Therefore, before the effective date, the investors must pay 9.7619*80bps annually. This means that the investors have net outcome of 195.238bps quarterly. Until the second year, the investors receive the net income of 453.762bps. Thus, for equity tranche investors, the premium at least for one year should be received in order to cover the hedging cost. By comparing between Figure 13 to 16, we show that hedging parameters are similar after delaying the effective date. However, the investors must pay greater hedging cost because of the delayed premium income. In general, the farer the effective date is, the more difficult hedging is.

IV. Conclusion

From the above analysis, we show that because of the feature of deferred premium for the FCDO, the investors must pay the hedging cost and have no premium before effective date when implementing a hedging strategy using delta. Furthermore, the hedging cost of the CDS index as a hedging instrument is very high. For equity tranche investors, at least one year of premium have to be received to cover the hedging cost. For the highest rated tranche investors, the hedging cost is higher than income so that this hedge strategy is not feasible. In general, the difficulty of hedging increases as the effective date becomes farer from beginning date of the contract. However, at present, in order to make FCDO more attractive, the issuers would pay a premium the same level as LIBOR before the effective date. The main objective of this design is to smooth the premium income to every payment date before and after the effective date. Therefore the investors have earlier premium income and reduce the difficulty of hedging.

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98 年度專題研究計畫研究成果彙整表

計畫主持人：江彌修	計畫編號：98-2410-H-004-059-
計畫名稱：基於跨期違約相關性描述下信用衍生性商品之評價	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	1	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	4	0	100%	人次	
		博士生	1	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 □未發表之文稿 ■撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

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3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

This research adapts the inter-temporal factor copulae model of Andersen (2006) in order to calculate the expected losses of forward-starting CDO tranches. Under the inter-temporal framework, we derive the relevant tranche spreads of forward-starting CDOs. In addition, we allow the systematic and idiosyncratic risk factors and the factor loadings to be inter-related across time horizons, in order to properly characterize the inter-temporal feature of the forward-starting CDO tranches.