

# **Credit Risk Pricing in Single Name Corporate CDS**

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## ABSTRACT

The paper examines the determinants of the dynamics and term structure of credit default swap (CDS) spreads. I focus on roles of the interest rate risk and default risk. I extract interest rate factors from libor-swap curve, based on affine models. With a large data set, I test a three-factor CDS spread term structure model for 100 companies, using exact matching technique. The factors consist of two interest rate factors and one default risk factor. The estimation shows intricate interaction between interest rate factor and credit risk factor in determining the default process. I find that positive shock of the first interest rate factor will increase subsequent default risk factor, while positive shock on the second interest rate factor will decrease the subsequent default risk factor. In terms of direct effect of interest rate factors on the default process, positive shock on the first interest rate factor will decrease the default arrival rate at the moment, while positive shock on the second interest rate factor will increase the default arrival rate at the moment. Most of the effects of the shocks to interest rate factors will be sent to the default process indirectly through their impact on the subsequent move of the credit risk factor. CDS spreads of high credit rating companies are less responsive to the shocks on default risk than those of low credit rating companies. The work enhances our understanding of the process which underlies the CDS spreads movement and regimes. Such knowledge is essential for CDS pricing, risk measurement and management, hedging the related risk.

## 1. Introduction

Today the world economy is facing the biggest challenge in decades. Declining oil price couldn't reverse the full-blown economic recession in the United States. On the finance side, the substantial global credit crunch has led to the collapse of some well established investment banks, Bear Stearns and Lehman Brothers, as well as a number of commercial banks around the world. This ongoing financial crisis also puts a spotlight

on the obscure world of credit default swap, a fast growing major type of credit derivative. More important, some types of credit default swaps have played a critical role in the unfolding financial crisis.

Credit default swap (CDS) is a privately negotiated bilateral contract, initially created to insure against credit risk. The protection buyer pays a fixed premium to the protection seller for a set period of time. In return, the protection seller will pay the buyer the amount of loss if a pre-specified “credit event” occurs. The “credit event” includes bankruptcy, default and sometimes restructuring of the underlying company or sovereign. In the occurrence of a credit event, the contract is settled and ended. If no credit event occurs during the contract term, the protection buyer continues to pay the premium until maturity. The premium is termed as “CDS spread” or “CDS rate”. There are two kinds of settlement methods. One is physical settlement, and the other is cash settlement. Via physical settlement, the seller pays par and gets distressed bond, while via cash settlement, the seller pays the difference between the par and the recovery value of the bond. The issuer of the insured debt instrument is termed as “reference entity”. It could be a corporation, a sovereign government, or any other form of legal entity which has incurred debt. Recently, CDS on package of mortgage loans is blamed to encourage the reckless behavior during the housing bubble.

CDS can be classified as single-name CDS and basket swaps. In single-name CDS, there is only one reference entity. Most of the single-name CDS trade are standard. Basket swaps involve more than one reference entities, and are classified as *Nth* default swaps, subordinate basket default swaps and senior basket default swaps.

Most CDS contracts range between \$10 million and \$20 million in notional amount. Maturity falls from one year to ten year. Five-year is the most common maturity. Unlike corporate bond, entering a CDS contract does not require initial funding, which makes it an easy way to gain exposure to credit risk. A CDS

transaction can even be entered where a cash bond of the reference entity of a particular maturity is not available.

As CDS is traded over the counter, it's not clear exactly when the CDS market came to existence. In the late 1990s, the contracts started to trade for corporate bonds. By 2000, the CDS market was approximately 900 billion. According to the report by Bank of International Settlements\*, by the end of 2007, this number has exploded to more than 55 trillion. It was expanding by 36%, slower than the first half of 2007, the growth rate of which is 49%. The size of the CDS market is almost the size of entire world stock market, which was 60.8 trillion at the end of 2007†. Credit default swap now is the most widely traded credit derivative product.

The most active players on this market are commercial banks and insurance companies. The CDS market provides a fantastic way for commercial bank to transfer credit risk without removing assets from its balance sheet and without involving borrowers. Banks also use CDS to diversify its portfolios, which often concentrates in certain geographic area and industries. Global hedge funds are also said to be increasingly active in this market, but since there is no reliable survey data, it is hard to draw any conclusion about their activities.

A typical CDS contract usually has two potential cash flow streams, a fixed leg and a contingent leg. On the fixed leg side, the buyer of the protection makes a series of fixed, periodic payment of CDS premium until maturity or until the credit event. On the contingent leg side, the protection seller makes one payment only if the credit event occurs. The value of the CDS contract is the difference between the present value of the protection leg and contingent leg. The fair CDS spread is set to make the initial value of the CDS contract

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\*Baba and Gallardo (2008), Bank of International Settlements, "OTC Derivatives Market Activity in the Second Half of 2007"

†World Federation of Exchanges, "<http://www.world-exchanges.org/WFE/home.asp?menu=395> nav=ns6", (Sep 23, 2008)

equal to zero, that is to equate the present value of all of premium payment to the expected default loss. Both interest rate risk and credit risk will affect CDS spread. CDS spread is different from credit spread, which is the spread between corporate bond and Treasury securities that are identical in all respects except for quality rating. In practice, CDS spread is quoted in basis points per annum of the contract's notional amount. It is paid quarterly.

The valuation and hedging of CDS are always important topics for market practitioners. The fast growth of the CDS market also provides a fresh topic for risk management. Controlling the risk of CDS contracts makes it necessary to understand the role of interest rate risk and default risk in determining the term structure of the CDS spread. How can the current market data be exploited and its information content extracted? One needs a combined interest rate and credit risk model to provide a quantitative framework to describe CDS spread movements and valuing and hedging the product. In this thesis, I will focus on how interest rate risk dynamically interacts with default risk to govern the term structure of single name corporate CDS spread. I find that a two-factor interest rate model well capture the dynamics and term structure of libor and swap rates. These two interest risk factors impact CDS spreads simultaneously, but more importantly they affect the subsequent credit risk, thus impact CDS spreads indirectly. The estimates for model parameters vary a lot across the sample companies even within industry and credit rating class, but exist some consistency in term of direction. The three-factor model (two interest risk factor and one default risk factor) works better on long maturities than on short maturities, because the latter ones are less liquid and may need another factor in the default process. The results advance our understanding of how default risk relate to interest rate risk, and it may enhance our understanding of the process which underlie the CDS spreads movements and regimes.

This paper is organized as follows. Section 1 is an brief introduction of credit default swap. Section 2 reviews the recent literature on interest rate and credit risk modeling. Section 3 describes the methodology in modeling CDS spread term structure in this work. Section 4 describes the data sets. Section 5 illustrates the estimation strategy applied in the thesis. Section 6 shows the results of estimation, followed by a conclusion in Section 7.

## **2. Literature Review**

Credit risk (or default risk) plays an important role in the dynamics and term structure of CDS spreads. Default risk in CDS is intrinsically linked to the payment obligations of the reference entity. It includes,

- Arrival risk, is the uncertainty that whether a default will occur or not.
- Timing risk, refers to the uncertainty about the precise time to default.
- Recovery risk, describes the uncertainty about the severity of the losses if a default happened.
- Market risk, is the risk of changes in the market price of a defaultable asset, even if no default occurs.

The impact of the default risk can be affected by the behavior of other market variables, such as default-free interest rates. For a given recovery rate, a default on a fixed-coupon bond in a high-interest-rate environment is less severe than a default on the same bond in a low-interest-rate environment, because the net present value of the lost claim is lower in the former case. Therefore interest rate risk is also one important part of determining the dynamics and term structure of CDS spreads. In this chapter I will review the recent literature on credit risk models and interest rate risk models.

## 2.1. Credit Risk Models

With the fast growth of credit derivative market and deterioration of global credit quality, the development of credit risk models has become an important issue in finance.

Modern credit risk models can be classified into two basic categories, structural models and reduced form models. Structural model was first anticipated by Merton (1970), proposed by Black and Scholes (1973), and extended by Merton (1974). Structural model is also called as Merton model due to his great contribution. It assumes a company defaults on the debts if the value of the company's assets falls below a certain point. Thus defaults can be modeled as an option, and option pricing technique can be applied to the modeling of default risk. The second category of credit risk models is known as reduced form model. It assumes default is a random event. So reduced form models focus on modeling the default probability instead of the structural features. Reduced form models are pioneered by Jarrow and Turnbull (1995) and Duffie and Singleton (1999). The default-risky bond price is the cornerstone of pricing CDS.

By the structural model, a company will default if the value of its assets is less than the debt repayment. Assume the asset value is  $A(T)$  at maturity  $T$ , and the face value of the zero coupon bond is  $K$ . Then the company's equity value at maturity is,

$$E(T) = \max\{A(T) - K, 0\} \quad (1)$$

The payoff of the equity is just identical to that of a call option. According to put-call parity, the company's debt can be viewed as a risk free bond with a short position of the put option on the value of the firm struck at the bond's maturity value.

$$D(T) = K - \max\{K - A(T), 0\} \quad (2)$$

The default risk is reflected by the put option. Merton model assumes that the dynamics of the asset value follow a lognormal stochastic process, which is the same as for the stock price used by Black-Scholes for the option pricing.

$$\frac{dA(t)}{A(t)} = rdt + \sigma dW(t) \quad (3)$$

According to the formula of option price,

$$E(t) = A(t)N(d_1) - e^{-r(T-t)}KN(d_2) \quad (4)$$

$$d_2 = \frac{\ln(A(t)/K) + (r - \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}} \quad (5)$$

$$d_1 = d_2 + \sigma\sqrt{T-t} \quad (6)$$

$$D(t) = A(t) - E(t) \quad (7)$$

also the bond price  $D(t)$  can be written as

$$D(t) = Ke^{r(T-t)} - P^{BS}(A(t), K, \sigma, r, T-t)$$

Where  $P^{BS}$  is the Black-Scholes put option value. The bond price  $D(t)$  has the following characteristics,

- It increases with firm value  $A(t)$ . With the face value unchanged, the value of put option decreases as  $A(t)$  increases.
- It increases with face value  $K$ . As a result of increasing face value, the equity becomes less valuable. If  $A(t)$  is held constant, the bond value will increase.
- It decreases in interest rate. The value of call option increases, when interest rate goes up.
- It decreases in time to maturity. When time to maturity increase, the call option becomes more valuable, and the bond value drop correspondingly.
- It decreases in volatility. Volatility increases value of call option.

and the default-risky debt yield is

$$y = \frac{\ln K - \ln D(t)}{T - t} \quad (8)$$

After Merton (1974), Black and Cox (1976) work on certain types of bond indenture provisions, such as safety covenants, subordination arrangements, and restrictions on the financing of interest and dividend payments. Their work also touches on the issue of optimal capital structure. Geske (1977) develops expressions for the price of risky coupon bond in terms of multivariate normal integrals. Ho and Singer (1982) and Ho and Singer (1984) study the effects of sinking-fund provisions. Merton (1990) develops the jump-diffusion model for option pricing, which can also be applied to the credit risk in corporate bond. Zhou (2001) also works on the jump risk in credit spread. One of the unrealistic assumptions of the first generation structural model is that default can occur only at maturity of the debt when the firm's assets couldn't cover the debt. Second generation structural model was tried to remove such restriction by assuming default may occur anytime between debt issuance and maturity when asset value is lower than a threshold. They include mod-

els derived by K.Ramaswamy and Sundaresan (1993), Hull and White (1995), and Longstaff and Schwartz (1995). Shimko, Tejima, and van Deventer (1993) introduces stochastic interest rate into Merton's model. Briys and de Varenne (1997) also work on stochastic interest rate but allow for a judicious default boundary. The case of Cox-Ingersoll-Ross dynamics of the interest rate is treated in Kim, Ramaswamy, and Sundaresan (1993). Ericsson and Reneby (2002) and Duan (1994) discuss the maximum-likelihood procedure for estimating a firm's asset value from equity.

The other stream of the credit risk modeling focuses on the "reduced-form" approach. The dynamics of probability of default and recovery rate are modeled independently from the structural features of the firm. Reduced form models assume default is unpredictable and driven by some exogenous process, usually a Poisson process. The desirable mathematical properties of Poisson process greatly reduce the complexity of modeling default risk. Researchers also make assumptions on recovery rate to generate close-form solutions for a reduced-form model. Reduced form models are represented by Jarrow and Turnbull (1995) and Duffie and Singleton (1999). Both types of model employ risk neutral measure to price securities.

Jarrow and Turnbull (1995)'s model assumes a frictionless, arbitrage-free and complete market. Default is based on Poisson process, and assumed be independent of default-free interest rate. They also assume that the recovery payment is paid at maturity time no matter when the default happens.  $B(t, T)$  is the value of a default-risky coupon bond with maturity  $T$ . Then,

$$B(t, T) = p(t, T)\delta(T)(1 - e^{-\lambda(T-t)}) + \sum_{j=1}^n p(t, T_j)C_j e^{-\lambda(T_j-t)} \quad (9)$$

where  $p(t, T)$  is the risk-free discount factor,  $C_j$  is the coupon payment, and  $\delta(T)$  is the recovery rate.  $e^{-\lambda(T_j-t)}$  is the survival probability between  $t$  and  $T_j$ . In practice, Jarrow and Turnbull (1995) model is

modified to accommodate stochastic  $\lambda$ , and the recovery is assumed to be paid upon default. The bond price becomes,

$$B(t, T) = \int_t^T p(t, u) \delta(u) \lambda(u) e^{-\int_t^u \lambda(w) dw} du + \sum_{j=1}^n p(t, T_j) C_j e^{-\int_t^{T_j} \lambda(w) dw} \quad (10)$$

With Jarrow and Turnbull (1995)'s model, risk neutral default probability curve can be calibrated quickly using a series of default-risky zero coupon bond. We can use the solved risk neutral default probability curve to price all kinds of credit derivatives.

Duffie and Singleton (1999) presented another well known reduced-form approach. They allow the payment of recovery to occur at any time, and the amount of recovery is proportional to the bond price at default time as if it didn't default. The basic idea is that the recovery price should be some fraction of the bond price immediately before default. They model the default-adjusted short rate as the default free interest rate plus a term that jointly reflects the default arrival rate and recovery rate.

$$D(t, T) = \frac{1}{1 + r\Delta t} \{p\delta E[D(t + \Delta t, T)] + (1 - p)E[D(t + \Delta t, T)]\} \quad (11)$$

By recursive substitutions,

$$D(t, T) = \left[ \frac{1 - p\Delta t(1 - \delta)}{1 + r\Delta t} \right]^n X(T) \quad (12)$$

$$D(t, T) = \frac{\exp(-p(1 - \delta)T)}{\exp(rT)} X(T) \quad (13)$$

$$= \exp(-(r + s)T) X(T) \quad (14)$$

where  $s = p(1 - \delta)$ . When  $r$  and  $s$  go to stochastic, the bond value becomes,

$$D(t, T) = E_t^Q \left[ \exp\left(-\int_t^T R_t dt\right) \right] X(T), \quad R_t = r_t + \lambda_t(1 - \delta_t) \quad (15)$$

Discounting at the adjusted short rate  $R$  accounts for both the probability and the timing of default, as well as the effect of losses on default. The product of  $\lambda_t$  and  $(1 - \delta_t)$  serves as a spread over the risk free discount rate. By parameterizing  $R$  instead of  $r$ , it allows one to model default risky interest rates in the same way modeling default free interest rates and overcomes the computational difficulty of implementing reduced form models. In the Jarrow and Turnbull (1995) model, the recovery assumption is separate from the default probability. In other words, the default probability is calibrated when a recovery assumption is made. But with Duffie-Singleton model, the recovery and default probability together determine the credit spread.

Hull and White (2000) provide a methodology for valuing credit default swaps when the payoffs is contingent on default by a single reference entity and there is no counter-party default risk. Their model use a default density concept for the default probability, instead of hazard rate. Default density is generated

based on a set of zero-coupon corporate bond prices and treasury bond prices. Then the default density term structure is used to calculate the premium of a credit default swap contract.

Other reduced-form models are presented by Jarrow, Lando, and Turnbull (1997), Lando (1998) and Duffie, Pedersen, and Singleton (2003). In this thesis, I use the reduced-form framework to model credit risk inside the CDS spreads.

## 2.2. Interest Rate Models

The purpose of interest rate modeling is to understand interest rate behavior. By fitting a model to available interest rate data, we could discover the dynamics of interest rate. It enable traders and researchers to price and hedge interest rate products. Risk managers use models to simulate market behavior with historical parameters, so that they could put limits on the range of future values of a portfolio.

There are three main types of interest rate model.

- Affine yield models, for example, Duffie and Kan (1994) and Duffie and Kan (1996)
- Whole yield models, for example, Heath, Jarrow, and Morton (1992) and Brace, Gatarek, and Musiela (1997)
- Market models, for example, Jamshidian (1996) and Jamshidian (1997)

In affine models, spot rates are affine functions of the state variables, and the state variables can be taken to the spot rates of particular maturities. To ensure these properties, the dynamics of the state variables have to be restricted. The short rate is affine in the state variables,  $r_t = f + g'X_t$ ,  $f$  and  $g$  are constants. The process for state variable  $X_t$  should be in the form of

$$dX_t = (uX_t + v)dt + \Sigma V_t dz_t \quad (16)$$

where  $z_t$  is an  $n$ -dimensional Wiener process,  $u$  and  $\Sigma$  are constant  $n \times n$  matrices, and  $v$  is a constant  $n$ -dimensional vector.  $V_t$  is a diagonal matrix of the form,

$$V_t = \begin{pmatrix} \sqrt{\alpha_1 + \beta'_1 X_t} & & 0 \\ & \dots & \\ 0 & & \sqrt{\alpha_n + \beta'_n X_t} \end{pmatrix}$$

where  $\alpha_i \in \mathbb{R}$ ,  $\beta_i \in \mathbb{R}^n$ ,  $i = 1, \dots, n$ , are constants. In this setting, the model produce simple partial differential equation solutions for spot rates. Spot rates are in the form of  $r_t(\tau) = (1/\tau)a(\tau) + (1/\tau)b(\tau)X_t$ , where  $a(\tau)$  and  $b(\tau)$  satisfy the following pair of differential equations

$$a'(\tau) = f + v'b - \frac{1}{2}b'\Sigma \text{diag}(\alpha)\Sigma' b \quad (17)$$

$$b'(\tau) = g + u'b - \frac{1}{2}b'\Sigma\beta\Sigma' b \quad (18)$$

with boundary conditions  $a(0) = 0$  and  $b(0) = 0$ . A special form of the generalized affine model is the dynamic mean model, where one of the state variable is the short rate itself and the short rate mean reversion level is time dependant. For example, the extended Vasicek model,  $dr(t) = \alpha(t)(\theta(t) - r_t)dt + \sigma(t)dz_t$ .

Whole yield curve model describe the yield curve as a whole. It is usually specified quite generally in terms of the instantaneous forward rate process,

$$df_t(T) = \alpha(t, T, \omega)dt + \sigma(t, T, \omega)dz_t, \quad t \leq T \quad (19)$$

where  $z_t$  is an  $\mathbb{R}^n$  valued Brownian motion and  $\omega$  is a sample point in the sample space  $\Omega$ .  $\alpha$  and  $\sigma$  are path dependent, and can depend on previous and current forward rates. This class of models is first developed by Heath, Jarrow, and Morton (1992).

Market models recover market pricing formula by direct modeling market quote rates. The motivation is to obtain Black-Scholes formula to value the options. This require log-normal state variables. It can't be short rate, as it explodes. Nor should it be expected future rate, as it become unbounded. Then market quoted rate come as the state variables, because it can safely be log-normal without problems. Caplet and swaption prices can thus be obtained by Black-Scholes formula.

### **3. Model Framework in this Thesis**

The model applied in this work includes two components: a term structure model of benchmark risk-free interest rate and a term structure model of the CDS spreads. I adopt the framework of Duffie and Singleton (1999), and Duffie, Pedersen, and Singleton (2003).

### 3.1. Benchmark Interest Rate Dynamics and Term Structure

In this thesis, first, I model the term structure of the benchmark libor and swap rates using two interest-rate factors. Then I take the interest-rate factors extracted from the libor and swaps rates as given to estimate the credit risk dynamics for each of the sample companies using their CDS spreads.

In the interest rate dynamics, I use the specifications of Duffie and Kan (1996). I assume libor and swap rates are governed by two dynamic factors. Formally, the interest rate dynamics can be described by fixing a filtered probability space  $\{\Omega, \mathcal{F}, (\mathcal{F}_t)_{t \geq 0}, \mathbb{Q}\}$  with some fixed horizon  $\Gamma$ .  $X_t \in \mathbb{R}^2$  is used to denote the two dimensional vector Markov process that represents the systematic state of the libor-swap curve.  $\mathbb{E}[\cdot]$  denotes the expectation under risk neutral measure  $\mathbb{Q}$ . Interest rate  $r$  is affine in the state vector  $X$ ,

$$r_t = a_r + b_r^\top X_t, \quad (20)$$

Then the model implied value of the zero coupon bond with maturity  $\tau$  is,

$$\begin{aligned} P(X, \tau) &= \mathbb{E}\left[\exp\left(-\int_0^\tau r_t dt\right)\right] \\ &= \mathbb{E}\left[\exp\left(-\int_0^\tau (a_r + b_r^\top X_t) dt\right)\right] \end{aligned}$$

While under risk-neutral measure  $\mathbb{Q}$ , the state vector is governed by the Ornstein-Uhlenbeck(OU) process,

$$dX_t = (\theta_x - \kappa_x^Q X_t)dt + dW_t^Q, \quad (21)$$

where  $\kappa_x^Q \in \mathbb{R}^{2 \times 2}$  controls the mean reversion of the process and  $(\kappa_x^Q)^{-1}\theta_x \in \mathbb{R}^2$  controls the long run mean. As  $X_t$  falls below the long run mean  $(\kappa_x^Q)^{-1}\theta_x$ ,  $\theta_x - \kappa_x^Q X_t$  becomes positive, which makes  $dX_t$  is more likely to be positive. In the long run,  $X_t$  will move toward and revert to  $(\kappa_x^Q)^{-1}\theta_x$ . Ornstein-Uhlenbeck(OU) process is known as mean reverting process. In order to be a stationary OU process, the real part of the eigenvalues of  $\kappa_x^Q$  must be positive. For identification purpose,  $\kappa_x^Q$  is constrained to a lower triangular matrix. Thus the diagonal values of  $\kappa_x^Q$  are constrained to be positive. I also normalize  $X_t$  to have identity diffusion matrix for identification purpose.

Under statistical measure  $\mathbb{P}$ ,  $X_t$  also follows a multi-variate OU process. For identification purpose, I normalize the long-run mean of  $X_t$  to zero under  $\mathbb{P}$ . The diagonal elements of  $\kappa_x^P$  are also constrained to positive to guarantee stationarity. Therefore, the dynamics could be described as,

$$dX_t = -\kappa_x^P X_t dt + dW_t^P, \quad (22)$$

I assume affine market price of risk on both factors,

$$\gamma(X_t) = \gamma_{x0} + \langle \gamma_{x1} \rangle X_t, \quad (23)$$

where  $\gamma_{x0}$  and  $\gamma_{x1}$  are both vectors of relevant dimensions and  $\langle \cdot \rangle$  denotes a diagonal matrix, with diagonal elements given by the vector inside. For two factor interest rate model,  $\gamma_{x0}$  and  $\gamma_{x1}$  have two dimensions.

With such specifications of risk-neutral and statistical dynamics of interest rate factors, we can get

$$\begin{aligned}
\gamma(X_t) &= -\kappa_x^P X_t - (\theta_x - \kappa_x^Q X_t) \\
&= -\theta_x + (\kappa_x^Q - \kappa_x^P) X_t \\
\kappa_x^P &= \kappa_x^Q - \langle \gamma_{x1} \rangle, \quad \theta_x = -\gamma_{x0}
\end{aligned}$$

According to Duffie and Kan (1996), the model implied value of the zero coupon bond with maturity  $\tau$  is an exponential affine function of the current value of  $X$ ,

$$P(X_t, \tau) = \exp(-a(\tau) - b(\tau)^\top X_t), \quad (24)$$

Where  $a(\tau)$  and  $b(\tau)$  are determined by the following ODE and boundary conditions,

$$\left\{ \begin{array}{l}
a'(\tau) = a_r + b(\tau)^\top \theta_x - b(\tau)^\top b(\tau)/2 \\
b'(\tau) = b_r - (\kappa_x^Q)^\top b(\tau) \\
a(0) = 0 \\
b(0) = 0
\end{array} \right.$$

Under affine Model, the continuous compounded spot rate is affine function of the two dynamic factors.

$a(\tau)/\tau$  measures the mean term structure and  $b(\tau)/\tau$  measures the response coefficients.

$$\begin{aligned}
R(X_t, \tau) &= -\frac{\ln P(X_t, \tau)}{\tau} \\
&= \frac{a(\tau)}{\tau} + \left[ \frac{b(\tau)}{\tau} \right]^\top X_t
\end{aligned}$$

Given the model implied value of zero coupon bond, libor value is

$$LIBOR(X_t, \tau) = \frac{100}{\tau} \left( \frac{1}{P(X_t, \tau)} - 1 \right) \quad (25)$$

where  $\tau$  is the time to maturity. In my thesis, I use 1-year libor rate, so  $\tau = 1$ .

For swap pricing, if the notional amount is 1, the present value of the fixed coupon payments and that of the float coupon payments are respectively,

$$\begin{aligned}
PV_{fixed}(X_t, \tau) &= \sum_{i=1}^{h\tau} \left( \frac{1}{h} \cdot \frac{SWAP(X_t, \tau)}{100} \cdot P(X_t, \frac{i}{h}) \right) \\
PV_{float}(X_t, \tau) &= 1 - P(X_t, \tau)
\end{aligned}$$

Equating the fixed leg and float leg, we get the model implied swap rate

$$SWAP(X_t, \tau) = 100h \frac{1 - P(X_t, \tau)}{\sum_{i=1}^{h\tau} P(X_t, i/h)} \quad (26)$$

$h$  denotes the number of payments in each year of the swap contract. The day counting convention for libor is actual/360, starting two business days forward. For U.S. dollar swap rates that I use here, the number of payments is twice per year,  $h=2$ , and the day counting convention is 30/360.

### 3.2. CDS Spreads Dynamics and Term Structure

First, I assume the CDS default risk is governed by two interest risk factors  $X$ , which is extracted from the libor swap dynamics, and one credit risk factor. For the one credit risk factor model, the Poisson default arrival rate is described by,

$$\lambda_t^i = a_i + b_i^\top X_t + c_i Y_t \quad (27)$$

where  $b_i \in \mathbb{R}^2$ ,  $c_i \in \mathbb{R}$ . Interest risk factor and credit risk factor both have a contemporaneous effect on default arrival rate. Under risk neutral measure  $\mathbb{Q}$ , I assume credit risk factor  $Y_t$  follows,

$$dY_t = (\theta_y - \kappa_{xy}^\mathbb{Q} X_t - \kappa_y^\mathbb{Q} Y_t) dt + dW_t^\mathbb{Q} \quad (28)$$

where  $\kappa_{xy}^\mathbb{Q} \in \mathbb{R}^2$ ,  $\kappa_y^\mathbb{Q} \in \mathbb{R}$ .  $\kappa_{xy}^\mathbb{Q}$  reflects how interest rate factor affect subsequent changes in credit risk factor under risk neutral measure  $\mathbb{Q}$ , while  $\kappa_y^\mathbb{Q}$  shows the autocorrelation of the credit risk factor.

Then under risk neutral measure  $\mathbb{Q}$ , the joint dynamics of  $Z = [X^\top, Y^\top]^\top \in \mathbb{R}^3$  becomes,

$$dZ_t = (\theta_z - \kappa_z^Q Z_t)dt + dW_t^Q$$

$$\text{where } \theta_z = \begin{bmatrix} \theta_x \\ \theta_y \end{bmatrix}, \kappa_z^Q = \begin{bmatrix} \kappa_x^Q & 0 \\ \kappa_{xy}^Q & \kappa_y^Q \end{bmatrix}$$

Similarly under statistical measure  $\mathbb{P}$ ,  $Z_t$  follows a multi-variate OU process,

$$dZ_t = -\kappa_z^P Z_t dt + dW_t^P \quad (29)$$

For stationarity, I also constrain the diagonal elements of  $\kappa_z^P$  to be positive. For identification purpose, I normalize the long-run mean of  $Z_t$  to zero under  $\mathbb{P}$ .

The market price of risk is affine on all factors,

$$\gamma(Z_t) = \gamma_{z0} + \langle \gamma_{z1} \rangle Z_t$$

$$\text{where } \gamma_{z1} = \begin{bmatrix} \gamma_{x1} \\ \gamma_{y1} \end{bmatrix}$$

Similarly, we can get

$$\kappa_z^P = \kappa_z^Q - \langle \gamma_{z1} \rangle, \quad \theta_z = -\gamma_{z0}$$

For CDS pricing, let  $S$  denotes CDS spread, which is the premium paid by the buyer of the protection.  $\omega$  reflects the fixed loss rate. In the estimation, I keep recovery rate  $(1 - \omega)$  constant, at 40 percent. The probability of no default between  $[0, t]$  is  $\exp(-\int_0^t \lambda_u du)$ , while the probability of one default between  $[0, t]$  is  $\lambda_t \exp(-\int_0^t \lambda_u du)$ . The present values of the premium leg and the protection leg are respectively,

$$\begin{aligned}
Premium(Z_t, \tau) &= \mathbb{E} \left[ S \int_0^\tau \exp(-\int_0^t r_u du) \exp(-\int_0^t \lambda_u du) dt \right] \\
&= \mathbb{E} \left[ S \int_0^\tau \exp(-\int_0^t (r_u + \lambda_u) du) dt \right] \\
&= \mathbb{E} \left[ S \int_0^\tau \exp(-\int_0^t (a_r + b_r^\top X_u + a_i + b_i^\top X_u + c_i Y_u) du) dt \right] \\
&= \mathbb{E} \left[ S \int_0^\tau \exp(-\int_0^t (a_z + b_z^\top Z_u) du) dt \right] \\
Protection(Z_t, \tau) &= \mathbb{E} \left[ \omega \int_0^\tau \lambda_t \exp(-\int_0^t \lambda_u du) \exp(-\int_0^t r_u du) dt \right] \\
&= \mathbb{E} \left[ \omega \int_0^\tau \lambda_t \exp(-\int_0^t (r_u + \lambda_u) du) dt \right] \\
&= \mathbb{E} \left[ \omega \int_0^\tau (a_i + b_i^\top X_t + c_i Y_t) \exp(-\int_0^t (a_r + b_r^\top X_u + a_i + b_i^\top X_u + c_i Y_u) du) dt \right] \\
&= \mathbb{E} \left[ \omega \int_0^\tau (c_z + d_z^\top Z_t) \exp(-\int_0^t (a_z + b_z^\top Z_u) du) dt \right]
\end{aligned}$$

With  $a_z = a_r + a_i$ ,  $b_z = [(b_r + b_i)^\top, c_i^\top]^\top$ ,  $c_z = a_i$ ,  $d_z = [b_i^\top, c_i^\top]^\top$ .  $a_r$  and  $b_r$  are calibrated from benchmark interest rate dynamics. The solution of the above functions are exponential affine in the current state vector  $Z_t$ .

$$Premium(Z_t, \tau) = S \int_0^\tau \exp(-a(t) - b(t)^\top Z_t) dt \quad (30)$$

$$Protection(Z_t, \tau) = \omega \int_0^\tau (c(t) + d(t)^\top Z_t) \exp(-a(t) - b(t)^\top Z_t) dt \quad (31)$$

Where  $a(t)$ ,  $b(t)$  are determined by the following ordinary differential equations and boundary conditions,

$$\begin{cases} a'(t) = a_z + b(t)^\top \theta_z - b(t)^\top b(t)/2 \\ b'(t) = b_z - (\kappa_z^Q)^\top b(t) \\ a(0) = 0 \\ b(0) = 0 \end{cases}$$

$c(t), d(t)$  are determined by

$$\begin{cases} c'(t) = d(t)^\top \theta_z - b(t)^\top d(t) \\ d'(t) = -(\kappa_z^Q)^\top d(t) \\ c(0) = c_z \\ d(0) = d_z \end{cases}$$

We can solve the CDS spread by equating the premium leg and protection leg.

$$S = \frac{\omega \int_0^T (c(t) + d(t)^\top Z_t) \exp(-a(t) - b(t)^\top Z_t) dt}{\int_0^T \exp(-a(t) - b(t)^\top Z_t) dt} \quad (32)$$

In one credit risk factor model,  $\kappa_{xy} \in \mathbb{R}^{2 \times 1}$ , and  $\kappa_y$  is a scalar.

## 4. Data

The libor and swap data are downloaded from Bloomberg. Libor is at 12-month, and swaps are from two year to ten years. In order to get weekly frequency, I picked Wednesday data to avoid weekend fluctuation. Sample period is from Jan.3, 2005 to Mar.30, 2007. Figure 1 graphs the interest rates time series and average term structure on the ten maturities. It shows that during the sample period, interest rates of all maturities trended up first and peaked at June, 2006, then dropped gradually. At the beginning of the sample period, the libor and swap curve is positively sloped, which indicates that the economy was experiencing an expansion. Then, the curve started to flat out, until the summer of 2006, sending out a signal of uncertainty. Later, the libor and swap curve inverted. An inverted curve has widely been viewed as a indicator of future recession.

[Figure 1 about here.]

Table 1 reports the summary statistics on weekly libor swap rates from Jan.3, 2005 to Mar.30, 2007. The libor and swap rates are relatively high during our sample period, and show an average upward term structure. The average of 12 month libor is 4.747 percentage point, with average swap rate ranging from 4.775 to 5.044 for the other nine maturities. The standard deviation for libor rate is higher than that for the swap rates. The skewness and excess kurtosis estimates are small. All the weekly autocorrelation for the ten series are above 0.95.

Principal component analysis (PCA) is a powerful dimension-reduction technique to study the covariance structure of vectors. Its key assumption is that the multitude of factors that affect a system can be neatly summarized by a few uncorrelated composite variables, called principal components. It will provide a parsimonious description of the system dynamics. The principal components are linear combinations of original vectors. As a result of mathematical derivation, the  $i$ th principal component is just the weighted average of the original vector by the  $i$ th eigenvector. The proportion of total variance explained by the  $i$ th principal component is simply the ratio between the  $i$ th eigenvalue and the sum of all eigenvalues of the covariance matrix. Table 2 reports the five largest eigenvalues and associated eigenvectors of the libor and swap rates series. It shows that the two largest principal components can explain more than 99% of the total variability of the data. The first component is a roughly equally weighted linear combination of the interest rates. It might represent the parallel movement of the libor-swap market, which makes it a market component. The second component represents the difference between the long and short maturities, which is just the steepness of the libor-swap curve. Such results encourage me to apply a two-factor interest rate model to the libor and swap series.

CDS spreads data analyzed in this thesis are from Bloomberg, too. They're average daily CDS spread quotes on ten maturities, ranging from one year to ten years of 125 US companies. These 125 companies are CDX.NA.IG.7 constituents. CDX.NA.IG is a CDS index compiled by Markit. It is composed of 125 investment grade entities domiciled in North America, distributed among 5 sub-sectors. The composition of the Index is determined by the member banks. All of the constituents entities are liquid names in the CDS market. CDX.NA.IG is rolled over every 6 months, beginning on September 21 and March 21 each year. The effective date CDX.NA.IG.7 is September 21, 2006.

I picked the Wednesday quotes to form a weekly sequence. Some quotes are not updated even for weekly frequency. There are some companies which have too many missing values, too few updates, or not consistent data points. I exclude them from my sample. As a result, there are 100 companies left in the sample. Appendix A shows the list of the 100 reference entities in the sample with their company Bloomberg ticker, credit ratings and industry sectors. The industry and credit rating information of the reference entity are downloaded from Markit website. The average number of updates in the weekly data for ten maturities are 40, 47, 95, 104, 111, 113, 106, 111, 111, 105. The average updates for 1 year and 2 year CDS spread are significantly less than those of other maturities, which indicate that they don't move with other maturities and contain relatively less risk information. Therefore I exclude them from my estimation either. The 100 reference entities are classified into five industry sectors by Markit, with 18 in finance, 13 in energy, 13 in TMT (technology, media and telecommunications), 26 in industrials, and 30 in consumer products. As for average credit ratings during the sample period, most of them belong to investment grade. Of the 100 reference entities, 2 are triple A, 3 are double A, 35 are single A, 57 are triple B, and 3 are double B. Appendix B lists the summary statistics on CDS spreads for each reference entities from Jan.3, 2005 to Mar.30, 2007. Table 3 reports summary statistics on CDS spreads across all reference entities.

All the CDS spreads increase with maturity. The skewness and kurtosis of short maturities are generally higher than those of long maturities. CDS spread time series of long maturities are more autocorrelated than those of short maturitis. By credit rating, I classified the reference entities into two groups. One is high rating group, with single A, double A and triple A credit ratings. It includes 40 companies. The other one is low rating group, including triple B and double B rating entities. 60 companies belong to this group. The statistical properties on the CDS spreads across the 100 companies differs substantially, even within the same industry and credit rating group. Take the mean of 5-year CDS spreads as an example. In the high

rating group, 5-year mean CDS spreads range from 10.91 (Walmart) to 46.51 (Countrywide), while in the low rating group, 5-year mean CDS spreads range from 24.49 (Lockheed Martin) to 126.99 (Residential Capital). Generally lower credit rating entity is associated with a larger CDS spread, but there are some overlaps between the two rating groups. The possible reason is that credit rating may not be a complete measure for the credit risk of reference entities. There may be other factors affecting CDS spreads, such as tax. CDS spreads also differ across industry. Among the entities in consumer goods sector, the lowest means spreads is 10.91 (Walmart), and the highest is 113.25 (Radioshack). In energy sector, it ranges from 19.46 (National Rural Utilities Cooperative Finance) to 41.90 (First Energy); in industrial, 16.86 (Honeywell) to 76.17 (Olin); in financial, 17.03 (Wells Fargo) to 126.99 (Residential Capital); and in TMT, 16.71 (IBM) to 69.65 (CenturyTel). In next chapter, I will present the model estimation strategy.

## **5. Estimation Strategy**

In this work, estimation is performed in two steps. I applied two estimation methods, Kalman Filter and Exact Matching, on estimating the dynamics and term structure of libor and swap rate. The two methods give out similar results. Then I select exact matching to estimate the dynamics and term structure on CDS spreads.

### **5.1. Kalman Filter**

Filtering is an algorithm which allows recursive estimation of unobserved, time varying parameters in the system. Kalman Filter is a discrete, recursive filter, adopted for econometrician from engineering. It uses the current observation to predict the value of the unobservable for next period, and use the realization of

the next period to update the forecast. I cast the model into a state-space form, obtaining efficient forecasts on the conditional mean and variance of observed interest rates using unscented Kalman Filter technique to build likelihood function on the forecasting error of the observed series. I assume the forecasting errors are normally distributed. The parameters are estimated by maximizing the likelihood function.

At the first step, I estimate the interest rate factor dynamics using libor swap rates.  $X_t$  is regarded as unobservable states. A discrete time version of the state dynamics as the state propagation equation is,

$$X_t = \Phi_x X_{t-1} + \sqrt{Q_x} \varepsilon_{xt}, \quad (33)$$

Where  $\Phi_x = \exp(-\kappa_x^P \Delta t)$  denotes the autocorrelation matrix of  $X$ ,  $Q_x = I \Delta t$  denotes the instantaneous covariance matrix of  $X$ , with  $I$  denoting an identity matrix of the relevant dimension and  $\Delta t = 1/T$  denoting the frequency. In this thesis, I use weekly data, so  $T = 52$ .  $\varepsilon_{xt}$  denotes a two-dimensional i.i.d. standard normal innovation vector.

The measurement equation is based on the observed libor and swap rates.

$$y_t = \begin{pmatrix} LIBOR(X_t, i) \\ SWAP(X_t, j) \end{pmatrix} + e_t \quad (34)$$

$$cov(e_t) = R^r \quad (35)$$

Where  $i = 1, j = 2, 3, \dots, 10$ .  $e_t$  denotes an  $10 \times 1$  vector of idiosyncratic risks, or measurement errors.  $R^r = E(e_t e_t^\top)$  is the covariance matrix of the measurement errors. We assume that the measurement errors

are independent of the state vector and are mutually independent, which means  $R_{ii}^r = \sigma_i^2$ , and  $R_{ij}^r = 0$  for  $i \neq j$ .

Let  $\bar{X}_t, \bar{V}_t, \bar{y}_t, \bar{A}_t$  denote the time  $t - 1$  ex ante forecasts of time  $t$  values of the state factors, the covariance matrix of the state factors, the measurement series and the covariance matrix of the measurement series. Let  $\hat{X}_t, \hat{V}_t$  denote the ex post update on the state factors and their covariance at time  $t$  based on the observation  $y_t$ . The ex ante predictions are,

$$\bar{X}_t = \Phi \hat{X}_{t-1} \quad (36)$$

$$\bar{V}_t = \Phi \hat{V}_{t-1} \Phi^\top + Q \quad (37)$$

$$\bar{y}_t = g(\bar{X}_t; \Theta) + e_t \quad (38)$$

$$\bar{A}_t = G(\bar{X}_t; \Theta) \bar{V}_t G(\bar{X}_t; \Theta)^\top + R^r \quad (39)$$

where

$$\frac{\partial g(\bar{X}_t; \Theta)}{\partial X_t} \Big|_{X_t = \bar{X}_t} = G(\bar{X}_t; \Theta)$$

$$\Phi = \exp(-\kappa_x^P \cdot \Delta t)$$

$$Q = I \cdot \Delta t, \quad \Delta t = 1/T$$

The Kalman gain is

$$k_t^g = \bar{V}_t G(\bar{X}_t; \Theta) (\bar{A}_t)^{-1} \quad (40)$$

The ex post filtering updates are,

$$\hat{X}_t = \bar{X}_t + k_t^g (y_t - \bar{y}_t) \quad (41)$$

$$\hat{V}_t = \bar{V}_t - k_t^g \bar{A}_t (k_t^g)^\top \quad (42)$$

I then obtain a time series of the ex ante forecasts and ex post updates on both the mean and covariance of the state variables conditional on the observed series via iterative procedure, using the unscented Kalman filter. By assuming the forecasting errors on the libor and swap rates are normally distributed, the log likelihood function is defined as,

$$l_t(\Theta) = -\frac{1}{2} \log |\bar{V}_t| - \frac{1}{2} ((y_t - \bar{y}_t)^\top (\bar{V}_t)^{-1} (y_t - \bar{y}_t)) \quad (43)$$

Where  $y_t$  and  $\bar{V}_t$  denote the conditional mean and variance forecasts on the libor and swap series respectively. The model parameter  $\theta \equiv [a_r, b_r, \gamma_{x0}, \gamma_{x1}, \kappa_x^Q, R^r]$  are estimated by maximizing the sum of the log likelihood function.

$$\Theta = \operatorname{argmax} \sum_{t=1}^T l_t(\Theta) \quad (44)$$

## 5.2. Exact Matching

In Kalman Filter, we only have assumption on the distribution of  $X_t$ .  $X_t$  is unobserved and is estimated through the filtering technique. While by exact matching, we can find the value of  $X_t$  by part of the data set, that is making  $X_t$  observable. And then using the observed  $X_t$  to explore the libor swap dynamics. Practically, I choose 5-year and 10-year swap rate data to do the exact match part, because these two maturities show good term structure properties and cover both mid and long maturities. The assumption of  $X_t$  are the same as Kalman filter.

$$X_t = \Phi_x X_{t-1} + \sqrt{Q_x} \varepsilon_{xt}$$
$$\Phi_x = \exp(-\kappa_x^P), Q_x = I \Delta t$$

The measurement equation for other maturities are,

$$y_t^j = \begin{pmatrix} LIBOR(X_t, j) \\ SWAP(X_t, j) \end{pmatrix} + e_t^j, j = 1, 2, 3, 4, 6, 7, 8, 9 \quad (45)$$

I assume serial correlation on the error term of the measurement equations. The error term are independent from different maturities.

$$e_t^j = \varphi_j e_{t-1}^j + \sigma_j \varepsilon_t^j \quad (46)$$

$$\text{cov}(e_t^j, e_t^i) = 0, i \neq j \quad (47)$$

Where  $\varepsilon_t^j$  is i.i.d., and the covariance matrix of  $\varepsilon$  is an identity matrix. The maximum likelihood function is made of two parts,

$$l_t^1(\Theta) = -\frac{1}{2} \log |Q_{xt}| - \frac{1}{2} ((X_{t+1} - \Phi_x X_t)^\top Q_{xt}^{-1} (X_{t+1} - \Phi_x X_t)) \quad (48)$$

$$l_t^2(\Theta) = -\frac{1}{2} \log |\Omega_{xt}| - \frac{1}{2} ((e_{t+1} - \Psi e_t)^\top \Omega_t^{-1} (e_{t+1} - \Psi e_t)) \quad (49)$$

$$l_t(\Theta) = l_t^1(\Theta) + l_t^2(\Theta) \quad (50)$$

Where  $\Phi = \text{diag}(\varphi_1, \varphi_2, \dots)$ ,  $\Omega = \text{diag}(\sigma_1^2, \sigma_2^2, \dots)$ . The model parameter

$\Theta \equiv [a_r, b_r, \gamma_{x0}, \gamma_{x1}, \kappa_x^Q, \Phi, \Omega]$  are estimated by maximizing the sum of the above log likelihood function.

In the one default risk factor model to price the CDS spread, I match 5-year CDS spread exactly and use the extracted factor to price other maturities. The reason is that 5-year CDS is widely considered the most liquid, which makes the quote reflect less liquidity risk.

## 6. Empirical Results

To estimate the libor swap dynamics, I tried both kalman filter and exact matching for the estimation. Table 4 reports the summary statistics on the pricing error of libor and swap rates under two-factor affine model specifications by kalman filter. Table 5 reports the summary statistics on the pricing error of libor and swap rates under two-factor affine model specifications by exact matching.

Table 6 reports the estimated parameters and their associated t-value by the two methods. The two methods provide quite consistent parameter estimations.  $\kappa_x$  determines the mean reversion of the interest rate factor  $X$ . The prediction of the first factor depends only on its own past values, while the prediction of the second factor depends on the past value of both factors. The diagonal part of  $\kappa_x$  captures the persistence of the interest rate factor. Estimates for the first factor by both methods are quite small, reflecting high persistency. The estimates for the off diagonal part are -0.2399 and -0.1952 respectively by the two methods. The off diagonal part of  $\kappa_x$  is negative, which means positive shock of the first factor will have a positive effect on the subsequent move of the second factor. The estimates of  $\kappa_x$  are significant from 0 by both methods.

Figure 2 plots the time series of the two extracted factors by the two methods. The solid line depicts the first interest rate factor, while the dotted line depicts the second interest risk factor.

[Figure 2 about here.]

The estimates on  $\gamma_0$  measure the constant portion of the market price. The estimates for  $\gamma_0$  are negative.  $\gamma_1$  determine the proportional components of the market price. Estimates on  $\gamma_1$  are negative and insignificant from 0, which indicate that market price of risk doesn't vary significantly with the factor level. Given the

parameter estimates and the extracted interest rate factors, we can compute the market price of each factor. Figure 3 shows the market price of the two factors. The market price of the first factor is positive and for the second factor is negative. The market price of the second factor becomes more negative at the end of the sample period.

[Figure 3 about here.]

$a_r$  and  $b_r$  interact with risk-neutral factor dynamics  $\kappa^Q$  to determine both the mean term structure of the libor swap rate, measured by  $a(\tau)/\tau$ , and the factor loading across the term structure, measured by  $b(\tau)/\tau$ . Figure 4 and Figure 5 plot the mean term structure (the left panel) and loadings (the right panel) by kalman filter and exact matching respectively. The upward sloping mean term structure is consistent with the data observation. The upward solid line on the bottom panel depicts the contemporaneous response of spot rate curve to the unit shock of first factor. The downward dotted line depicts the contemporaneous response of spot rate curve to the unit shock of the second factor. As maturity increases, the response to the first factor increases and to the second factor decreases. In other words, the second factor affect short term rate more than long term rate, but in the same direction. Therefore, the second factor could represent a level factor in PCA.

[Figure 4 about here.]

[Figure 5 about here.]

By Kalman Filter, the response to the first factor is greater than to the second factor only at longer maturities. By exact matching, the response to the first factor is always less than to the second factor. By

both methods, the responses to the two factors are always positive. Since the first factor is very persistent under risk-neutral measure  $\mathbb{Q}$ , the response to the first factor persists as maturity increases. In contrast, the second factor is less persistent, so its impact declines quickly as maturities increase. Compared with the mean term structure, yield curve is flattened by the two factors. In sum, my results suggest that during the sample period, short term rate is largely determined by the second factor, whereas long term rate varies with both factors.

The default process estimation is performed for each of the 100 reference entities. Appendix C report the parameter estimates that determine the one-factor default arrival dynamics and the term structure on the CDS for each reference entity. Table 7 and table 8 summarize the estimates by rating groups and by industry sector. The estimates vary widely. Figure 6 shows the distribution of these parameter estimates.

[Figure 6 about here.]

[Figure 7 about here.]

$\kappa_{xy}$  governs the predictive power of interest risk factors on the default risk factor. The estimates on the first element of  $\kappa_{xy}$  range from -0.0308 (Burlington Northern Santa Fe Corporation) to 0.0916 (Eastman Chemical Company). Let  $\kappa_{xy}(1)$  and  $\kappa_{xy}(2)$  denote the first and second elements of  $\kappa_{xy}$ . 82 of 100 firms have a negative estimates of  $\kappa_{xy}(1)$ . This happens especially in financial firms. 17 out of 18 financial firms carry a negative estimated value of  $\kappa_{xy}(1)$ . Such result means that positive shock of the first interest rate factor will have a positive effect on the subsequent move of the default risk factor for most reference entities, especially financial firms. In other words, positive shock of the first interest rate factor will more likely increase subsequent credit default spreads.

The estimates on the second element of  $\kappa_{xy}$  range from -0.0691 (Eastman Chemical Company) to 0.0462 (Marsh & McLennan Companies Inc.). 81 out of 100 estimates on  $\kappa_{xy}(2)$  are positive, which means that positive shock of the second interest rate factor will have a negative effect on the subsequent move of the default risk factor for most of the companies, narrowing credit default spreads. 12 out of 13 energy firms, 17 out of 18 financial firms carry a positive  $\kappa_{xy}(2)$ . And 39 out 40 firms in the high rating group are associated with a positive value of  $\kappa_{xy}(2)$ . Increase in the second interest factor is more likely to decrease the subsequent credit risk factor, lowering CDS spread subsequently for most companies.

The vector  $b_i$  captures the contemporaneous impact of the interest rate factors on the default arrival rate  $\lambda_i$ .  $b_i(1)$  and  $b_i(2)$  are the first and second element of  $b_i$ .  $b_i(1)$  ranges from -0.0053 (Eastman Chemical) to 0.0029 (Marriott International), whereas  $b_i(2)$  ranges from -0.0060 (Marriott International) to 0.012 (Anadarko Petroleum). 93 out of 100 estimates on the first element of  $b_i$  are reported negative, whereas 89

out of 100 estimates on the second element are positive. Such results indicate that for most reference entities positive shock on the first interest rate factor will decrease the default arrival rate at the moment, while positive shock on the second interest rate factor will increase the default arrival rate at the moment. No energy firms have a positive  $b_i(1)$ , and no financial firms have a negative  $b_i(2)$ .  $\kappa_{xy}$  and  $b_i$  together determine the complicated dynamic interactions between the interest rate factors and default arrival rate.

Most of the estimates on  $\kappa_y$  are very small, which shows a near unit root behavior for the default risk factor. Only two of the estimates on  $\kappa_y$  are significantly greater than others. They are 0.036 (Autozone) and 0.010 (Residential Capital). The mean of  $c_i$  for high rating group is 0.0159, ranging from 0.0075 (E. I. du Pont de Nemours and Company) to 0.0446 (Walt Disney). The mean for low rating group is 0.0257, ranging from 0.0123 (CIGNA) to 0.0508 (Radioshack). This shows that CDS default process for the high rating companies is less responded to the default risk factor. The distribution of the estimated value for  $c_i$  does not show any noticeable difference among different industries. The estimate of  $c_i$  is larger than  $b_i$  in magnitude. Thus the default risk factor affect the default arrival rate more than interest risk factors with the same level of shock. It indicates that most part of the shock on interest rate factors will be sent to the default process indirectly through their impact on subsequent move of the credit risk factor.

The estimates on  $\gamma_0$  measure the constant portion of the market price, and the estimates on  $\gamma_1$  determine the proportional components on default risk factor of the market price. All the estimates of  $\gamma_0$  here are negative, ranging from -0.3354 (Radioshack) to -0.0871 (Eastman Chemical). The estimates of  $\gamma_1$  on 93 firms are positive, with 0.3271 (International Paper Company) as the largest and -0.5536 (Federated Department Stores) as the smallest.

Appendix D lists the CDS model pricing error for all the reference entities. Table 9 reports the summary statistics of the CDS pricing error. Due to the methodology used, when the spread of other maturity does

not move with the 5-year, we will expect a larger pricing error. The pricing error for 3-year CDS spread is the largest. We can see that 3-year CDS is not as liquid as longer terms, because the weekly price updates are less than other maturities. This indicates that its default process may include another liquidity factor.

In this work, I test a three-factor (two factor for interest rate risk and one factor for default risk) CDS spread term structure model using CDS spreads quotes for 100 companies. The 100 companies are classified into 2 rating groups and 5 industry sectors. The estimation result shows intricate interaction between interest rate factor and credit risk factor in determining the default process. Although estimation results differ within rating group and industry sector, there are some similar patterns among most of the companies.

- $\kappa_{xy}(1) < 0$  and  $\kappa_{xy}(2) > 0$  for most companies. Positive shock of the first interest rate factor will increase default risk subsequently, therefore increase CDS spreads. The second interest rate factor plays the opposite role. Positive shock of the second interest rate factor will lower the subsequent default risk, therefore narrows the CDS spreads.
- $b_i(1) < 0$  and  $b_i(2) > 0$  for most companies. Positive shock on the first interest rate factor will decrease the default arrival rate at the moment, while positive shock on the second interest rate factor will increase the default arrival rate at the moment.
- Magnitude of  $c_i$  is greater than  $b_i$  for all companies. Most part of the shock on interest rate factors will be sent to the default process indirectly through their impact on subsequent move of the credit risk factor. Estimates on  $c_i$  of high rating group are generally lower than those of low rating group, which means CDS spreads of high rating companies are less responded to the default risk factor.

## 7. Conclusion

The paper examines the determinants of the dynamics and term structure of credit default swap (CDS) spreads. I focus on roles of the interest rate risk and default risk. I extract interest rate factors from libor-swap curve, based on affine models. With a large data set, I test a three-factor CDS spread term structure model for 100 companies, using exact matching technique. The factors consist of two interest rate factors and one default risk factor. The estimation shows intricate interaction between interest rate factor and credit risk factor in determining the default process. I find that positive shock of the first interest rate factor will increase subsequent default risk factor, while positive shock on the second interest rate factor will decrease the subsequent default risk factor. In terms of direct effect of interest rate factors on the default process, positive shock on the first interest rate factor will decrease the default arrival rate at the moment, while positive shock on the second interest rate factor will increase the default arrival rate at the moment. Most of the effects of the shocks to interest rate factors will be sent to the default process indirectly through their impact on the subsequent move of the credit risk factor. CDS spreads of high credit rating companies are less responsive to the shocks on default risk than those of low credit rating companies. The work enhances our understanding of the process which underlies the CDS spreads movement and regimes. Such knowledge is essential for CDS pricing, risk measurement and management, hedging the related risk.

**Table 1****Summary statistics of libor and swap rates**

Entries report the summary statistics of U.S. dollar libor at 12-month maturity and swap rates at two to ten years. Mean, Std, Skew, Kurtosis and Auto denote the sample estimates of the mean, standard deviation, skewness, excess kurtosis, and the first-order autocorrelation, respectively. Data are weekly from Jan.3, 2005 to Mar.30, 2007.

Maturity	Mean	Std	Skew	Kurtosis	Auto
1	4.747	0.739	-0.636	-0.982	0.975
2	4.775	0.581	-0.519	-0.912	0.969
3	4.803	0.512	-0.406	-0.854	0.965
4	4.840	0.475	-0.303	-0.846	0.965
5	4.880	0.449	-0.218	-0.844	0.964
6	4.917	0.429	-0.146	-0.828	0.965
7	4.951	0.412	-0.088	-0.792	0.965
8	4.983	0.397	-0.034	-0.750	0.965
9	5.014	0.384	0.011	-0.707	0.965
10	5.044	0.372	0.045	-0.657	0.964

**Table 2****Principal component analysis results for libor swap rates**

Entries report eigenvalue, proportion of the explained variance, cumulative proportion of the explained variance and eigenvector from principal component analysis on libor and swap rates weekly series. Sample period is Jan. 3, 2005 to Mar. 30, 2007.

<i>n</i> th	1	2	3	4	5
Eigenvalue	2.288	0.077	0.004	0.000	0.000
Proportion	0.966	0.033	0.002	0.000	0.000
Cumulative	0.966	0.998	0.999	1.000	1.000
Eigenvector	0.471	0.687	-0.497	0.236	-0.053
	0.381	0.246	0.315	-0.715	0.394
	0.338	0.053	0.440	-0.068	-0.584
	0.313	-0.066	0.357	0.306	-0.307
	0.296	-0.147	0.222	0.349	0.283
	0.281	-0.209	0.067	0.245	0.344
	0.268	-0.257	-0.066	0.142	0.283
	0.257	-0.298	-0.188	-0.021	0.066
	0.246	-0.332	-0.296	-0.161	-0.103
	0.236	-0.361	-0.389	-0.325	-0.337

**Table 3****Summary statistics of CDS spreads**

Entries report the mean, standard deviation, minimum and maximum of the summary statistics on CDS spreads weekly series (Appendix B) across all sample companies. Mat, Mean, Std, Min and Max denote maturity, mean, standard deviation, minimum and maximum respectively. The sample period of CDS spreads is Jan.3, 2005 to Mar.30, 2007.

Mat	1	2	3	4	5	6	7	8	9	10
Mean of CDS Spreads										
Mean	9.95	15.40	21.33	30.29	38.37	44.41	50.01	54.26	58.23	62.07
Std	8.88	11.78	14.80	18.54	22.12	24.57	26.34	27.82	28.95	29.67
Min	3.47	4.43	5.67	7.77	10.91	11.54	16.55	14.80	16.25	22.26
Max	77.26	99.30	109.56	118.10	126.99	132.75	138.71	146.18	153.06	158.98
Standard Deviation of CDS Spreads										
Mean	4.90	5.82	7.47	9.18	11.05	11.86	12.77	13.39	14.00	14.59
Std	5.34	4.38	5.40	6.09	7.07	7.57	7.91	8.09	8.19	8.23
Min	0.24	0.14	1.95	2.78	3.35	3.89	4.51	5.08	5.73	6.28
Max	39.36	31.88	32.59	36.86	41.94	44.06	48.19	49.77	51.30	52.62
Skewness of CDS Spreads										
Mean	0.47	0.57	0.64	0.45	0.35	0.24	0.20	0.18	0.16	0.17
Std	1.06	0.90	0.71	0.67	0.61	0.61	0.61	0.61	0.60	0.61
Min	-1.31	-3.61	-0.72	-1.19	-1.16	-1.43	-1.41	-1.41	-1.37	-1.32
Max	4.67	3.37	3.44	2.96	2.40	2.27	2.15	2.12	2.05	1.99
Kurtosis of the CDS Spreads										
Mean	0.66	0.61	0.85	0.52	0.36	0.18	0.15	0.10	0.07	0.06
Std	4.44	4.21	2.49	2.14	1.73	1.59	1.47	1.45	1.46	1.46
Min	-1.94	-1.90	-1.35	-1.41	-1.50	-1.56	-1.58	-1.60	-1.60	-1.60
Max	24.71	37.00	17.02	13.59	9.08	8.89	8.30	7.38	7.37	7.97
Autocorrelation of CDS Spreads										
Mean	0.89	0.88	0.86	0.91	0.92	0.92	0.92	0.92	0.92	0.92
Std	0.11	0.09	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Min	0.27	0.17	0.66	0.72	0.71	0.71	0.73	0.73	0.73	0.73
Max	0.97	0.97	0.95	0.96	0.98	0.98	0.97	0.98	0.98	0.98

**Table 4****Summary statistics of the pricing error on libor and swap rates by kalman filter**

Entries report the summary statistics of the pricing errors on the U.S.dollar libor and swap rates under two-factor affine model by kalman filter. The pricing error is defined as difference between the observed interest rate quotes and the model implied fair values, in basis points. Mean, Std, Auto, Max and VR denote the sample estimates of the mean, standard deviation, first-order autocorrelation, maximum absolute error and the explained percentage variance, which is one minus the ratio of pricing error variance to the interest rate variance in percentage, respectively. The last row reports the maximized log likelihood for the model.

Maturity	Mean	Std	Auto	Max	VR
1	-2.757	21.181	0.914	53.081	91.784
2	1.485	7.073	0.943	16.282	98.519
3	0.125	2.235	0.875	5.969	99.809
4	-0.195	0.670	0.626	2.040	99.980
5	-0.011	0.120	0.494	0.484	99.999
6	0.079	0.219	0.259	1.284	99.997
7	0.027	0.203	0.505	0.687	99.998
8	-0.029	0.088	0.118	0.421	100.000
9	-0.024	0.238	0.217	0.749	99.996
10	0.136	0.378	0.531	1.301	99.990
Average	-0.116	3.214	0.548	8.230	99.007
L			4354.436		

**Table 5****Summary statistics of the pricing error on libor and swap rates by exact matching**

Entries report the summary statistics of the pricing errors on the U.S.dollar libor and swap rates under two-factor affine model by exact matching. The pricing error is defined as difference between the observed interest rate quotes and the model implied fair values, in basis points. Mean, Std, Auto, Max and VR denote the sample estimates of the mean, standard deviation, first-order autocorrelation, maximum absolute error and the explained percentage variance, which is one minus the ratio of pricing error variance to the interest rate variance in percentage, respectively. The last row reports the maximized log likelihood for the model.

Maturity	Mean	Std	Auto	Max	VR
1	-4.999	22.682	0.925	56.486	90.579
2	0.270	7.972	0.953	18.914	98.119
3	-0.440	2.680	0.904	7.561	99.726
4	-0.379	0.838	0.684	3.040	99.969
5	-0.011	0.020	0.261	0.101	100.000
6	0.128	0.298	0.441	1.335	99.995
7	0.047	0.350	0.600	1.053	99.993
8	-0.069	0.308	0.491	0.827	99.994
9	-0.114	0.308	0.029	1.128	99.994
10	0.033	0.056	0.443	0.180	100.000
Average	-0.553	3.551	0.573	9.063	98.837
L			4553.172		

**Table 6****Dynamics and term structure of libor swap rates**

Entries report the parameter estimates and the absolute magnitude of the t-statistics (in parentheses) that govern the dynamics and term structure of the libor swap rates by kalman filter and by exact matching.

Model	$\kappa_x$		$\gamma_{x0}$	$\gamma_{x1}$	$a_r$	$b_r$
Kalman Filter	0.0464	0	-0.0836	-0.1064		0.0000
	(7.50)	–	(-0.29)	(-0.08)	0.0299	(0.00)
Exact Matching	-0.2399	0.2072	-0.6813	-1.4177	(2.04)	0.0079
	(-6.72)	(25.53)	(-0.52)	(-1.29)		(9.77)
Exact Matching	0.0776	0	-0.0143	-0.0695		0.0002
	(9.77)	–	(-11.10)	(-0.08)	0.0347	(0.43)
Exact Matching	-0.1952	0.1300	-0.4404	-1.5159	(63.46)	0.0148
	(-25.62)	(10.54)	(-34.63)	(-0.81)		(46.64)

**Table 7****Summary statistics on estimated parameters in the CDS model I**

Entries report the mean, standard deviation, minimum and maximum of the estimated parameters across all the sample companies (Appendix C) in the CDS pricing model. Those statistics are also reported by rating groups. Mean, Std, Min and Max denote mean, standard deviation, minimum and maximum respectively. The sample period of CDS spreads is Jan. 3, 2005 to Mar. 30, 2007.

	$\kappa_{xy}$	$\kappa_y$	$\gamma_{y0}$	$\gamma_{y1}$	$a_i$	$b_i$	$c_i$		
All Reference Entities									
Mean	-0.0033	0.0118	0.0009	-0.2087	0.0695	0.0114	-0.0006	0.0001	0.0215
Std	0.0155	0.0185	0.0040	0.0393	0.0926	0.0158	0.0008	0.0011	0.0087
Min	-0.0308	-0.0691	0.0000	-0.3354	-0.5536	0.0000	-0.0053	-0.0060	0.0075
Max	0.0916	0.0462	0.0367	-0.0871	0.3271	0.0712	0.0029	0.0012	0.0508
High Rating Group									
Mean	-0.0070	0.0194	0.0006	-0.1896	0.0728	0.0149	-0.0005	0.0004	0.0152
Std	0.0054	0.0091	0.0015	0.0256	0.0400	0.0195	0.0003	0.0003	0.0044
Min	-0.0217	-0.0022	0.0000	-0.2462	-0.0658	0.0000	-0.0011	-0.0001	0.0075
Max	0.0095	0.0453	0.0065	-0.1377	0.1596	0.0712	0.0004	0.0011	0.0243
Low Rating Group									
Mean	-0.0008	0.0068	0.0011	-0.2215	0.0673	0.0090	-0.0007	-0.0000	0.0258
Std	0.0193	0.0213	0.0050	0.0418	0.1154	0.0125	0.0010	0.0014	0.0084
Min	-0.0308	-0.0691	0.0000	-0.3354	-0.5536	0.0000	-0.0053	-0.0060	0.0123
Max	0.0916	0.0462	0.0367	-0.0871	0.3271	0.0599	0.0029	0.0012	0.0508

**Table 8****Summary statistics on estimated parameters in the CDS model II**

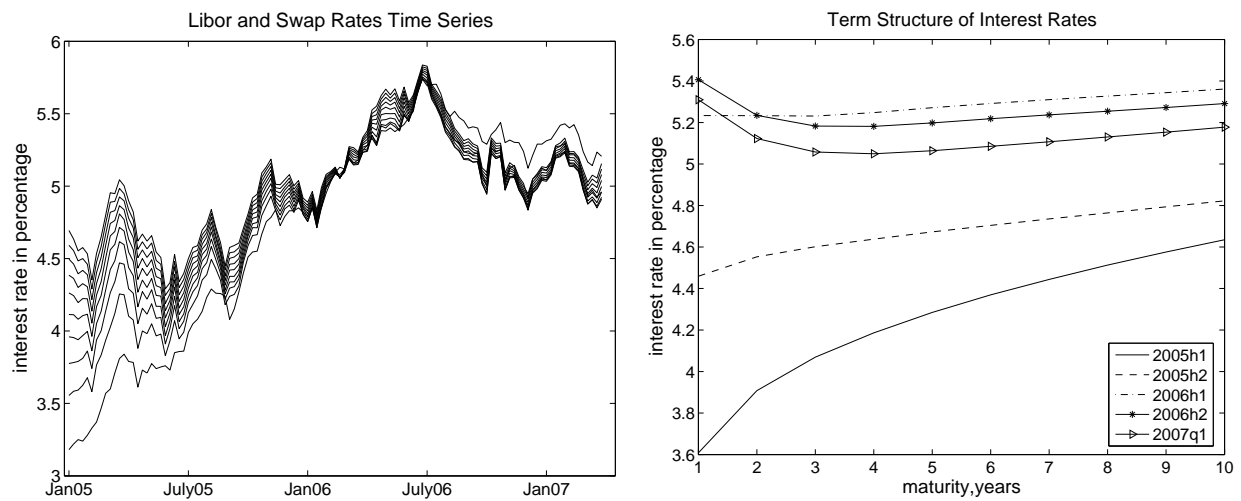
Entries report the mean, standard deviation, minimum and maximum of the estimated parameters across the sample companies (Appendix C) by industry in the CDS pricing model. Mean, Std, Min and Max denote mean, standard deviation, minimum and maximum respectively. The sample period of CDS spreads is Jan.3, 2005 to Mar.30, 2007.

	$\kappa_{xy}$	$\kappa_y$	$\gamma_{y0}$	$\gamma_{y1}$	$a_i$	$b_i$	$c_i$		
Consumer									
Mean	-0.0031	0.0143	0.0016	-0.2239	0.0303	0.0110	-0.0006	-0.0001	0.0238
Std	0.0139	0.0147	0.0068	0.0460	0.1334	0.0181	0.0008	0.0017	0.0110
Min	-0.0217	-0.0225	0.0000	-0.3354	-0.5536	0.0000	-0.0023	-0.0060	0.0097
Max	0.0350	0.0401	0.0367	-0.1475	0.1529	0.0712	0.0029	0.0011	0.0508
Energy									
Mean	-0.0062	0.0134	0.0001	-0.1971	0.0957	0.0035	-0.0010	0.0001	0.0211
Std	0.0089	0.0080	0.0001	0.0154	0.0607	0.0047	0.0006	0.0009	0.0043
Min	-0.0199	-0.0040	0.0000	-0.2236	-0.0015	0.0001	-0.0022	-0.0027	0.0099
Max	0.0097	0.0282	0.0005	-0.1756	0.2289	0.0137	-0.0005	0.0009	0.0255
Financial									
Mean	-0.0073	0.0176	0.0012	-0.1817	0.0625	0.0152	-0.0005	0.0004	0.0174
Std	0.0035	0.0106	0.0026	0.0355	0.0226	0.0197	0.0002	0.0002	0.0067
Min	-0.0144	-0.0022	0.0000	-0.2698	0.0343	0.0000	-0.0009	-0.0000	0.0079
Max	0.0019	0.0462	0.0100	-0.1377	0.1153	0.0504	-0.0000	0.0007	0.0379
Industrial									
Mean	0.0001	0.0101	0.0005	-0.2089	0.1057	0.0144	-0.0006	0.0003	0.0227
Std	0.0240	0.0265	0.0011	0.0354	0.0802	0.0161	0.0011	0.0009	0.0088
Min	-0.0308	-0.0691	0.0000	-0.2776	0.0006	0.0000	-0.0053	-0.0038	0.0075
Max	0.0916	0.0453	0.0038	-0.0871	0.3271	0.0606	0.0010	0.0011	0.0434
TMT									
Mean	-0.0021	0.0002	0.0008	-0.2226	0.0710	0.0087	-0.0006	0.0002	0.0202
Std	0.0129	0.0195	0.0018	0.0313	0.0489	0.0068	0.0004	0.0006	0.0071
Min	-0.0129	-0.0407	0.0000	-0.2931	-0.0608	0.0000	-0.0010	-0.0013	0.0098
Max	0.0291	0.0194	0.0065	-0.1670	0.1363	0.0179	0.0007	0.0012	0.0325

**Table 9****Summary statistics on the CDS spreads pricing error**

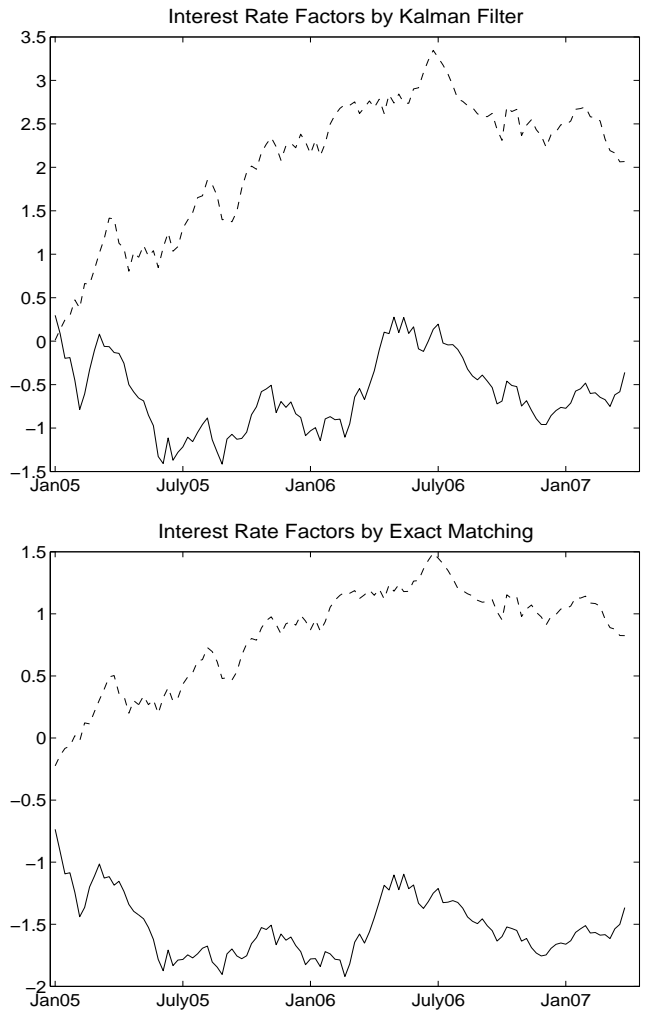
Entries report the mean, standard deviation, minimum and maximum of the summary statistics on CDS pricing error (Appendix D) across all sample companies. Mat, Mean, Std, Min and Max denote maturity, mean, standard deviation, minimum and maximum respectively. The sample period of CDS spreads is Jan.3, 2005 to Mar.30, 2007.

Mat	3	4	5	6	7	8	9	10
Mean of Pricing Error								
Mean	-0.44	-0.32	-0.00	-0.45	-0.39	-0.56	-0.13	1.01
Std	1.84	1.27	0.00	1.37	0.88	1.63	1.68	1.58
Min	-7.39	-8.25	-0.02	-10.84	-4.47	-12.26	-12.54	-1.82
Max	5.62	2.03	0.00	0.92	1.57	1.18	4.14	9.84
Standard Deviation of Pricing Error								
Mean	5.27	3.33	0.01	2.08	3.45	4.06	4.73	5.44
Std	3.17	1.99	0.01	1.24	1.95	2.39	2.73	3.00
Min	1.98	1.05	0.00	0.67	1.27	1.00	1.40	2.13
Max	20.79	11.20	0.03	6.91	12.72	15.14	17.00	18.52
Autocorrelation of Pricing Error								
Mean	0.71	0.57	0.11	0.52	0.56	0.65	0.71	0.73
Std	0.12	0.16	0.30	0.19	0.18	0.17	0.15	0.14
Min	0.36	0.23	-0.30	0.06	0.17	0.22	0.28	0.30
Max	0.91	0.86	0.96	0.94	0.86	0.90	0.91	0.93
Maximum of Absolute Pricing Error								
Mean	18.68	13.96	0.08	9.16	12.78	14.35	15.58	17.10
Std	12.22	10.40	0.05	7.09	8.20	8.81	9.15	9.49
Min	6.21	3.19	0.00	1.45	2.86	3.96	4.80	5.74
Max	68.18	58.77	0.22	34.22	46.43	41.65	46.41	52.56
Explained Percentage on the Variance of Pricing Error								
Mean	33.50	82.48	100.00	95.23	90.82	88.60	86.19	83.62
Std	36.94	17.89	0.00	8.44	5.86	7.24	8.14	9.12
Min	-95.76	-58.96	99.99	16.97	66.63	58.57	54.72	48.54
Max	92.09	98.19	100.00	99.74	99.25	98.97	98.59	98.15



**Figure 1**  
**Libor and Swap Rates**

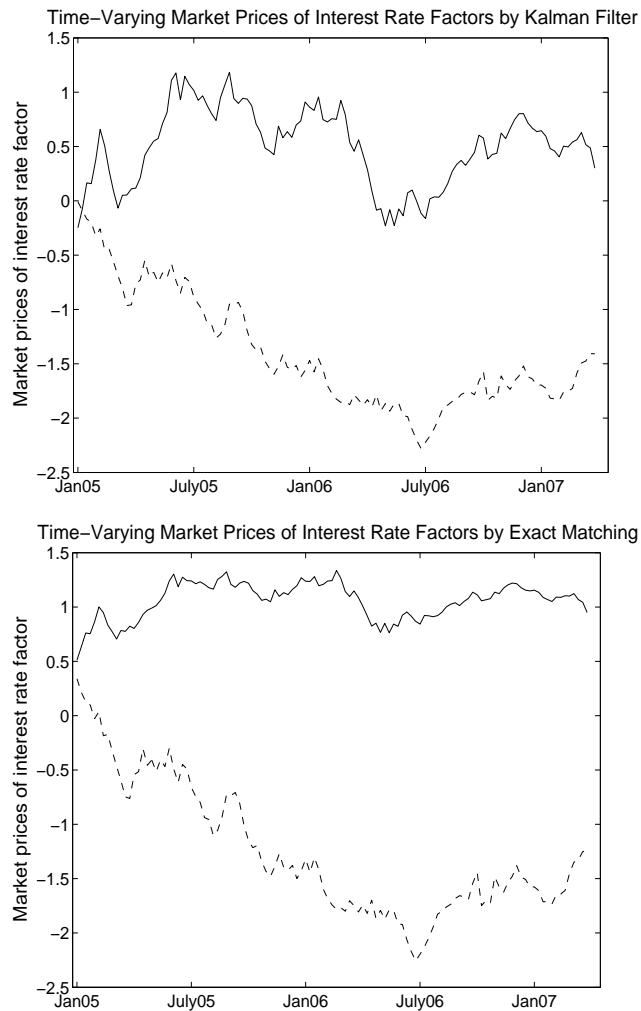
The top graph plots 12 month libor and 2-year to 10-year swap rates in weekly time series from Jan.3, 2005 to March 30, 2007. The bottom graph depicts the term structure of the average libor and swap rates in the first half of 2005, the second half of 2005, the first half and 2006, the second half of 2006, and the first quarter in 2007.



**Figure 2**

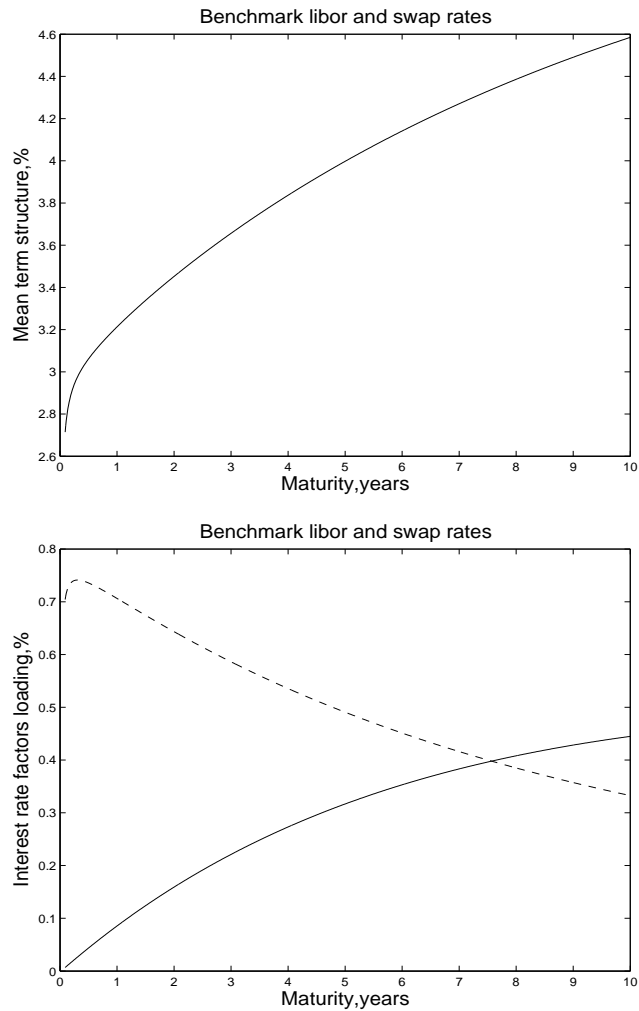
**Time series of extracted interest rate factors**

The graph at the top shows the interest rate factors extracted by Kalman Filter. The graph at the bottom shows the interest rate factors extracted by Exact Matching. In both graphs, the solid line depicts the first factor, and the dotted line depicts the second factor.



**Figure 3**  
**Time series of market price on interest rate factors**

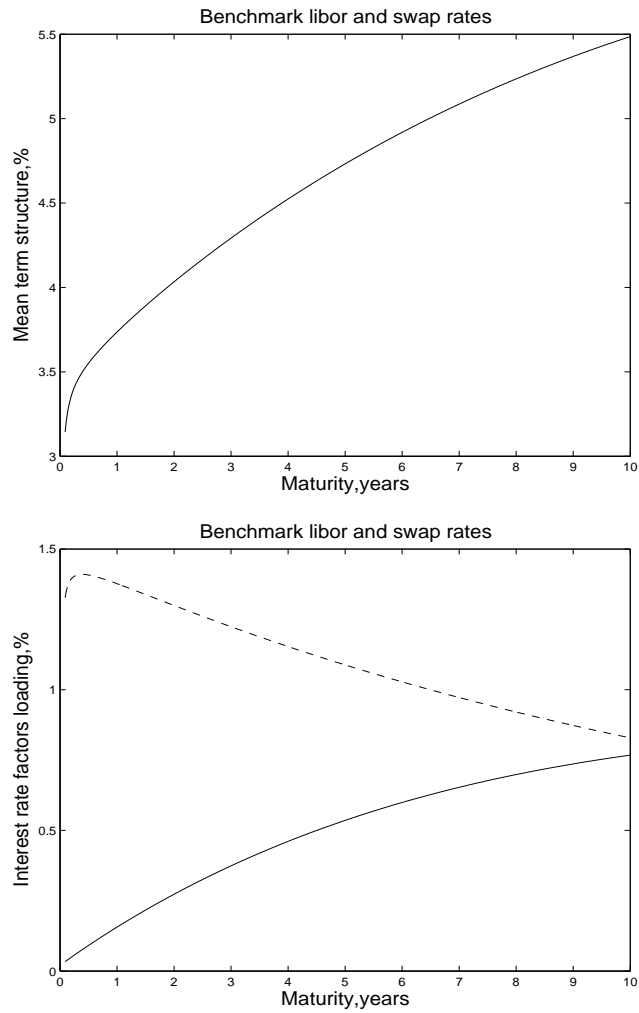
The graph at the top shows the market price of risk calibrated by Kalman Filter. The graph at the bottom shows the market price of risk calibrated by Exact Matching. In both graphs, the first solid line depicts the market price of first factor, and the dotted line depicts the market price of the second factor. For comparison and clarity, I magnify the market price of the first factor by a scale of 10.



**Figure 4**

**Mean term structure and impulse response of libor swap rate by kalman filter**

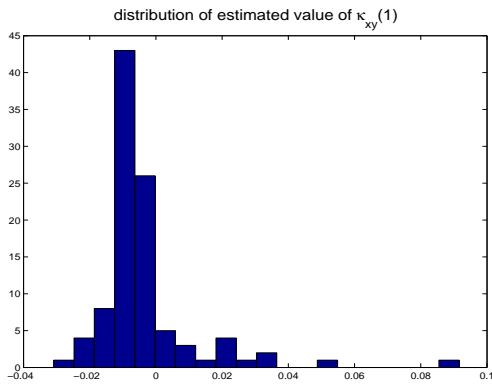
Solid line in the top graph plots the mean term structure of continuously compounded spot rate. The two lines in the bottom graph depict the contemporaneous response of the continuously compounded benchmark spot rate to unit shocks from the first(solid line) and second (dashed line) interest rate factors.



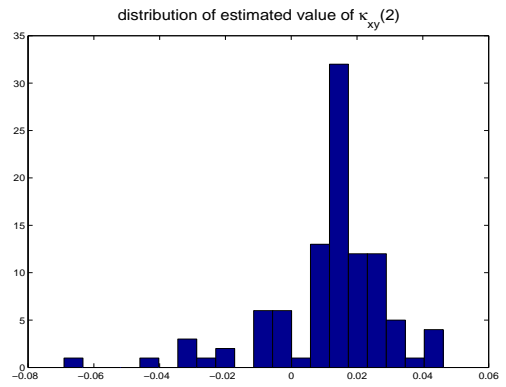
**Figure 5**

**Mean term structure and impulse response of libor swap rate by exact matching**

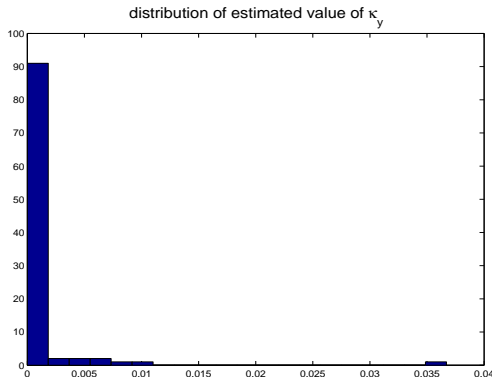
Solid line in the top graph plots the mean term structure of continuously compounded spot rate. The two lines in the bottom graph depict the contemporaneous response of the continuously compounded benchmark spot rate to unit shocks from the first(solid line) and second (dashed line) interest rate factors.



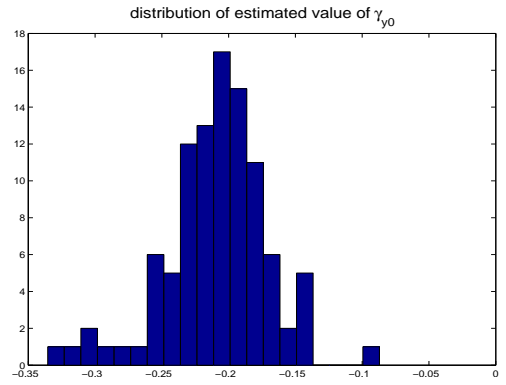
(a) Estimate of parameter  $\kappa_{xy}(1)$



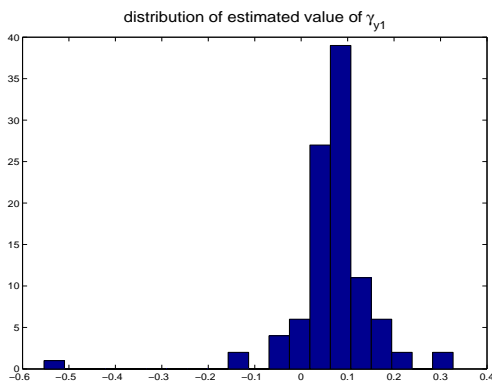
(b) Estimate of parameter  $\kappa_{xy}(2)$



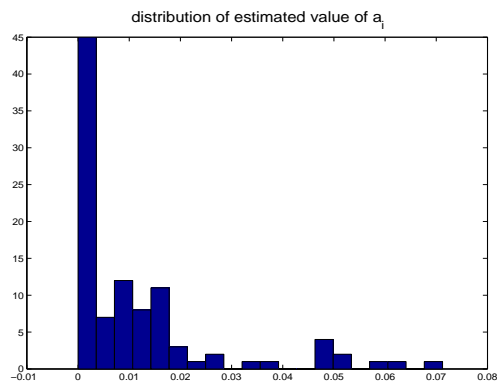
(c) Estimate of parameter  $\kappa_y$



(d) Estimate of parameter  $\gamma_{y0}$

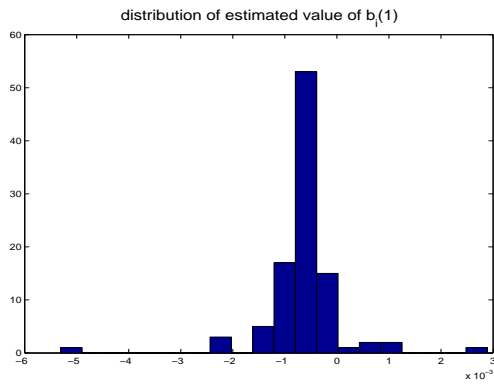


(e) Estimate of parameter  $\gamma_{y1}$

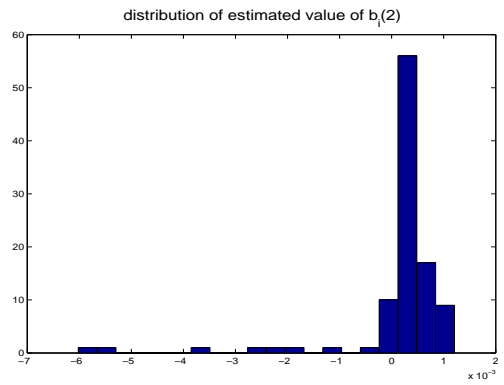


(f) Estimate of parameter  $a_i$

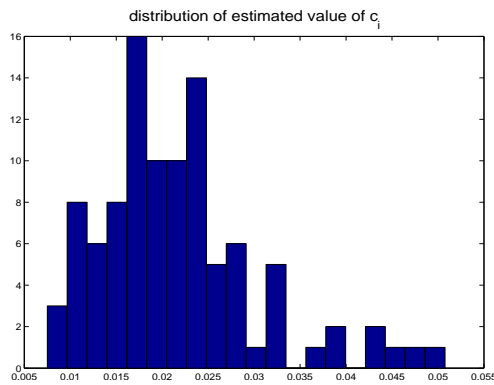
**Figure 6**  
**Distribution of estimated parameters of default arrival dynamics and term structure of CDS spreads**



(g) Estimate of parameter  $b_i(1)$



(h) Estimate of parameter  $b_i(2)$



(i) Estimate of parameter  $c_i$

**Figure 6**  
**Distribution of the estimated parameters of default arrival dynamics and term structure of credit default spreads (continued)**

# Appendix A

## List of reference entities in the sample

No.	CorpName	Ticker	Industry	Rating
1	ACE Ltd.	ACE	Financials	A
2	AT&T Inc.	T	TMT	A
3	Cingular Wireless LLC	CNG	TMT	A
4	Aetna Inc.	AET	Financials	A
5	Alcan Inc.	AL	Industrials	BBB
6	Alcoa Inc.	AA	Industrials	A
7	The Allstate Corporation	ALL	Financials	A
8	Altria Group Inc.	MO	Consumer	BBB
9	American Electric Power Company Inc.	AEP	Energy	BBB
10	American Express Company	AXP	Financials	A
11	American International Group Inc.	AIG	Financials	AA
12	Amgen Inc.	AMGN	Consumer	A
13	Anadarko Petroleum Corporation	APC	Energy	BBB
14	Arrow Electronics	ARW	TMT	BBB
15	AutoZone	AZO	Consumer	BBB
16	Baxter International Inc.	BAX	Consumer	A
17	Bristol-Myers Squibb Company	BMJ	Consumer	A
18	Burlington Northern Santa Fe Corporation	BNI	Industrials	BBB

*continued on the next page*

<i>continued from previous page</i>				
No.	CorpName	Ticker	Industry	Rating
19	CIT Group	CIT	Financials	A
20	Cox Communications Inc.	COXENT	TMT	BBB
21	CSX Corporation	CSX	Industrials	BBB
22	CVS Corporation	CVS	Consumer	BBB
23	Campbell Soup Company	CPB	Consumer	A
24	Capital One Bank	COF	Financials	A
25	Cardinal Health Inc.	CAH	Consumer	BBB
26	Carnival Corporation	CCL	Consumer	A
27	Caterpillar Inc.	CAT	Industrials	A
28	Centex Corporation	CTX	Industrials	BBB
29	CenturyTel Inc.	CTL	TMT	BBB
30	The Chubb Corporation	CB	Financials	A
31	CIGNA Corporation	CI	Financials	BBB
32	Comcast Calbe Communications LLC	CMCSA	TMT	BBB
33	ConAgra Foods Inc.	CAG	Consumer	BBB
34	Constellation Energy Group Inc.	CEG	Energy	BBB
35	Countrywide Home Loans Inc.	CFC	Financials	A
36	Deere & Company	DE	Industrials	A
37	Devon Energy Corporation	DVN	Energy	BBB
38	Dominion Resources	D	Energy	BBB
39	Duke Energy Corporation	DUK	Energy	BBB
40	E. I. du Pont de Nemours and Company	DD	Industrials	A
41	Eastman Chemical Company	EMN	Industrials	BBB
42	Federated Department Stores Inc.	FD	Consumer	BBB
43	FirstEnergy Corp.	FE	Energy	BBB
44	Federal Home Loan Mortgage Association	FHLMC	Financials	AAA
45	The Gap Inc.	GPS	Consumer	BB
46	General Electric Capital Corporation	GE	Financials	AAA
47	General Mills Inc.	GIS	Consumer	BBB
48	Goodrich Corporation	GR	Industrials	BBB
49	Halliburton Company	HAL	Energy	BBB
50	The Hartford Financial Service Group Inc.	HIG	Financials	A
51	Hewlett-Packard Company	HPQ	TMT	A
52	Honeywell International	HON	Industrials	A
53	Ingersoll-Rand Company	IR	Industrials	A
54	International Business Machines Corporation	IBM	TMT	A
55	International Lease Finance Corporation	ILFC	Financials	A
56	International Paper Company	IP	Industrials	BBB
57	Jones Apparel Group Inc.	JNY	Consumer	BBB
58	Kraft Foods Inc.	KFT	Consumer	A
59	The Kroger Co.	KR	Consumer	BBB
60	Lennar Corporation	LEN	Industrials	BBB
61	Lockheed Martin Corporation	LMT	Industrials	BBB
62	Limited Brands Inc.	LTD	Consumer	BBB

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No.	CorpName	Ticker	Industry	Rating
63	Marriott International Inc.	MAR	Consumer	BBB
64	Marsh & McLennan Companies INC.	MMC	Financials	BBB
65	McDonald's Corporation	MCD	Consumer	A
66	McKesson Corporation	MCK	Consumer	BBB
67	Motorola Inc.	MOT	TMT	BBB
68	National Rural Utilities Cooperative Finance Corporation	NRUC	Energy	A
69	Newell Rubbermaid Inc.	NWL	Consumer	BBB
70	Nordstrom Inc.	JWN	Consumer	A
71	Norfolk Southern Corporation	NSC	Industrials	BBB
72	Northrop Grumman Corporation	NOC	Industrials	BBB
73	Olin Corporation	OLN	Industrials	BBB
74	Omnicom Group Inc.	OMC	TMT	BBB
75	Progress Energy Inc.	PGN	Energy	BBB
76	Pulte Homes Inc.	PHM	Industrials	BBB
77	RadioShack Company	RSH	Consumer	BB
78	Raytheon Company	RTN	Industrials	BBB
79	Residential Capital Corporation	RESCAP	Financials	BBB
80	Rohm and Haas Company	ROH	Industrials	A
81	Safeway Inc.	SWY	Consumer	BBB
82	Sara Lee Corporation	SLE	Consumer	BBB
83	Sempra Energy	SRE	Energy	BBB
84	The Shervin-Williams Company	SHW	Industrials	A
85	Sprint Nextel Corp	S	TMT	BBB
86	Starwood Hotel & Resorts Wwide Inc.	HOT	Consumer	BB
87	Target Corporation	TGT	Consumer	A
88	Temple-Inland Inc.	TIN	Industrials	BBB
89	Textron Financial Corporation	TXT	Industrials	A
90	Time Warner Inc.	TWX	TMT	BBB
91	Transocean Inc.	RIG	Energy	BBB
92	Union Pacific Corporation	UNP	Industrials	BBB
93	Valero Energy Corporation	VLO	Energy	BBB
94	WalMart Stores Inc.	WMT	Consumer	AA
95	The Walt Disney Company	DIS	TMT	BBB
96	Wells Fargo & Company	WFC	Financials	AA
97	Weyerhaeuser Company	WY	Industrials	BBB
98	Whirlpool Corporation	WHR	Consumer	BBB
99	Wyeth	WYE	Consumer	A
100	XL Capital LTD	XL	Financials	A

# Appendix B

## Summary statistics of credit default swap spreads

Entries report the summary statistics of the credit default swap spreads (in basis point) at one year to ten years. Mat, Mean, Std, Skew, Kurtosis and Auto denote the sample estimates of the maturity, mean, standard deviation, skewness, excess kurtosis, and the first-order autocorrelation, respectively. Data are weekly from Jan.3, 2005 to April 2, 2007.

Mat	1	2	3	4	5	6	7	8	9	10
	1. ACE Ltd. (ACE)									
Mean	5.46	15.74	19.78	28.73	35.76	40.81	45.07	48.87	52.20	55.16
Std	3.04	5.55	8.70	11.00	13.12	13.98	14.76	15.35	15.89	16.37
Skew	-0.36	-0.95	0.44	0.29	0.27	0.14	0.08	0.03	-0.01	-0.04
Kurt	-1.92	-0.84	-0.80	-0.94	-0.87	-0.94	-0.97	-1.04	-1.10	-1.15
AR	0.94	0.94	0.91	0.94	0.93	0.94	0.94	0.95	0.95	0.95

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Mat	1	2	3	4	5	6	7	8	9	10
2. AT&T Inc. (T)										
Mean	7.81	10.40	14.77	21.76	28.67	36.73	43.90	49.67	54.88	59.55
Std	6.14	3.08	4.60	5.69	7.17	8.33	9.44	10.13	10.88	11.57
Skew	4.67	0.35	-0.13	-0.04	-0.15	-0.18	-0.22	-0.27	-0.32	-0.35
Kurt	24.71	-0.31	-0.86	-0.73	-0.88	-0.78	-0.65	-0.66	-0.68	-0.66
AR	0.73	0.86	0.89	0.89	0.94	0.94	0.94	0.94	0.94	0.94
3. Cingular Wireless LLC (CNG)										
Mean	4.33	7.34	10.33	15.61	20.02	26.42	32.07	36.80	41.06	44.98
Std	2.68	2.73	3.37	4.24	5.36	6.36	7.46	8.06	8.64	9.25
Skew	0.56	1.10	0.19	0.15	-0.00	-0.41	-0.66	-0.95	-1.17	-1.32
Kurt	-0.50	0.72	-0.60	-0.31	-0.45	-0.06	0.38	0.77	1.13	1.40
AR	0.93	0.81	0.89	0.93	0.96	0.96	0.95	0.95	0.95	0.94
4. Aetna Inc. (AET)										
Mean	5.78	13.43	13.88	19.86	24.49	27.99	30.93	33.79	36.68	39.31
Std	2.65	4.91	4.11	4.93	5.80	6.29	6.90	7.13	7.53	7.93
Skew	-0.36	-0.55	0.01	-0.24	-0.09	-0.15	-0.04	-0.20	-0.33	-0.45
Kurt	-1.92	-1.75	0.39	-0.30	-0.29	-0.42	-0.35	-0.19	-0.18	-0.18
AR	0.94	0.95	0.87	0.94	0.93	0.94	0.92	0.93	0.93	0.93
5. Alcan Inc. (AL)										
Mean	5.51	12.67	16.70	24.30	30.98	36.87	42.07	45.78	49.03	51.91
Std	2.58	7.48	6.83	7.57	9.34	10.05	11.00	11.25	11.46	11.64
Skew	0.54	0.96	1.57	1.49	1.24	1.28	1.29	1.31	1.31	1.29
Kurt	-1.56	-0.52	3.16	2.80	1.32	1.51	1.53	1.51	1.49	1.46
AR	0.95	0.96	0.81	0.88	0.92	0.92	0.92	0.92	0.92	0.92
6. Alcoa Inc. (AA)										
Mean	5.66	8.84	12.39	18.09	23.43	28.33	32.80	36.17	39.21	41.90
Std	3.71	3.90	4.44	5.53	6.93	7.63	8.67	8.90	9.18	9.45
Skew	2.17	1.84	1.68	1.73	1.70	1.48	1.28	1.30	1.30	1.32
Kurt	6.16	3.94	4.89	5.97	4.91	3.77	2.43	2.37	2.25	2.18
AR	0.86	0.78	0.70	0.81	0.84	0.88	0.88	0.88	0.88	0.88
7. The Allstate Corporation (ALL)										
Mean	4.99	12.21	11.04	16.16	20.11	23.39	26.22	28.75	31.03	33.11
Std	2.83	4.55	3.83	4.85	6.12	6.43	6.87	7.17	7.48	7.79
Skew	1.27	-0.74	0.28	-0.09	-0.13	-0.34	-0.42	-0.55	-0.61	-0.64
Kurt	4.43	-0.37	-1.14	-1.03	-0.52	-0.47	-0.49	-0.51	-0.48	-0.43
AR	0.88	0.84	0.86	0.94	0.91	0.95	0.95	0.95	0.95	0.94
8. Altria Group Inc. (MO)										
Mean	26.15	36.73	47.12	56.98	65.37	71.43	76.92	81.35	85.33	88.96
Std	14.84	20.06	25.73	29.12	32.13	33.37	34.66	35.47	36.14	36.73
Skew	0.99	0.70	0.47	0.35	0.29	0.29	0.31	0.32	0.32	0.33
Kurt	1.34	0.26	-0.73	-1.00	-1.15	-1.20	-1.21	-1.24	-1.26	-1.28
AR	0.89	0.92	0.95	0.96	0.97	0.97	0.97	0.97	0.97	0.97

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Mat	1	2	3	4	5	6	7	8	9	10
9. American Electric Power Company, Inc. (AEP)										
Mean	8.89	11.01	19.26	27.24	34.34	38.97	42.99	46.66	49.96	52.97
Std	1.62	2.94	6.10	7.59	8.81	9.95	10.65	11.04	11.54	12.03
Skew	1.17	0.58	-0.72	-1.19	-1.16	-1.43	-1.41	-1.41	-1.37	-1.32
Kurt	13.54	-0.62	-0.35	0.35	0.53	0.90	0.93	1.03	0.96	0.88
AR	0.27	0.87	0.86	0.94	0.94	0.95	0.95	0.95	0.95	0.95
10. American Express Company (AXP)										
Mean	4.88	7.60	11.51	15.92	19.54	22.21	24.48	27.04	29.38	31.55
Std	1.21	1.87	3.59	5.04	6.22	6.86	7.37	8.15	8.86	9.53
Skew	-0.61	-0.45	0.20	0.05	0.03	-0.08	-0.16	-0.17	-0.18	-0.19
Kurt	-1.12	-1.01	0.16	-0.32	-0.51	-0.64	-0.72	-0.77	-0.80	-0.82
AR	0.84	0.90	0.92	0.96	0.97	0.98	0.97	0.98	0.98	0.98
11. American International Group, Inc. (AIG)										
Mean	5.83	9.49	12.07	16.93	20.13	23.60	26.06	28.50	30.69	32.68
Std	1.85	4.16	6.36	7.84	9.11	9.52	10.04	10.48	10.87	11.25
Skew	0.96	1.38	1.35	1.20	0.94	0.81	0.68	0.61	0.56	0.51
Kurt	-0.15	0.53	1.04	0.94	0.46	0.16	-0.22	-0.29	-0.33	-0.37
AR	0.95	0.92	0.91	0.94	0.95	0.95	0.96	0.97	0.97	0.97
12. Amgen Inc. (AMGN)										
Mean	3.58	5.19	8.44	12.05	14.91	17.79	20.36	22.89	25.14	27.20
Std	2.03	1.73	3.15	4.14	4.95	5.48	5.96	6.86	7.65	8.45
Skew	-0.42	0.70	0.06	0.08	0.15	-0.09	-0.26	-0.21	-0.20	-0.16
Kurt	-1.88	-1.30	-0.14	-0.44	-0.70	-0.85	-0.93	-0.86	-0.91	-0.96
AR	0.95	0.96	0.89	0.94	0.96	0.96	0.95	0.96	0.96	0.96
13. Anadarko Petroleum Corporation (APC)										
Mean	10.61	13.76	17.83	26.86	34.41	40.64	45.97	50.59	54.78	58.63
Std	4.64	4.38	5.02	6.24	8.08	8.66	9.17	9.78	10.41	11.10
Skew	0.66	0.76	0.06	0.46	0.97	0.66	0.40	0.33	0.28	0.23
Kurt	-0.88	-0.46	-0.23	0.25	1.60	0.90	0.41	0.20	-0.04	-0.28
AR	0.95	0.93	0.87	0.88	0.87	0.87	0.87	0.87	0.87	0.88
14. Arrow Electronics (ARW)										
Mean	21.04	23.89	33.45	49.33	63.00	72.83	81.50	88.05	93.86	99.05
Std	15.58	8.03	11.19	11.57	12.03	11.26	10.50	10.49	10.59	10.78
Skew	2.19	0.36	0.63	0.14	-0.29	-0.18	0.07	0.08	0.12	0.17
Kurt	3.53	-1.33	-0.03	-0.45	-0.60	-0.36	-0.12	-0.07	-0.01	0.05
AR	0.91	0.91	0.90	0.91	0.92	0.90	0.87	0.87	0.85	0.83
15. AutoZone (AZO)										
Mean	14.84	22.58	37.15	54.14	68.91	78.77	87.07	93.85	99.88	105.29
Std	6.27	7.92	12.18	15.39	18.41	18.27	18.25	18.19	18.27	18.31
Skew	0.62	0.90	-0.21	-0.28	-0.30	-0.36	-0.37	-0.35	-0.31	-0.26
Kurt	-0.94	0.79	-0.88	-0.89	-0.77	-0.73	-0.66	-0.63	-0.58	-0.52
AR	0.96	0.88	0.88	0.92	0.92	0.92	0.91	0.91	0.91	0.91

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Mat	1	2	3	4	5	6	7	8	9	10
16. Baxter International Inc. (BAX )										
Mean	4.68	9.46	11.62	17.46	21.57	25.42	28.61	32.23	35.55	38.58
Std	2.77	4.81	4.44	5.74	6.90	7.38	7.75	8.58	9.46	10.33
Skew	-0.35	-0.55	-0.38	-0.66	-0.77	-0.93	-1.01	-1.04	-1.02	-0.99
Kurt	-1.93	-1.75	-0.91	-0.68	-0.60	-0.39	-0.21	-0.17	-0.18	-0.22
AR	0.95	0.95	0.94	0.94	0.95	0.96	0.95	0.96	0.96	0.96
17. Bristol-Myers Squibb Company (BMY )										
Mean	3.49	7.82	8.64	13.83	17.21	21.12	24.45	27.90	31.00	33.83
Std	2.09	2.89	2.65	3.74	4.86	5.68	6.43	7.16	7.92	8.71
Skew	-0.36	-0.69	0.14	0.04	-0.06	-0.09	-0.05	-0.12	-0.16	-0.19
Kurt	-1.93	-1.10	-1.12	-1.36	-1.22	-1.19	-1.11	-1.23	-1.30	-1.34
AR	0.95	0.97	0.81	0.90	0.93	0.94	0.94	0.95	0.95	0.96
18. Burlington Northern Santa Fe Corporation (BNI )										
Mean	4.15	9.50	12.90	19.72	25.62	31.37	36.31	40.48	44.10	47.37
Std	2.82	3.94	3.45	5.24	6.95	8.03	8.99	9.86	10.45	10.98
Skew	0.17	0.50	1.87	1.77	1.42	1.23	1.14	1.19	1.14	1.09
Kurt	-1.68	-1.15	4.09	4.27	2.54	1.44	1.08	1.39	1.26	1.20
AR	0.95	0.95	0.83	0.86	0.89	0.90	0.90	0.90	0.89	0.89
19. CIT Group (CIT )										
Mean	8.31	14.48	18.64	25.26	30.94	34.57	37.56	41.41	44.90	48.10
Std	1.86	7.95	4.32	5.46	6.47	6.51	6.54	6.93	7.31	7.68
Skew	0.05	3.37	0.82	0.89	0.76	0.72	0.70	0.70	0.70	0.71
Kurt	1.36	10.37	1.05	0.38	-0.09	0.02	0.16	0.20	0.24	0.27
AR	0.80	0.85	0.85	0.90	0.91	0.91	0.89	0.90	0.91	0.92
20. Cox Communications, Inc. (COXENT)										
Mean	10.64	21.47	30.18	44.63	56.73	65.86	73.74	80.32	86.19	91.57
Std	5.75	6.80	9.36	11.63	14.06	14.56	15.05	15.31	15.56	15.82
Skew	-0.41	0.09	-0.69	-1.01	-1.06	-1.05	-1.04	-1.06	-1.07	-1.09
Kurt	-0.60	-0.16	-0.35	-0.11	-0.02	0.08	0.16	0.30	0.42	0.57
AR	0.92	0.81	0.92	0.94	0.95	0.94	0.93	0.94	0.93	0.93
21. CSX Corporation (CSX )										
Mean	6.78	11.24	16.51	25.36	33.22	39.27	44.38	48.84	52.76	56.27
Std	4.05	4.90	5.32	7.30	9.52	10.65	11.69	12.35	12.94	13.47
Skew	0.62	0.69	1.22	1.09	1.11	1.06	1.06	1.08	1.10	1.12
Kurt	-0.79	0.62	1.30	1.68	2.14	1.77	1.82	2.00	2.16	2.32
AR	0.94	0.95	0.85	0.86	0.88	0.88	0.86	0.86	0.86	0.85
22. CVS Corporation (CVS )										
Mean	7.27	10.55	15.18	22.01	28.03	33.85	39.01	43.74	48.03	52.02
Std	5.41	2.97	5.12	6.76	8.38	9.29	10.08	10.75	11.41	11.99
Skew	1.27	0.26	0.83	0.76	0.61	0.50	0.47	0.40	0.37	0.35
Kurt	-0.15	-1.22	-0.05	-0.18	-0.46	-0.62	-0.54	-0.68	-0.82	-0.93
AR	0.96	0.88	0.87	0.92	0.95	0.95	0.94	0.95	0.94	0.94

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Mat	1	2	3	4	5	6	7	8	9	10
23. Campbell Soup Company (CPB )										
Mean	4.10	6.97	10.40	15.69	21.41	26.15	30.33	33.88	37.22	40.28
Std	2.28	2.44	3.83	5.21	7.16	8.26	9.36	10.10	10.90	11.66
Skew	-0.51	0.73	0.58	0.65	0.37	0.23	0.15	0.11	0.08	0.06
Kurt	-1.44	-0.89	-0.28	-0.35	-0.87	-1.10	-1.20	-1.20	-1.19	-1.17
AR	0.96	0.88	0.80	0.89	0.95	0.95	0.95	0.96	0.96	0.96
24. Capital One Bank (COF )										
Mean	7.25	11.20	17.54	23.96	29.72	33.73	35.48	39.68	42.70	44.72
Std	2.02	3.58	7.99	10.27	12.35	12.98	13.80	14.52	15.19	16.13
Skew	0.59	0.09	1.07	0.70	0.52	0.42	0.64	0.39	0.37	0.58
Kurt	2.12	-1.50	1.01	-0.17	-0.46	-0.50	-0.28	-0.52	-0.50	-0.33
AR	0.79	0.93	0.93	0.95	0.96	0.96	0.96	0.95	0.95	0.97
25. Cardinal Health, Inc. (CAH )										
Mean	4.70	13.53	22.37	32.43	40.24	46.83	52.36	57.05	61.16	64.82
Std	2.80	3.96	10.82	13.35	15.31	16.02	16.66	17.11	17.49	17.83
Skew	-0.42	-0.78	1.02	0.78	0.65	0.65	0.64	0.62	0.60	0.58
Kurt	-1.83	-1.27	0.38	-0.45	-0.77	-0.89	-0.90	-0.97	-1.03	-1.07
AR	0.97	0.95	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96
26. Carnival Corporation (CCL )										
Mean	5.08	8.10	12.97	21.02	25.93	31.41	36.15	40.30	44.04	47.46
Std	1.05	2.71	2.39	4.62	5.10	5.71	6.28	6.84	7.41	7.99
Skew	-0.28	1.56	0.46	0.15	-0.09	-0.19	-0.35	-0.40	-0.42	-0.42
Kurt	-1.29	3.85	1.02	-0.58	0.11	0.12	-0.38	-0.49	-0.60	-0.69
AR	0.90	0.88	0.72	0.88	0.93	0.91	0.90	0.92	0.93	0.93
27. Caterpillar Inc. (CAT )										
Mean	3.67	6.00	9.70	14.77	18.50	22.69	26.45	29.66	32.53	35.13
Std	0.24	0.14	2.83	3.59	4.31	4.97	5.54	5.98	6.44	6.89
Skew	0.66	-3.61	1.60	1.35	1.43	0.98	0.87	0.80	0.70	0.62
Kurt	-1.61	37.00	4.16	3.23	3.61	1.88	1.50	1.29	1.03	0.79
AR	0.95	0.17	0.72	0.89	0.91	0.94	0.92	0.93	0.92	0.91
28. Centex Corporation (CTX )										
Mean	13.18	19.74	31.47	44.52	57.71	67.15	75.28	81.78	87.48	92.62
Std	3.61	5.72	9.87	11.74	12.87	13.29	13.86	14.31	14.71	15.13
Skew	0.59	0.90	1.46	1.42	1.49	1.38	1.18	1.22	1.26	1.28
Kurt	-0.38	0.44	4.34	5.58	6.59	6.48	5.76	6.59	7.37	7.97
AR	0.92	0.80	0.72	0.72	0.71	0.71	0.73	0.73	0.73	0.73
29. CenturyTel Inc. (CTL )										
Mean	12.47	24.47	36.52	55.03	69.65	81.66	92.09	100.23	107.47	114.03
Std	7.59	7.34	7.99	9.55	9.66	9.98	10.97	11.69	12.51	13.41
Skew	0.01	0.58	0.16	0.09	-0.10	-0.39	-0.36	-0.34	-0.29	-0.21
Kurt	-0.26	-0.48	-0.46	0.06	0.29	0.26	0.04	0.09	0.09	0.05
AR	0.90	0.83	0.84	0.83	0.82	0.79	0.79	0.80	0.81	0.82

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30. The Chubb Corporation (CB )										
Mean	4.51	7.28	11.30	16.39	19.77	23.00	26.14	28.62	30.87	32.82
Std	2.97	2.92	4.58	5.31	5.58	6.06	6.50	7.24	7.84	8.37
Skew	-0.35	-0.55	0.75	0.24	-0.29	-0.58	-0.73	-0.61	-0.54	-0.47
Kurt	-1.94	-1.75	-0.60	-0.82	-0.76	-0.82	-0.73	-0.85	-0.90	-0.92
AR	0.95	0.95	0.91	0.96	0.96	0.97	0.97	0.97	0.97	0.96
31. CIGNA Corporation (CI )										
Mean	6.09	16.48	19.03	26.80	32.91	37.00	40.53	43.97	47.03	49.78
Std	0.26	2.64	5.20	6.02	7.16	7.61	8.22	8.52	8.89	9.24
Skew	3.98	-0.56	0.27	-0.01	-0.20	-0.16	-0.06	-0.20	-0.32	-0.42
Kurt	15.90	-1.75	-0.84	-0.84	-0.35	-0.66	-0.67	-0.62	-0.58	-0.54
AR	0.57	0.95	0.90	0.93	0.92	0.93	0.92	0.93	0.94	0.94
32. Comcast Calbe Communications, LLC (CMCSA )										
Mean	6.07	13.10	19.48	29.25	37.92	45.65	52.73	58.85	64.41	69.52
Std	3.68	4.99	7.00	8.65	10.98	11.84	12.55	12.90	13.28	13.70
Skew	0.10	0.15	0.21	-0.06	-0.07	0.03	0.00	-0.01	-0.04	-0.08
Kurt	-0.66	-0.15	-0.37	-0.61	-0.45	-0.43	-0.37	-0.32	-0.29	-0.31
AR	0.94	0.90	0.93	0.93	0.96	0.95	0.93	0.94	0.95	0.95
33. ConAgra Foods, Inc. (CAG )										
Mean	7.83	13.03	18.60	28.63	37.97	44.84	50.72	55.41	59.54	63.25
Std	3.32	5.70	7.44	10.59	14.11	15.29	16.37	16.93	17.40	17.81
Skew	0.07	1.59	0.26	0.27	0.16	0.12	0.10	0.09	0.08	0.08
Kurt	-0.29	3.71	-1.35	-1.41	-1.50	-1.56	-1.58	-1.60	-1.60	-1.60
AR	0.92	0.89	0.90	0.95	0.96	0.97	0.97	0.97	0.97	0.97
34. Constellation Energy Group, Inc. (CEG )										
Mean	9.21	23.30	18.90	26.63	33.25	38.60	42.61	45.69	48.50	51.04
Std	3.45	14.70	7.12	7.30	8.96	9.87	10.47	10.65	10.91	11.23
Skew	0.94	0.58	1.40	0.14	-0.03	-0.15	-0.09	-0.01	0.04	0.09
Kurt	0.55	-1.46	2.47	0.34	0.15	-0.10	0.10	0.23	0.24	0.16
AR	0.93	0.96	0.87	0.92	0.92	0.94	0.93	0.93	0.92	0.92
35. Countrywide Home Loans Inc. (CFC )										
Mean	11.50	19.30	27.90	37.95	46.51	50.70	54.36	58.51	62.16	65.44
Std	2.72	5.48	7.12	8.68	10.71	11.18	11.52	12.18	12.58	12.94
Skew	0.58	1.10	0.30	0.12	0.21	0.18	0.08	0.19	0.18	0.09
Kurt	0.14	1.94	-0.22	-0.29	-0.36	-0.42	-0.32	-0.48	-0.59	-0.67
AR	0.77	0.78	0.82	0.86	0.87	0.88	0.88	0.89	0.89	0.89
36. Deere & Company (DE )										
Mean	3.67	5.64	10.45	16.34	21.01	25.34	29.24	32.75	35.88	38.74
Std	0.89	2.71	2.71	3.40	4.06	4.56	5.01	5.40	5.84	6.28
Skew	-0.26	1.08	0.74	0.57	0.55	0.54	0.68	0.48	0.35	0.24
Kurt	-1.68	1.45	1.46	1.90	1.83	1.59	1.47	1.28	1.07	0.87
AR	0.83	0.81	0.78	0.88	0.88	0.91	0.88	0.89	0.89	0.88

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37. Devon Energy Corporation (DVN )										
Mean	8.30	13.86	17.03	25.65	32.41	38.07	42.97	46.90	50.42	53.58
Std	3.93	6.31	6.07	7.29	8.80	8.99	9.22	9.57	9.97	10.40
Skew	1.05	1.28	2.04	1.53	1.15	0.99	0.85	0.85	0.87	0.88
Kurt	1.66	3.22	7.69	5.70	3.70	2.77	1.94	1.87	1.81	1.73
AR	0.90	0.83	0.83	0.89	0.90	0.90	0.89	0.90	0.90	0.89
38. Dominion Resources (D )										
Mean	10.17	14.91	21.41	28.75	36.24	40.81	44.93	48.54	51.70	54.55
Std	4.76	4.77	6.77	7.92	9.79	10.25	10.96	11.41	11.90	12.39
Skew	-0.13	-0.42	-0.49	-0.72	-0.67	-0.75	-0.72	-0.73	-0.71	-0.69
Kurt	-0.41	-0.46	-0.64	-0.32	-0.30	-0.31	-0.37	-0.33	-0.35	-0.39
AR	0.93	0.84	0.90	0.94	0.95	0.97	0.97	0.97	0.96	0.95
39. Duke Energy Corporation (DUK )										
Mean	7.94	11.67	16.24	22.01	28.03	32.30	36.55	39.96	42.98	45.74
Std	2.63	3.96	5.90	7.24	8.93	10.31	11.34	12.11	12.79	13.44
Skew	-0.58	-0.21	-0.19	-0.50	-0.50	-0.52	-0.48	-0.50	-0.51	-0.52
Kurt	-0.84	-0.91	-0.69	-0.14	-0.37	-0.28	-0.38	-0.28	-0.19	-0.09
AR	0.96	0.93	0.93	0.95	0.96	0.96	0.96	0.96	0.95	0.95
40. E. I. du Pont de Nemours and Company (DD )										
Mean	4.83	7.16	10.52	13.96	17.39	21.00	24.01	27.65	30.18	32.50
Std	3.20	2.60	3.73	4.29	4.70	5.60	6.94	6.20	6.57	6.96
Skew	0.33	1.55	0.31	0.20	0.19	-0.09	-0.59	-0.11	-0.21	-0.27
Kurt	-1.21	2.08	-0.22	-0.73	-1.13	-0.97	0.32	-0.98	-0.96	-0.94
AR	0.94	0.77	0.79	0.87	0.92	0.93	0.89	0.93	0.93	0.93
41. Eastman Chemical Company (EMN )										
Mean	18.38	20.45	26.62	38.44	48.92	57.51	64.82	70.32	75.08	79.31
Std	19.06	7.58	7.84	8.28	9.06	9.60	10.55	10.62	10.90	11.20
Skew	1.85	1.22	0.49	0.44	0.27	-0.06	-0.32	-0.32	-0.35	-0.35
Kurt	1.52	0.34	-0.03	0.22	0.01	-0.33	-0.26	-0.20	-0.02	0.13
AR	0.92	0.92	0.77	0.77	0.84	0.84	0.83	0.85	0.84	0.83
42. Federated Department Stores, Inc. (FD )										
Mean	8.09	12.36	20.43	32.24	41.96	51.24	59.14	65.02	70.19	74.82
Std	1.08	3.07	4.38	5.51	7.17	8.81	10.60	11.86	12.78	13.59
Skew	1.19	0.11	0.48	0.26	0.57	0.78	0.88	0.94	0.90	0.86
Kurt	3.05	0.04	0.38	0.06	0.24	0.16	0.29	0.31	0.13	0.02
AR	0.71	0.81	0.84	0.81	0.88	0.89	0.90	0.90	0.91	0.91
43. FirstEnergy Corp. (FE )										
Mean	12.64	17.59	24.03	32.98	41.91	47.54	52.74	56.62	60.15	63.33
Std	5.62	8.33	8.15	10.04	11.97	12.93	14.24	14.93	15.67	16.39
Skew	0.22	0.97	-0.06	-0.58	-0.62	-0.83	-0.81	-0.81	-0.77	-0.73
Kurt	-0.77	1.58	0.19	0.04	0.10	0.18	0.11	0.12	0.09	0.03
AR	0.96	0.93	0.88	0.94	0.95	0.95	0.95	0.95	0.94	0.93

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44. Federal Home Loan Mortgage Association (FHLMC )										
Mean	4.37	4.94	11.27	7.77	19.42	11.54	24.69	14.80	16.25	31.80
Std	1.76	3.32	4.25	3.79	7.73	4.36	9.28	5.49	6.02	11.19
Skew	0.99	1.67	1.80	1.74	1.01	0.52	0.85	0.38	0.32	0.80
Kurt	-0.72	2.42	3.60	4.78	-0.23	-1.01	-0.69	-1.14	-1.20	-0.83
AR	0.86	0.80	0.86	0.87	0.98	0.97	0.97	0.97	0.97	0.98
45. The Gap, Inc. (GPS )										
Mean	18.07	32.98	51.54	73.59	94.49	107.32	118.20	125.80	132.45	138.33
Std	4.99	8.27	13.24	19.20	23.85	27.31	30.58	32.66	34.40	35.92
Skew	-0.06	-0.16	-0.39	-0.44	-0.45	-0.27	-0.04	0.01	0.06	0.10
Kurt	-0.54	-0.63	0.04	-0.27	-0.08	0.09	0.32	0.32	0.34	0.38
AR	0.87	0.81	0.83	0.90	0.90	0.91	0.91	0.92	0.93	0.94
46. General Electric Capital Corporation (GE )										
Mean	5.62	8.29	11.21	15.00	18.27	20.57	22.61	24.75	26.92	28.66
Std	1.87	2.14	2.90	4.16	5.27	5.88	6.44	7.27	7.95	8.85
Skew	2.91	0.21	0.29	0.45	0.43	0.43	0.41	0.39	0.36	0.34
Kurt	19.91	0.21	-0.50	-0.51	-0.81	-0.82	-0.83	-0.96	-1.02	-1.12
AR	0.49	0.79	0.89	0.96	0.98	0.98	0.97	0.98	0.98	0.98
47. General Mills, Inc. (GIS )										
Mean	4.46	7.99	13.15	20.06	26.76	32.19	36.81	40.80	44.42	47.71
Std	2.44	3.98	4.83	6.61	7.97	8.87	9.69	10.42	11.07	11.67
Skew	-0.68	2.81	0.77	0.69	0.29	0.30	0.31	0.29	0.29	0.28
Kurt	-1.45	8.06	0.05	-0.46	-1.11	-1.23	-1.29	-1.29	-1.26	-1.21
AR	0.96	0.90	0.88	0.94	0.96	0.96	0.95	0.96	0.96	0.96
48. Goodrich Corporation (GR )										
Mean	7.02	12.32	21.26	32.62	41.82	49.14	55.40	60.04	64.12	67.72
Std	3.31	5.59	8.85	11.65	14.65	15.44	16.19	16.54	16.87	17.19
Skew	-0.26	0.98	0.71	0.45	0.63	0.54	0.53	0.47	0.42	0.38
Kurt	-1.89	0.16	0.89	0.87	2.28	1.69	1.42	1.09	0.76	0.45
AR	0.93	0.91	0.92	0.93	0.92	0.93	0.93	0.93	0.94	0.93
49. Halliburton Company (HAL )										
Mean	6.57	11.72	14.96	22.60	28.72	34.15	38.77	42.83	46.45	49.71
Std	2.44	2.70	4.68	5.14	5.87	6.31	6.65	7.24	7.84	8.43
Skew	-0.55	1.62	1.02	0.45	0.03	0.01	-0.11	-0.03	0.02	0.05
Kurt	-0.71	2.89	1.92	0.44	0.22	0.16	-0.22	-0.33	-0.44	-0.52
AR	0.94	0.92	0.79	0.88	0.91	0.91	0.89	0.90	0.91	0.91
50. The Hartford Financial Service Group, Inc. (HIG )										
Mean	6.32	13.91	12.91	19.19	24.11	27.96	31.21	34.06	36.58	38.85
Std	4.40	7.60	5.18	6.85	8.44	8.78	9.10	9.84	10.53	11.16
Skew	-0.35	-0.56	0.29	0.07	0.03	-0.26	-0.42	-0.42	-0.41	-0.38
Kurt	-1.94	-1.75	-0.98	-0.82	-0.53	-0.72	-0.72	-0.77	-0.81	-0.86
AR	0.95	0.95	0.93	0.96	0.95	0.96	0.95	0.96	0.96	0.96

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51. Hewlett-Packard Company (HPQ )										
Mean	11.25	11.32	13.20	18.49	22.99	28.85	34.06	37.54	40.65	43.48
Std	10.16	6.33	8.07	8.78	9.70	10.80	11.91	12.84	13.69	14.54
Skew	1.36	0.76	1.47	1.28	0.88	0.46	0.16	0.15	0.15	0.16
Kurt	-0.06	-0.98	2.77	2.58	1.52	0.70	0.17	0.10	0.02	-0.04
AR	0.95	0.94	0.94	0.95	0.96	0.96	0.95	0.96	0.95	0.95
52. Honeywell International (HON )										
Mean	5.08	7.46	9.34	13.71	16.86	20.78	24.18	27.39	30.20	32.80
Std	2.64	3.07	2.52	3.18	3.81	4.31	4.87	5.40	6.01	6.67
Skew	-0.85	0.56	-0.68	-0.42	-0.20	-0.56	-0.68	-0.78	-0.66	-0.45
Kurt	-1.28	-1.24	0.28	1.02	1.02	0.66	0.28	0.34	0.24	0.16
AR	0.96	0.95	0.86	0.92	0.91	0.92	0.90	0.94	0.94	0.93
53. Ingersoll-Rand Company (IR )										
Mean	5.83	9.07	13.03	20.17	25.52	30.75	35.24	39.29	42.90	46.16
Std	3.90	2.44	3.62	4.58	5.63	6.71	7.84	8.32	8.82	9.28
Skew	-0.42	0.38	1.03	0.73	0.64	0.66	0.71	0.67	0.66	0.66
Kurt	-1.88	-1.90	0.67	-0.15	-0.43	-0.63	-0.53	-0.45	-0.33	-0.17
AR	0.90	0.91	0.82	0.88	0.91	0.92	0.92	0.92	0.91	0.90
54. International Business Machines Corporation (IBM )										
Mean	9.85	9.34	9.36	13.29	16.71	21.10	24.99	27.99	30.70	33.18
Std	6.36	5.59	3.98	4.49	5.19	6.15	7.12	8.10	9.07	10.04
Skew	0.26	0.77	1.20	0.50	-0.03	-0.31	-0.43	-0.49	-0.48	-0.44
Kurt	-1.76	-1.14	2.46	0.52	-0.20	-0.29	-0.33	-0.42	-0.46	-0.48
AR	0.96	0.95	0.90	0.94	0.94	0.95	0.95	0.95	0.94	0.93
55. International Lease Finance Corporation (ILFC )										
Mean	6.48	10.27	16.70	22.45	27.41	30.31	32.79	35.97	38.85	41.51
Std	1.60	3.24	7.00	8.69	10.50	11.02	11.48	12.19	12.86	13.48
Skew	0.20	-0.01	0.99	0.81	0.76	0.64	0.56	0.54	0.53	0.53
Kurt	-0.55	-0.70	0.43	-0.02	-0.05	-0.26	-0.32	-0.38	-0.42	-0.44
AR	0.89	0.86	0.94	0.96	0.95	0.96	0.96	0.96	0.97	0.97
56. International Paper Company (IP )										
Mean	13.66	21.35	30.45	43.99	57.49	66.78	74.63	80.64	85.99	90.81
Std	13.96	11.17	11.78	13.40	17.00	18.06	19.21	19.06	18.97	18.96
Skew	3.31	1.59	0.49	0.29	0.15	0.07	-0.16	-0.04	0.03	0.06
Kurt	10.93	2.76	-0.60	-0.99	-1.33	-1.22	-0.54	-0.99	-1.18	-1.21
AR	0.84	0.88	0.88	0.92	0.95	0.93	0.90	0.92	0.93	0.93
57. Jones Apparel Group, Inc. (JNY )										
Mean	21.27	33.15	53.38	76.73	98.46	112.18	122.73	131.04	138.17	144.10
Std	7.27	15.20	21.63	30.12	39.82	43.60	45.60	46.35	46.84	46.75
Skew	1.68	1.25	1.08	1.06	1.04	0.98	0.88	0.83	0.77	0.71
Kurt	2.12	0.84	0.23	0.29	0.29	0.24	0.08	0.06	-0.00	-0.08
AR	0.91	0.93	0.93	0.94	0.94	0.95	0.94	0.95	0.94	0.94

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58. Kraft Foods Inc. (KFT )										
Mean	5.74	10.80	12.11	17.38	23.03	28.03	32.32	36.00	39.22	42.15
Std	2.53	12.13	3.30	4.39	5.35	5.98	6.68	7.18	7.62	8.03
Skew	-1.31	2.21	0.21	0.25	0.08	-0.07	-0.11	-0.12	-0.10	-0.09
Kurt	-0.21	3.27	-0.42	-0.95	-0.80	-0.80	-0.73	-0.72	-0.69	-0.66
AR	0.97	0.91	0.85	0.87	0.94	0.96	0.94	0.93	0.92	0.90
59. The Kroger Co. (KR )										
Mean	8.79	16.17	26.58	38.96	51.40	61.07	69.36	75.74	81.46	86.63
Std	2.36	6.12	8.97	12.78	14.96	15.37	16.00	16.65	17.21	17.72
Skew	1.40	0.72	0.93	1.03	1.03	0.99	1.00	1.03	1.07	1.10
Kurt	2.76	-0.59	0.30	0.33	0.36	0.24	0.27	0.38	0.47	0.56
AR	0.86	0.92	0.89	0.94	0.95	0.95	0.95	0.95	0.95	0.95
60. Lennar Corporation (LEN )										
Mean	14.67	24.36	37.91	53.56	68.26	77.85	86.04	92.67	98.52	103.74
Std	4.37	7.23	10.01	11.77	12.91	13.31	13.85	14.09	14.38	14.68
Skew	0.56	0.88	0.47	0.45	0.44	0.48	0.49	0.40	0.29	0.18
Kurt	-0.73	-0.08	-0.06	0.54	1.34	2.13	2.83	2.89	2.85	2.74
AR	0.94	0.83	0.80	0.79	0.77	0.76	0.75	0.75	0.76	0.77
61. Lockheed Martin Corporation (LMT )										
Mean	6.24	8.11	12.46	19.15	24.48	29.48	33.84	37.26	40.36	43.19
Std	2.98	3.97	4.91	7.16	9.50	10.73	11.89	12.45	13.07	13.66
Skew	-0.88	1.02	0.53	0.22	0.43	0.28	0.19	0.08	0.02	-0.02
Kurt	-0.73	0.59	0.27	-0.49	0.35	0.00	-0.19	-0.32	-0.43	-0.53
AR	0.94	0.94	0.93	0.96	0.95	0.96	0.96	0.96	0.96	0.95
62. Limited Brands, Inc. (LTD )										
Mean	11.40	20.58	36.54	53.05	67.78	78.38	87.21	94.17	100.27	105.77
Std	4.34	7.65	14.43	18.15	19.76	20.61	21.22	21.39	21.47	21.53
Skew	0.65	1.10	0.94	0.73	0.60	0.55	0.53	0.49	0.47	0.46
Kurt	-1.00	0.09	0.30	-0.78	-1.00	-0.95	-0.77	-0.76	-0.72	-0.69
AR	0.89	0.92	0.90	0.93	0.95	0.92	0.91	0.91	0.91	0.91
63. Marriott International, Inc. (MAR )										
Mean	7.80	12.61	17.48	27.39	35.86	42.91	48.76	53.49	57.72	61.79
Std	1.27	2.79	3.86	5.00	6.47	7.11	8.05	8.59	9.20	9.12
Skew	0.13	0.70	0.02	0.00	0.03	-0.06	-0.11	-0.29	-0.46	-0.03
Kurt	-0.38	-0.72	-0.43	-1.15	-1.01	-0.93	-0.57	-0.03	0.73	-0.79
AR	0.69	0.84	0.72	0.86	0.90	0.87	0.83	0.82	0.80	0.83
64. Marsh & McLennan Companies, INC. (MMC )										
Mean	23.17	27.58	34.51	45.07	53.02	60.65	66.99	73.19	78.58	83.46
Std	14.09	12.58	14.95	15.16	15.61	16.42	16.96	17.90	18.29	18.73
Skew	0.78	1.94	1.71	1.27	1.05	1.03	0.93	1.05	0.95	0.87
Kurt	0.35	6.03	3.50	1.71	0.91	0.77	0.36	1.06	0.61	0.27
AR	0.93	0.90	0.90	0.91	0.90	0.90	0.90	0.87	0.87	0.87

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65. McDonald's Corporation (MCD )										
Mean	5.24	6.46	10.80	16.08	21.04	25.52	29.37	32.73	35.76	38.52
Std	2.02	2.52	4.46	6.42	8.59	9.93	11.19	12.14	13.04	13.90
Skew	-0.06	1.15	0.47	0.63	0.60	0.59	0.59	0.61	0.63	0.66
Kurt	-0.31	0.22	-0.89	-0.88	-1.05	-1.08	-1.06	-1.04	-0.99	-0.92
AR	0.91	0.83	0.94	0.96	0.97	0.97	0.97	0.97	0.97	0.97
66. McKesson Corporation (MCK )										
Mean	4.52	11.18	20.26	30.32	37.36	43.85	49.30	54.10	58.26	61.99
Std	2.97	4.98	11.10	13.57	15.21	16.28	17.32	17.98	18.61	19.19
Skew	-0.36	-0.55	1.13	0.86	0.67	0.57	0.48	0.37	0.30	0.23
Kurt	-1.92	-1.75	0.44	-0.37	-0.78	-0.90	-0.96	-1.04	-1.11	-1.16
AR	0.95	0.95	0.94	0.95	0.96	0.96	0.96	0.96	0.96	0.97
67. Motorola, Inc. (MOT )										
Mean	9.62	11.60	15.16	23.04	30.57	38.24	45.05	49.27	53.03	56.41
Std	8.26	5.10	5.63	7.49	9.63	10.66	11.62	12.39	13.17	13.99
Skew	1.83	0.46	0.83	0.56	0.44	0.35	0.29	0.34	0.39	0.43
Kurt	1.88	-1.29	0.85	0.21	-0.51	-0.67	-0.68	-0.66	-0.62	-0.60
AR	0.91	0.95	0.87	0.91	0.92	0.92	0.91	0.91	0.90	0.89
68. National Rural Utilities Cooperative Finance Corporation(NRUC )										
Mean	7.36	8.76	11.15	15.68	19.46	22.74	25.60	29.33	32.14	34.73
Std	2.14	2.08	3.56	4.91	5.91	6.64	7.19	8.65	9.43	10.22
Skew	-0.78	-0.13	-0.44	-0.47	-0.57	-0.69	-0.69	-0.56	-0.60	-0.60
Kurt	-0.24	0.15	-1.05	-0.43	-0.39	-0.15	-0.24	-0.50	-0.55	-0.59
AR	0.90	0.88	0.95	0.96	0.95	0.95	0.94	0.95	0.95	0.94
69. Newell Rubbermaid Inc. (NWL )										
Mean	8.91	13.14	21.37	31.32	41.28	49.13	55.89	61.04	65.58	69.64
Std	2.67	5.76	9.20	11.17	13.60	14.04	14.51	15.02	15.49	15.93
Skew	-0.99	1.31	0.68	0.51	0.28	0.21	0.16	0.14	0.13	0.12
Kurt	2.21	1.73	-0.35	-0.69	-1.07	-1.10	-1.09	-1.10	-1.11	-1.12
AR	0.86	0.84	0.87	0.93	0.95	0.96	0.95	0.95	0.94	0.94
70. Nordstrom, Inc. (JWN )										
Mean	7.29	9.40	14.32	22.28	28.27	34.45	39.57	44.53	49.01	53.10
Std	5.52	3.62	5.74	8.63	10.39	11.57	12.13	13.12	14.08	15.02
Skew	1.07	1.04	1.53	1.35	1.27	1.37	1.21	1.05	0.93	0.83
Kurt	0.91	-0.17	2.27	1.36	1.42	2.16	1.57	1.00	0.59	0.30
AR	0.94	0.95	0.90	0.94	0.94	0.91	0.91	0.93	0.93	0.93
71. Norfolk Southern Corporation (NSC )										
Mean	4.45	9.35	12.84	19.67	25.62	31.42	36.43	40.53	44.16	47.42
Std	3.24	4.52	3.61	5.52	7.01	8.32	9.38	10.07	10.70	11.26
Skew	0.27	0.52	1.58	1.49	1.45	1.39	1.26	1.16	1.08	1.00
Kurt	-1.65	-1.17	3.05	2.90	2.51	2.24	1.71	1.33	1.04	0.83
AR	0.94	0.91	0.87	0.86	0.89	0.88	0.88	0.89	0.89	0.89

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72. Northrop Grumman Corporation (NOC )										
Mean	6.21	9.98	12.35	19.26	24.54	29.56	33.87	37.32	40.37	43.12
Std	3.44	4.56	4.84	6.93	9.08	10.15	11.14	11.73	12.28	12.80
Skew	-0.80	0.12	0.79	0.62	0.88	0.55	0.37	0.24	0.16	0.10
Kurt	-1.25	-1.16	1.41	1.20	2.81	1.21	0.39	-0.02	-0.30	-0.50
AR	0.94	0.97	0.92	0.94	0.92	0.94	0.95	0.96	0.96	0.95
73. Olin Corporation (OLN )										
Mean	19.15	32.67	42.08	62.11	76.17	89.17	98.70	105.58	111.37	116.32
Std	9.51	7.95	9.53	11.22	14.36	15.99	18.26	20.65	22.73	24.57
Skew	2.08	1.42	0.19	-0.25	-0.22	-0.16	-0.13	0.04	0.10	0.09
Kurt	2.48	1.35	0.24	-0.18	-0.58	-0.11	-0.21	-0.12	-0.22	-0.42
AR	0.91	0.92	0.76	0.82	0.84	0.84	0.86	0.87	0.88	0.89
74. Omnicom Group Inc. (OMC )										
Mean	5.12	8.75	13.19	20.42	26.65	33.08	38.69	42.84	46.52	49.84
Std	2.85	2.26	3.94	5.65	7.55	8.14	8.87	9.50	10.13	10.77
Skew	0.02	-0.12	-0.33	-0.14	-0.19	-0.33	-0.35	-0.30	-0.23	-0.13
Kurt	-1.35	-1.61	-0.55	-0.97	-1.14	-1.17	-1.02	-1.18	-1.24	-1.26
AR	0.95	0.89	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.91
75. Progress Energy Inc. (PGN )										
Mean	8.48	13.37	20.05	27.87	36.03	40.99	45.39	49.21	52.57	55.64
Std	5.25	6.44	9.69	11.66	15.33	16.52	17.87	18.73	19.49	20.17
Skew	-0.55	0.06	0.31	-0.02	0.33	0.03	0.03	0.01	-0.00	-0.02
Kurt	-1.32	-1.04	-0.88	-0.95	0.48	-0.54	-0.64	-0.64	-0.64	-0.65
AR	0.96	0.96	0.94	0.95	0.96	0.97	0.97	0.97	0.97	0.96
76. Pulte Homes, Inc. (PHM )										
Mean	15.66	25.42	39.74	55.42	70.06	79.93	88.25	95.04	100.97	106.41
Std	4.79	7.79	11.03	12.71	14.00	14.09	14.44	14.61	14.70	14.68
Skew	0.58	0.86	0.56	0.55	0.34	0.61	0.83	0.91	0.96	1.00
Kurt	-0.29	0.36	1.83	2.03	2.01	3.11	3.86	3.90	3.95	4.09
AR	0.91	0.83	0.75	0.77	0.78	0.74	0.76	0.76	0.76	0.76
77. RadioShack Company (RSH )										
Mean	29.46	49.64	66.29	90.34	113.25	126.80	138.58	146.18	153.06	158.98
Std	11.76	14.89	24.67	30.88	38.31	43.24	48.19	49.77	51.30	52.62
Skew	0.78	0.57	-0.36	-0.42	-0.42	-0.34	-0.22	-0.17	-0.13	-0.08
Kurt	-0.50	-0.54	0.47	0.90	0.83	0.76	0.63	0.62	0.57	0.53
AR	0.93	0.88	0.93	0.93	0.94	0.95	0.95	0.95	0.95	0.95
78. Raytheon Company (RTN )										
Mean	7.49	14.97	14.94	23.23	29.59	35.05	39.75	43.48	46.77	49.71
Std	4.25	6.52	6.14	9.22	12.05	13.26	14.29	15.00	15.59	16.13
Skew	-0.75	-0.32	0.56	0.28	0.25	0.13	0.06	-0.01	-0.05	-0.08
Kurt	-1.31	-1.34	0.81	0.10	0.20	-0.06	-0.18	-0.32	-0.44	-0.53
AR	0.96	0.95	0.94	0.96	0.96	0.96	0.97	0.97	0.96	0.96

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79. Residential Capital Corporation (RESCAP)										
Mean	77.26	99.30	109.56	118.10	126.99	132.75	138.71	142.92	146.61	149.85
Std	25.19	31.88	32.59	36.86	41.94	44.06	45.50	46.87	47.82	48.52
Skew	0.35	0.37	0.20	0.57	0.82	0.93	0.96	0.98	0.99	1.00
Kurt	-0.72	-0.59	-1.12	-0.82	-0.41	-0.35	-0.34	-0.33	-0.32	-0.31
AR	0.87	0.88	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
80. Rohm and Haas Company (ROH )										
Mean	4.03	8.18	14.11	20.79	26.09	31.38	35.93	39.29	42.25	44.89
Std	2.68	3.05	4.83	5.94	6.55	7.25	7.86	8.03	8.20	8.38
Skew	-0.08	-0.02	1.16	0.46	0.21	0.02	-0.10	-0.12	-0.13	-0.12
Kurt	-1.67	-1.40	2.24	0.48	0.34	-0.32	-0.61	-0.61	-0.59	-0.57
AR	0.94	0.97	0.84	0.92	0.93	0.94	0.93	0.93	0.94	0.93
81. Safeway Inc. (SWY )										
Mean	10.17	18.84	31.17	44.76	59.15	69.13	77.76	84.62	90.73	96.25
Std	2.87	6.79	10.61	14.24	16.76	17.41	17.99	18.89	19.73	20.53
Skew	0.64	0.50	0.44	0.45	0.51	0.56	0.60	0.66	0.71	0.76
Kurt	-0.13	-0.60	-0.49	-0.66	-0.39	-0.39	-0.41	-0.29	-0.19	-0.09
AR	0.83	0.91	0.90	0.93	0.95	0.95	0.94	0.94	0.94	0.94
82. Sara Lee Corporation (SLE )										
Mean	11.39	19.57	25.73	38.55	50.64	59.36	67.18	73.07	78.24	82.86
Std	3.11	5.89	9.90	13.91	17.13	19.28	21.30	22.31	23.30	24.22
Skew	0.76	0.80	0.59	0.36	-0.10	-0.17	-0.21	-0.21	-0.21	-0.20
Kurt	-0.64	0.83	1.27	1.02	0.79	0.89	0.98	1.03	1.06	1.09
AR	0.85	0.78	0.85	0.87	0.89	0.90	0.90	0.90	0.90	0.90
83. Sempra Energy (SRE )										
Mean	8.16	15.49	18.52	26.10	34.57	39.22	43.57	47.05	50.55	53.73
Std	3.01	6.13	7.63	9.61	13.50	13.71	14.75	15.80	16.85	17.87
Skew	0.61	1.49	0.16	-0.10	0.22	-0.25	-0.25	-0.27	-0.24	-0.20
Kurt	-0.56	2.11	-1.22	-1.01	-0.04	-1.22	-1.21	-1.11	-1.08	-1.04
AR	0.91	0.92	0.94	0.95	0.96	0.98	0.97	0.97	0.97	0.96
84. The Shervin-Williams Company (SHW )										
Mean	24.00	26.63	23.87	33.44	39.62	45.23	50.18	54.34	58.02	61.32
Std	15.12	8.94	13.43	15.74	17.62	19.00	19.99	20.17	20.25	20.24
Skew	1.37	-0.09	1.27	1.01	0.69	0.67	0.69	0.68	0.69	0.70
Kurt	0.49	-1.25	1.60	0.48	-0.78	-0.74	-0.65	-0.66	-0.66	-0.64
AR	0.78	0.80	0.87	0.89	0.95	0.96	0.95	0.95	0.94	0.94
85. Sprint Nextel Corp (S )										
Mean	11.69	13.71	20.73	31.71	41.15	50.28	58.49	64.80	70.56	76.09
Std	9.38	4.66	4.52	7.12	7.97	9.34	10.98	11.89	12.94	14.05
Skew	3.55	-0.08	0.36	0.28	0.40	0.51	0.66	0.78	0.88	0.95
Kurt	14.79	-0.39	0.01	-0.71	-0.53	-0.34	-0.10	0.15	0.31	0.37
AR	0.46	0.78	0.79	0.89	0.89	0.89	0.89	0.91	0.91	0.92

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86. Starwood Hotel & Resorts Wwide Inc. (HOT )										
Mean	23.63	42.67	66.24	87.55	104.50	118.16	129.19	136.49	142.85	148.47
Std	7.41	18.34	27.45	24.20	24.59	25.85	26.86	28.14	29.45	30.75
Skew	0.58	1.02	1.12	0.66	0.55	0.12	-0.03	-0.04	-0.02	0.01
Kurt	-0.60	0.44	0.55	0.50	0.25	-0.56	-0.76	-0.86	-0.92	-0.96
AR	0.85	0.92	0.92	0.92	0.93	0.92	0.92	0.92	0.93	0.93
87. Target Corporation (TGT )										
Mean	27.79	4.43	6.11	9.77	12.91	15.91	18.58	21.52	24.24	26.81
Std	39.36	1.85	2.16	2.81	3.68	3.91	4.51	5.53	6.50	7.41
Skew	1.18	0.73	1.03	1.09	1.31	0.64	0.63	0.67	0.75	0.85
Kurt	-0.62	-0.32	1.29	1.19	3.05	0.31	0.11	0.09	0.27	0.50
AR	0.96	0.80	0.90	0.89	0.72	0.91	0.94	0.95	0.96	0.96
88. Temple-Inland Inc. (TIN )										
Mean	13.44	24.50	36.82	54.75	70.11	80.70	89.75	96.53	102.45	107.69
Std	4.46	7.52	14.46	14.98	16.96	17.90	19.02	19.78	20.45	21.04
Skew	0.44	0.63	1.90	0.94	0.19	-0.03	-0.15	-0.17	-0.17	-0.17
Kurt	-0.81	-1.03	7.26	2.28	-0.30	-0.36	-0.32	-0.33	-0.32	-0.29
AR	0.94	0.95	0.80	0.83	0.87	0.86	0.86	0.86	0.86	0.86
89. Textron Financial Corporation (TXT )										
Mean	4.27	8.93	11.40	18.12	23.26	28.63	33.25	36.88	40.09	42.98
Std	2.33	3.81	3.08	4.73	6.31	7.59	8.79	9.36	9.89	10.36
Skew	-0.71	1.13	0.21	-0.27	-0.21	-0.36	-0.41	-0.50	-0.56	-0.59
Kurt	-1.50	-0.42	1.78	-0.23	-0.44	-0.45	-0.42	-0.38	-0.35	-0.36
AR	0.95	0.86	0.81	0.92	0.94	0.95	0.94	0.94	0.94	0.94
90. Time Warner Inc. (TWX )										
Mean	7.72	15.62	23.15	34.58	44.94	53.27	60.49	66.59	72.07	77.09
Std	3.52	6.06	7.49	9.05	11.33	12.04	12.73	13.27	13.79	14.39
Skew	-0.06	0.49	0.42	0.24	0.18	0.18	0.14	0.13	0.11	0.10
Kurt	-0.31	-0.40	-0.16	-0.43	-0.53	-0.45	-0.39	-0.30	-0.24	-0.16
AR	0.91	0.85	0.91	0.91	0.93	0.93	0.92	0.93	0.93	0.93
91. Transocean Inc. (RIG )										
Mean	8.27	12.30	14.56	22.48	28.53	34.47	39.58	43.61	47.17	50.38
Std	2.99	2.46	2.94	3.29	4.02	4.79	5.78	6.44	7.19	8.00
Skew	0.68	1.09	0.34	0.21	0.30	0.47	0.69	0.89	1.03	1.11
Kurt	-0.69	0.31	-0.33	-0.60	0.31	0.86	1.45	2.12	2.77	3.32
AR	0.87	0.86	0.66	0.79	0.80	0.82	0.81	0.84	0.83	0.83
92. Union Pacific Corporation (UNP )										
Mean	6.65	14.53	16.08	25.23	33.33	39.47	44.65	48.87	52.53	55.77
Std	4.35	6.43	4.97	7.02	9.14	10.24	11.31	11.91	12.47	12.97
Skew	0.77	0.21	1.05	0.70	0.68	0.80	0.87	0.88	0.89	0.90
Kurt	-0.90	-1.53	0.93	0.55	0.84	1.02	1.16	1.31	1.45	1.59
AR	0.94	0.91	0.86	0.90	0.90	0.89	0.87	0.87	0.86	0.86

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93. Valero Energy Corporation (VLO )										
Mean	14.50	21.25	22.54	32.27	40.70	46.95	52.26	56.71	60.55	63.98
Std	4.41	8.91	9.42	10.79	12.70	12.85	13.22	14.17	14.69	15.23
Skew	0.65	1.36	3.44	2.96	2.40	2.27	2.15	2.12	2.05	1.99
Kurt	3.07	4.27	17.02	13.59	9.08	8.89	8.30	7.38	6.82	6.26
AR	0.84	0.88	0.82	0.83	0.88	0.87	0.86	0.90	0.90	0.90
94. WalMart Stores, Inc. (WMT )										
Mean	3.59	4.66	5.67	8.37	10.91	13.91	16.55	18.64	20.53	22.26
Std	1.34	1.70	2.11	2.78	3.35	3.89	4.53	5.14	5.75	6.36
Skew	0.03	0.07	0.61	0.59	0.38	0.08	-0.05	-0.08	-0.09	-0.08
Kurt	-1.84	-0.93	-0.35	-0.40	-0.34	-0.63	-0.73	-0.89	-1.04	-1.17
AR	0.88	0.88	0.71	0.87	0.91	0.96	0.96	0.97	0.97	0.97
95. The Walt Disney Company (DIS )										
Mean	5.71	8.48	12.90	19.57	25.04	31.20	36.66	41.29	45.51	49.42
Std	3.95	4.31	5.65	7.76	10.02	11.29	12.56	13.58	14.59	15.55
Skew	0.54	0.60	0.20	0.21	0.22	0.06	-0.08	-0.17	-0.25	-0.32
Kurt	-0.44	-0.62	-0.75	-0.74	-0.86	-0.88	-0.86	-0.82	-0.77	-0.72
AR	0.91	0.88	0.91	0.95	0.97	0.97	0.97	0.97	0.97	0.97
96. Wells Fargo & Company (WFC )										
Mean	4.65	4.63	8.08	10.12	17.03	14.69	22.75	19.27	21.44	30.42
Std	0.77	0.97	1.95	2.92	4.46	3.94	5.86	5.08	5.73	6.53
Skew	1.06	-0.82	0.05	-0.03	-0.38	-0.22	-0.30	-0.17	-0.11	-0.46
Kurt	0.06	-0.81	-0.72	-0.68	-0.83	-0.94	-1.01	-1.10	-1.16	-0.84
AR	0.88	0.92	0.84	0.93	0.96	0.96	0.97	0.97	0.98	0.97
97. Weyerhaeuser Company (WY)										
Mean	8.64	16.02	26.92	40.04	51.86	60.67	68.32	74.67	80.32	85.39
Std	3.28	4.43	10.79	12.83	15.06	15.91	16.87	17.04	17.23	17.43
Skew	0.57	0.45	2.43	2.10	1.51	1.02	0.56	0.48	0.37	0.26
Kurt	-0.79	-0.64	8.97	7.86	5.89	5.16	5.01	4.29	3.67	3.14
AR	0.86	0.89	0.70	0.84	0.88	0.86	0.81	0.82	0.82	0.82
98. Whirlpool Corporation (WHR)										
Mean	9.86	15.31	27.24	39.91	51.46	60.67	68.59	74.63	79.95	84.67
Std	2.73	6.12	8.93	11.16	12.57	12.97	13.41	14.27	15.08	15.77
Skew	0.47	2.12	0.94	0.84	0.51	0.35	0.23	0.28	0.35	0.40
Kurt	-0.05	5.51	0.53	0.03	-0.37	-0.58	-0.65	-0.64	-0.54	-0.48
AR	0.88	0.84	0.84	0.91	0.94	0.93	0.92	0.92	0.92	0.92
99. Wyeth (WYE)										
Mean	3.47	5.74	10.13	15.52	19.34	23.14	26.32	29.90	33.15	36.10
Std	2.11	3.19	3.62	5.29	6.59	7.24	8.04	9.02	9.99	10.96
Skew	-0.35	0.65	0.87	0.83	0.80	0.50	0.36	0.14	-0.01	-0.13
Kurt	-1.93	-0.73	2.13	2.99	3.06	1.98	1.47	0.86	0.41	0.08
AR	0.95	0.94	0.83	0.88	0.89	0.91	0.91	0.93	0.94	0.94

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Mat	1	2	3	4	5	6	7	8	9	10
100. XL Capital LTD (XL)										
Mean	9.11	21.38	22.07	31.59	38.89	43.66	47.57	51.49	54.94	58.03
Std	5.11	10.01	7.39	9.40	11.28	11.95	12.64	13.06	13.44	13.80
Skew	-0.73	-0.72	-0.21	-0.25	-0.18	-0.28	-0.32	-0.30	-0.27	-0.25
Kurt	-1.11	-0.89	-0.43	-0.14	-0.02	-0.05	-0.10	-0.15	-0.22	-0.29
AR	0.96	0.94	0.91	0.95	0.94	0.95	0.95	0.95	0.95	0.95

# Appendix C

## Dynamics and term structure of the credit default spreads

Entries report the parameter estimates that determine default arrival dynamics and the term structure of the CDS spreads for each of the 100 reference entities.

Tick	$\kappa_{xy}$	$\kappa_y$	$\gamma_{y0}$	$\gamma_{y1}$	$a_i$	$b_i$	$c_i$		
1.ACE	-0.0062	0.0262	0.0000	-0.2011	0.0561	0.0005	-0.0004	0.0003	0.0223
2.T	-0.0072	0.0194	0.0016	-0.2462	0.0535	0.0134	-0.0009	0.0004	0.0182
3.CNG	-0.0068	0.0060	0.0000	-0.2046	0.0574	0.0135	-0.0006	0.0003	0.0168
4.AET	-0.0098	0.0213	0.0015	-0.1780	0.0427	0.0159	-0.0008	0.0004	0.0179
5.AL	-0.0120	0.0431	0.0024	-0.2349	0.1117	0.0160	-0.0007	0.0002	0.0207
6.AA	0.0095	0.0453	0.0003	-0.2006	0.1596	0.0005	-0.0001	0.0000	0.0163
7.ALL	-0.0081	-0.0022	0.0000	-0.1457	0.1153	0.0504	-0.0005	0.0004	0.0150
8.MO	-0.0088	0.0346	0.0001	-0.2307	0.0655	0.0042	-0.0005	0.0005	0.0240
9.AEP	0.0097	0.0108	0.0000	-0.1756	0.0924	0.0010	-0.0022	0.0002	0.0241
10.AXP	0.0019	0.0262	0.0001	-0.1435	0.0343	0.0502	-0.0004	0.0007	0.0153
11.AIG	-0.0012	0.0248	0.0000	-0.1638	0.1005	0.0024	-0.0004	0.0003	0.0125
12.AMGN	-0.0178	0.0135	0.0000	-0.1634	-0.0658	0.0100	-0.0008	0.0009	0.0136
13.APC	-0.0071	0.0079	0.0002	-0.2067	0.0854	0.0014	-0.0007	0.0004	0.0219
14.ARW	-0.0030	-0.0237	0.0006	-0.2244	0.1158	0.0179	-0.0009	0.0012	0.0325
15.AZO	-0.0036	0.0174	0.0367	-0.2551	0.1367	0.0055	-0.0013	0.0005	0.0278

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Tick	$\kappa_{xy}$	$\kappa_y$	$\gamma_{y0}$	$\gamma_{y1}$	$a_i$	$b_i$	$c_i$		
16.BAX	-0.0077	0.0173	0.0001	-0.1925	0.0970	0.0094	-0.0008	0.0005	0.0116
17.BMY	-0.0067	0.0130	0.0003	-0.1828	0.0505	0.0084	-0.0005	0.0004	0.0116
18.BNI	-0.0308	0.0431	0.0003	-0.2565	0.0068	0.0148	0.0008	0.0003	0.0178
19.CIT	-0.0102	0.0169	0.0062	-0.2300	0.0518	0.0078	-0.0006	0.0003	0.0079
20.COXENT	-0.0113	-0.0093	0.0000	-0.2360	0.0676	0.0000	-0.0006	0.0001	0.0245
21.CSX	-0.0086	0.0243	0.0000	-0.2212	0.0555	0.0195	-0.0003	0.0005	0.0235
22.CVS	-0.0094	0.0157	0.0003	-0.2326	0.1083	0.0096	-0.0008	0.0000	0.0141
23.CPB	-0.0130	0.0226	0.0000	-0.2014	0.0981	0.0169	-0.0005	0.0004	0.0185
24.COF	-0.0144	0.0232	0.0000	-0.1914	0.0899	0.0022	-0.0005	0.0004	0.0214
25.CAH	-0.0132	0.0334	0.0000	-0.2403	0.0695	0.0169	-0.0006	0.0004	0.0227
26.CCL	-0.0033	0.0246	0.0000	-0.2070	0.0710	0.0000	-0.0002	0.0009	0.0163
27.CAT	-0.0094	0.0233	0.0038	-0.2017	0.0862	0.0104	-0.0007	0.0003	0.0116
28.CTX	-0.0102	-0.0087	0.0000	-0.2405	0.0737	0.0003	-0.0010	0.0001	0.0315
29.CTL	0.0234	-0.0407	0.0000	-0.2062	-0.0608	0.0000	-0.0010	-0.0013	0.0324
30.CB	-0.0104	0.0151	0.0002	-0.1662	0.0589	0.0493	-0.0003	0.0004	0.0142
31.CI	-0.0096	0.0103	0.0002	-0.1935	0.0351	0.0017	-0.0007	0.0003	0.0123
32.CMCSA	-0.0067	0.0154	0.0003	-0.2931	0.0552	0.0079	-0.0005	0.0005	0.0130
33.CAG	0.0347	-0.0225	0.0000	-0.1475	0.1529	0.0000	-0.0013	-0.0017	0.0214
34.CEG	0.0096	0.0071	0.0000	-0.1810	0.1849	0.0002	-0.0020	-0.0027	0.0250
35.CFC	-0.0080	0.0255	0.0000	-0.2055	0.0595	0.0015	-0.0008	0.0004	0.0240
36.DE	0.0005	0.0266	0.0000	-0.1894	0.1570	0.0489	-0.0009	0.0008	0.0150
37.DVN	-0.0088	0.0217	0.0000	-0.2119	-0.0015	0.0030	-0.0009	0.0002	0.0202
38.D	-0.0124	0.0080	0.0000	-0.1945	0.1561	0.0005	-0.0009	0.0001	0.0234
39.DUK	-0.0073	0.0145	0.0001	-0.1763	0.0645	0.0009	-0.0005	0.0004	0.0177
40.DD	-0.0042	0.0156	0.0000	-0.2189	0.0720	0.0060	-0.0006	0.0003	0.0075
41.EMN	0.0916	-0.0691	0.0000	-0.0871	0.3077	0.0137	-0.0053	-0.0004	0.0236
42.FD	0.0350	-0.0076	0.0000	-0.1895	-0.5536	0.0000	-0.0023	0.0009	0.0232
43.FE	0.0016	0.0210	0.0002	-0.2046	0.0563	0.0003	-0.0013	0.0004	0.0255
44.FHLMC	-0.0061	0.0113	0.0006	-0.1432	0.0637	0.0129	-0.0000	0.0003	0.0146
45.GPS	-0.0020	-0.0037	0.0000	-0.3004	0.0083	0.0469	-0.0011	0.0000	0.0481
46.GE	-0.0061	0.0067	0.0002	-0.1377	0.0484	0.0003	-0.0004	0.0005	0.0099
47.GIS	-0.0082	0.0155	0.0000	-0.2023	0.0810	0.0148	-0.0006	0.0004	0.0188
48.GR	-0.0130	0.0165	0.0009	-0.2327	0.0845	0.0004	-0.0010	0.0007	0.0256
49.HAL	-0.0199	0.0157	0.0000	-0.2133	0.0754	0.0119	-0.0005	0.0009	0.0190
50.HIG	-0.0065	0.0162	0.0000	-0.1711	0.0832	0.0016	-0.0004	-0.0000	0.0172
51.HPQ	-0.0083	0.0143	0.0001	-0.2169	0.0745	0.0077	-0.0007	0.0004	0.0126
52.HON	-0.0061	0.0140	0.0000	-0.2088	0.0590	0.0280	-0.0006	0.0003	0.0085
53.IR	-0.0041	0.0336	0.0000	-0.2143	0.1278	0.0045	-0.0001	0.0007	0.0153
54.IBM	-0.0066	0.0149	0.0065	-0.2087	0.0640	0.0085	-0.0005	0.0004	0.0098
55.ILFC	-0.0084	0.0160	0.0002	-0.1567	0.0630	0.0016	-0.0005	0.0002	0.0202
56.IP	0.0165	-0.0317	0.0000	-0.1790	0.3271	0.0000	0.0007	0.0011	0.0289
57.JNY	-0.0054	0.0187	0.0000	-0.3207	0.0844	0.0002	-0.0006	0.0004	0.0461
58.KFT	-0.0217	0.0314	0.0000	-0.2204	0.0051	0.0000	0.0004	0.0006	0.0168
59.KR	-0.0032	-0.0028	0.0000	-0.2380	0.0852	0.0279	-0.0014	0.0005	0.0274

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Tick	$\kappa_{xy}$	$\kappa_y$	$\gamma_{y0}$	$\gamma_{y1}$	$a_i$	$b_i$	$c_i$		
60.LEN	0.0020	-0.0105	0.0037	-0.2348	0.2103	0.0086	-0.0010	0.0006	0.0365
61.LMT	-0.0059	0.0172	0.0000	-0.1874	0.0706	0.0000	-0.0003	0.0003	0.0195
62.LTD	0.0213	-0.0106	0.0000	-0.2229	-0.1240	0.0000	-0.0001	-0.0053	0.0301
63.MAR	-0.0011	0.0180	0.0075	-0.2064	-0.0651	0.0599	0.0029	-0.0060	0.0226
64.MMC	-0.0062	0.0462	0.0000	-0.2698	0.0745	0.0046	-0.0003	0.0003	0.0181
65.MCD	-0.0046	0.0252	0.0013	-0.1841	0.0575	0.0712	-0.0008	0.0003	0.0214
66.MCK	-0.0111	0.0258	0.0000	-0.2283	0.0466	0.0157	-0.0004	0.0009	0.0217
67.MOT	-0.0129	0.0165	0.0000	-0.2350	0.1316	0.0174	-0.0007	0.0004	0.0247
68.NRUC	-0.0079	0.0130	0.0005	-0.1810	0.0606	0.0079	-0.0006	0.0003	0.0099
69.NWL	0.0238	-0.0014	0.0000	-0.1909	-0.1569	0.0000	-0.0012	-0.0022	0.0236
70.JWN	0.0027	0.0306	0.0000	-0.2157	0.1122	0.0009	-0.0005	0.0011	0.0175
71.NSC	-0.0114	0.0212	0.0000	-0.2144	0.0625	0.0149	-0.0003	0.0003	0.0196
72.NOC	-0.0086	0.0139	0.0000	-0.1883	0.0984	0.0041	-0.0002	0.0004	0.0191
73.OLN	0.0503	-0.0327	0.0000	-0.1755	0.1820	0.0347	0.0010	-0.0038	0.0387
74.OMC	-0.0073	-0.0104	0.0002	-0.1905	0.0849	0.0133	-0.0006	0.0004	0.0184
75.PGN	-0.0071	0.0282	0.0000	-0.2045	0.0734	0.0004	-0.0006	0.0006	0.0209
76.PHM	0.0207	-0.0322	0.0000	-0.1878	0.0006	0.0000	-0.0001	0.0003	0.0317
77.RSH	-0.0074	0.0150	0.0007	-0.3354	0.0809	0.0011	-0.0005	0.0005	0.0508
78.RTN	-0.0075	0.0222	0.0002	-0.2045	0.0515	0.0164	-0.0006	0.0003	0.0213
79.RESCAP	-0.0089	0.0075	0.0100	-0.2272	0.0571	0.0235	-0.0009	0.0005	0.0379
80.ROH	-0.0046	0.0102	0.0001	-0.1864	0.1249	0.0606	-0.0008	0.0005	0.0183
81.SWY	-0.0031	0.0079	0.0002	-0.2501	0.1058	0.0006	-0.0006	0.0002	0.0273
82.SLE	-0.0077	0.0160	0.0001	-0.2534	0.0807	0.0009	-0.0008	0.0006	0.0314
83.SRE	-0.0090	0.0157	0.0000	-0.1989	0.0965	0.0001	-0.0007	0.0002	0.0252
84.SHW	-0.0142	0.0141	0.0000	-0.2151	0.0584	0.0008	-0.0011	0.0010	0.0243
85.S	-0.0035	0.0013	0.0000	-0.2521	0.1363	0.0002	0.0007	-0.0002	0.0182
86.HOT	-0.0194	-0.0050	0.0000	-0.3041	-0.0610	0.0000	-0.0006	0.0006	0.0436
87.TGT	-0.0122	0.0401	0.0000	-0.1857	0.1233	0.0000	-0.0006	-0.0001	0.0146
88.TIN	-0.0055	0.0128	0.0000	-0.2776	0.0630	0.0374	-0.0003	0.0004	0.0434
89.TXT	-0.0082	0.0180	0.0000	-0.1988	0.0899	0.0146	-0.0004	0.0006	0.0176
90.TWX	0.0291	-0.0209	0.0000	-0.1670	0.0853	0.0000	-0.0004	-0.0001	0.0243
91.RIG	-0.0048	-0.0040	0.0001	-0.1906	0.2289	0.0137	-0.0013	0.0001	0.0182
92.UNP	-0.0218	0.0159	0.0000	-0.2295	0.0126	0.0196	-0.0002	0.0008	0.0253
93.VLO	-0.0178	0.0151	0.0000	-0.2236	0.0711	0.0039	-0.0005	0.0004	0.0227
94.WMT	-0.0068	0.0167	0.0001	-0.1656	0.0555	0.0081	-0.0006	0.0001	0.0097
95.DIS	-0.0058	0.0192	0.0005	-0.2128	0.0582	0.0134	-0.0006	0.0004	0.0176
96.WFC	-0.0061	0.0163	0.0020	-0.1587	0.0353	0.0466	-0.0004	0.0002	0.0136
97.WY	-0.0020	0.0158	0.0015	-0.2455	0.0944	0.0000	-0.0006	-0.0000	0.0281
98.WHR	-0.0089	0.0088	0.0000	-0.2533	0.0545	0.0003	-0.0008	0.0003	0.0279
99.WYE	-0.0053	0.0197	0.0000	-0.1950	0.1054	0.0009	-0.0007	0.0005	0.0104
100.XL	-0.0068	0.0099	0.0003	-0.1866	0.0552	0.0000	-0.0007	0.0004	0.0186

# Appendix D

## Summary statistics of pricing errors on CDS spreads

Entries report the summary statistics of pricing errors on the CDS spreads with one credit risk factor under affine specifications. The pricing error is defined as the difference between the spread quotes and the model implied fair values, in basis points. The columns titled Mat, Mean, Std, Auto, Max and VR denote the maturity, the sample mean, the standard deviation, the first order autocorrelation, the maximum absolute error, and the explained percentage of variance, respectively. VR is defined as one minus the ratio of pricing error variance to interest rate variance. Data are weekly series from Jan.3, 2005 to Mar.30, 2007.

Tick	Mat	3	4	5	6	7	8	9	10
1.ACE	Mean	-2.19	-0.67	-0.00	-0.30	-0.41	-0.06	0.70	1.92
	Std	4.96	2.35	0.01	1.53	2.74	3.10	3.56	4.05
	Auto	0.74	0.65	-0.00	0.32	0.43	0.57	0.66	0.69
	Max	17.06	8.52	0.08	5.61	9.17	8.22	8.48	11.64
	VR	67.55	95.42	100.00	98.80	96.56	95.91	94.98	93.87

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Tick	Mat	3	4	5	6	7	8	9	10
2.T	Mean	3.32	1.31	-0.00	0.61	1.07	0.84	0.75	0.76
	Std	3.51	2.71	0.01	1.57	2.97	3.70	4.53	5.24
	Auto	0.79	0.54	0.12	0.72	0.74	0.81	0.84	0.85
	Max	10.54	10.19	0.09	4.73	8.87	9.48	10.49	12.33
	VR	41.61	77.23	100.00	96.45	90.11	86.64	82.70	79.45
3.CNG	Mean	3.84	2.03	-0.00	0.57	0.99	1.08	1.27	1.65
	Std	2.45	1.52	0.01	1.42	2.73	3.52	4.32	5.13
	Auto	0.73	0.64	-0.01	0.75	0.74	0.82	0.86	0.87
	Max	9.57	4.88	0.10	5.11	9.94	12.65	14.98	16.90
	VR	47.14	87.19	100.00	94.99	86.57	80.99	75.01	69.24
4.AET	Mean	-0.78	-0.05	-0.00	-0.45	-0.84	-0.23	0.50	1.50
	Std	2.25	1.19	0.01	1.19	2.19	2.44	2.80	3.23
	Auto	0.51	0.47	0.08	0.52	0.54	0.69	0.77	0.80
	Max	7.72	3.99	0.09	4.94	9.79	10.94	12.23	13.72
	VR	69.92	94.20	100.00	96.40	89.97	88.27	86.14	83.40
5.AL	Mean	-0.27	-0.29	-0.01	-0.00	0.17	-0.31	-0.46	-0.24
	Std	6.49	4.06	0.01	2.82	3.55	3.73	3.90	4.12
	Auto	0.77	0.60	0.21	0.11	0.24	0.29	0.33	0.36
	Max	22.31	24.05	0.08	26.81	28.15	29.37	29.14	28.45
	VR	9.78	71.25	100.00	92.11	89.60	89.01	88.40	87.47
6.AA	Mean	0.66	0.17	0.00	0.04	0.26	-0.03	-0.10	0.02
	Std	3.97	2.30	0.01	2.09	3.24	3.31	3.52	3.78
	Auto	0.52	0.43	-0.01	0.16	0.27	0.28	0.31	0.30
	Max	21.48	10.21	0.10	14.85	18.37	18.53	18.36	19.05
	VR	19.82	82.68	100.00	92.52	86.00	86.16	85.26	83.99
7.ALL	Mean	-0.99	-0.13	-0.00	-0.09	-0.17	-0.14	0.06	0.44
	Std	3.62	1.94	0.01	1.31	2.25	2.43	2.64	2.91
	Auto	0.68	0.58	0.00	0.25	0.32	0.37	0.41	0.43
	Max	12.32	7.15	0.11	4.18	8.06	8.49	8.83	9.06
	VR	10.76	83.95	100.00	95.88	89.30	88.53	87.51	86.02
8.MO	Mean	-1.66	-0.71	-0.00	-0.42	-0.27	-0.11	0.63	1.97
	Std	7.23	3.92	0.01	1.71	3.00	3.60	4.29	5.00
	Auto	0.83	0.55	-0.01	0.42	0.56	0.66	0.69	0.68
	Max	18.68	11.95	0.07	6.11	7.93	8.08	9.55	15.14
	VR	92.09	98.19	100.00	99.74	99.25	98.97	98.59	98.15
9.AEP	Mean	-0.67	-0.41	0.00	-0.70	-0.91	-0.41	0.71	2.47
	Std	4.57	3.08	0.00	2.49	3.29	3.87	4.46	5.02
	Auto	0.69	0.63	0.93	0.62	0.68	0.74	0.77	0.77
	Max	16.70	17.06	0.00	14.08	15.08	15.30	14.73	13.40
	VR	43.88	83.49	100.00	93.72	90.43	87.73	85.10	82.54

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Tick	Mat	3	4	5	6	7	8	9	10
10.AXP	Mean	-0.96	-0.34	-0.00	-0.14	-0.20	0.48	1.35	2.45
	Std	2.65	1.39	0.01	0.71	1.32	1.81	2.36	2.92
	Auto	0.86	0.66	-0.02	0.54	0.48	0.74	0.83	0.86
	Max	6.50	4.66	0.11	2.05	3.49	3.96	4.80	7.12
	VR	45.32	92.42	100.00	98.93	96.82	95.07	92.89	90.61
11.AIG	Mean	-0.69	0.31	0.00	0.32	-0.03	-0.08	-0.06	0.05
	Std	3.93	2.64	0.01	1.43	1.78	2.04	2.44	2.95
	Auto	0.65	0.31	-0.01	0.28	0.37	0.51	0.57	0.58
	Max	16.66	16.23	0.13	6.52	5.22	6.88	9.10	11.43
	VR	61.81	88.66	100.00	97.74	96.86	96.21	94.94	93.14
12.AMGN	Mean	0.51	0.45	-0.00	-0.07	-0.11	0.16	0.49	0.95
	Std	2.61	1.58	0.01	1.13	1.97	2.56	3.24	4.00
	Auto	0.81	0.68	-0.02	0.61	0.68	0.81	0.87	0.90
	Max	6.86	8.31	0.12	5.09	6.37	7.57	8.96	10.44
	VR	31.30	85.49	100.00	95.74	89.07	86.04	82.05	77.65
13.APC	Mean	-0.50	-0.03	0.00	-0.31	-0.55	-0.59	-0.19	0.70
	Std	4.93	3.06	0.01	1.60	2.84	3.78	4.82	5.90
	Auto	0.73	0.47	-0.01	0.64	0.69	0.80	0.84	0.86
	Max	24.18	18.26	0.08	4.69	9.04	8.51	11.42	15.33
	VR	3.34	75.91	100.00	96.59	90.41	85.06	78.52	71.71
14.ARW	Mean	-1.49	-0.75	-0.01	-0.94	-1.00	-1.24	-0.38	1.59
	Std	4.81	3.16	0.00	2.08	3.46	3.88	4.46	5.19
	Auto	0.60	0.35	0.95	0.50	0.50	0.55	0.59	0.60
	Max	12.53	9.89	0.01	10.70	11.16	12.20	12.01	14.03
	VR	81.54	92.53	100.00	96.59	89.13	86.33	82.24	76.88
15.AZO	Mean	-7.39	-3.46	-0.02	0.05	-0.01	-0.35	-0.30	0.12
	Std	8.51	4.86	0.02	1.99	3.58	4.05	4.55	5.13
	Auto	0.78	0.61	0.77	0.31	0.34	0.45	0.53	0.58
	Max	32.04	15.20	0.07	8.62	15.77	16.67	17.51	18.19
	VR	51.19	90.01	100.00	98.82	96.16	95.04	93.79	92.16
16.BAX	Mean	-1.40	0.01	-0.00	0.03	-0.28	0.12	0.50	0.87
	Std	2.88	1.73	0.01	1.08	1.91	2.33	2.96	3.71
	Auto	0.79	0.57	-0.01	0.32	0.33	0.56	0.71	0.79
	Max	6.32	6.43	0.14	3.53	4.65	5.78	7.34	9.11
	VR	57.74	90.89	100.00	97.86	93.93	92.63	90.22	87.10
17.BMY	Mean	-0.15	0.67	-0.00	0.17	0.06	0.37	0.62	0.86
	Std	2.67	1.59	0.01	1.09	2.00	2.55	3.25	4.01
	Auto	0.75	0.68	-0.01	0.63	0.66	0.79	0.86	0.89
	Max	6.21	5.31	0.14	2.97	4.79	6.40	7.86	9.23
	VR	-1.42	81.95	100.00	96.28	90.31	87.28	83.16	78.77

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Tick	Mat	3	4	5	6	7	8	9	10
18.BNI	Mean	1.03	0.62	-0.00	-0.07	-0.25	-0.54	-0.74	-0.68
	Std	3.99	2.27	0.01	1.63	2.82	3.45	4.02	4.57
	Auto	0.74	0.51	-0.00	0.67	0.69	0.75	0.76	0.75
	Max	12.83	10.91	0.09	5.68	7.53	10.80	13.94	17.08
	VR	-33.40	81.24	100.00	95.90	90.13	87.73	85.15	82.68
19.CIT	Mean	-4.42	-1.84	-0.00	-0.04	-0.51	0.06	0.46	0.74
	Std	2.70	1.66	0.02	0.75	1.48	1.49	1.75	2.13
	Auto	0.68	0.40	-0.01	0.11	0.19	0.28	0.48	0.67
	Max	12.76	8.20	0.21	4.61	9.59	6.95	5.89	6.99
	VR	60.75	90.81	100.00	98.68	94.88	95.35	94.30	92.32
20.COXENT	Mean	-4.32	-1.64	-0.00	-0.05	-0.11	-0.30	-0.07	0.75
	Std	6.45	3.61	0.01	1.34	2.53	3.05	3.73	4.52
	Auto	0.80	0.61	-0.02	0.42	0.39	0.60	0.68	0.71
	Max	19.78	9.03	0.07	4.65	9.06	10.84	12.04	12.59
	VR	52.57	90.37	100.00	99.15	97.17	96.04	94.25	91.83
21.CSX	Mean	-0.01	-0.10	-0.00	-0.56	-0.96	-0.97	-0.51	0.47
	Std	4.74	2.77	0.01	1.89	3.32	4.01	4.69	5.33
	Auto	0.71	0.60	-0.01	0.55	0.60	0.67	0.69	0.69
	Max	20.70	13.84	0.07	6.63	12.60	16.60	20.60	24.74
	VR	20.73	85.56	100.00	96.85	91.92	89.44	86.83	84.34
22.CVS	Mean	0.05	0.19	-0.00	0.08	-0.04	-0.12	-0.22	-0.19
	Std	4.27	2.40	0.02	1.68	3.02	3.57	4.19	4.81
	Auto	0.79	0.54	-0.02	0.60	0.61	0.72	0.76	0.77
	Max	14.15	9.93	0.12	7.00	10.71	11.12	11.31	11.27
	VR	30.63	87.43	100.00	96.75	91.04	88.95	86.50	83.90
23.CPB	Mean	0.94	-0.11	-0.00	-0.17	-0.22	-0.23	0.17	0.89
	Std	4.40	3.44	0.01	1.65	2.88	3.82	4.40	5.00
	Auto	0.71	0.60	-0.01	0.54	0.64	0.67	0.74	0.78
	Max	16.96	17.71	0.09	8.05	7.42	17.02	16.31	15.33
	VR	-31.56	56.36	100.00	96.01	90.53	85.71	83.71	81.60
24.COF	Mean	-0.73	-0.50	0.00	-0.35	-2.11	-0.58	0.54	1.42
	Std	5.47	3.69	0.01	2.78	4.30	3.33	3.71	5.28
	Auto	0.77	0.70	-0.01	0.65	0.67	0.61	0.66	0.74
	Max	15.26	11.32	0.08	12.86	18.31	13.50	15.03	21.71
	VR	53.10	87.10	100.00	95.42	90.29	94.75	94.05	89.28
25.CAH	Mean	-1.05	0.05	-0.00	-0.19	-0.40	-0.46	-0.15	0.60
	Std	4.54	2.59	0.01	1.46	2.69	3.12	3.56	3.98
	Auto	0.74	0.44	-0.00	0.49	0.53	0.62	0.67	0.70
	Max	16.55	11.67	0.07	4.25	6.70	7.43	8.97	11.24
	VR	82.37	96.23	100.00	99.17	97.38	96.67	95.86	95.03

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Tick	Mat	3	4	5	6	7	8	9	10
26.CCL	Mean	-0.21	1.15	-0.00	0.03	-0.09	-0.22	-0.23	-0.04
	Std	3.25	2.84	0.00	1.25	2.16	2.58	3.09	3.65
	Auto	0.75	0.69	0.96	0.45	0.49	0.66	0.74	0.78
	Max	10.04	8.47	0.00	4.52	5.64	7.29	8.62	9.56
	VR	-85.88	62.42	100.00	95.20	88.18	85.79	82.58	79.09
27.CAT	Mean	0.06	0.54	-0.00	0.23	0.35	0.22	0.04	-0.13
	Std	2.14	1.05	0.01	1.26	2.13	2.40	2.77	3.18
	Auto	0.43	0.36	0.04	0.57	0.48	0.57	0.60	0.60
	Max	8.75	3.73	0.14	3.83	6.59	6.72	7.72	8.88
	VR	42.75	91.42	100.00	93.54	85.22	83.87	81.50	78.68
28.CTX	Mean	0.06	-1.07	0.00	-0.69	-0.79	-0.71	0.27	2.29
	Std	5.14	3.81	0.00	2.10	3.17	4.09	5.07	6.06
	Auto	0.57	0.35	-0.01	0.30	0.58	0.76	0.83	0.85
	Max	22.19	11.65	0.05	7.24	11.97	12.97	13.11	17.47
	VR	72.87	89.48	100.00	97.50	94.77	91.82	88.11	83.95
29.CTL	Mean	-0.68	0.40	-0.00	-0.69	-0.76	-1.07	-0.37	1.45
	Std	5.14	3.55	0.00	3.44	5.95	7.22	8.42	9.62
	Auto	0.60	0.36	-0.01	0.76	0.81	0.84	0.86	0.87
	Max	13.14	12.30	0.05	14.00	17.76	19.59	22.37	27.74
	VR	58.65	86.22	100.00	88.09	70.57	61.90	54.72	48.54
30.CB	Mean	-0.29	0.50	-0.00	0.09	-0.10	-0.05	-0.06	0.00
	Std	3.43	2.15	0.01	1.41	2.48	2.60	2.98	3.37
	Auto	0.76	0.65	0.08	0.65	0.77	0.81	0.85	0.86
	Max	8.87	8.95	0.12	4.69	6.14	7.47	8.48	9.50
	VR	44.05	83.61	100.00	94.57	85.41	87.06	85.54	83.75
31.CI	Mean	-4.53	-1.61	0.00	-0.06	-0.34	-0.37	-0.46	-0.56
	Std	2.92	1.69	0.01	1.29	2.17	2.36	2.68	3.09
	Auto	0.65	0.56	-0.01	0.51	0.57	0.64	0.68	0.70
	Max	11.68	5.72	0.14	4.44	6.85	7.11	7.17	7.13
	VR	68.54	92.10	100.00	97.12	93.05	92.31	90.89	88.84
32.CMCSA	Mean	-1.45	-0.43	-0.00	0.37	0.22	-0.40	-1.12	-1.82
	Std	4.59	3.30	0.01	1.58	3.07	3.06	3.36	3.88
	Auto	0.83	0.76	-0.02	0.37	0.35	0.58	0.74	0.79
	Max	12.12	8.59	0.13	9.51	19.35	13.13	11.41	13.32
	VR	57.09	85.48	100.00	98.23	94.01	94.36	93.61	91.96
33.CAG	Mean	-2.25	-1.35	0.00	-0.06	-0.08	-0.35	-0.27	0.21
	Std	7.44	4.13	0.01	1.68	3.17	3.66	4.14	4.62
	Auto	0.87	0.76	-0.01	0.58	0.56	0.63	0.66	0.67
	Max	19.37	9.19	0.08	4.40	12.12	12.36	12.33	11.94
	VR	-0.17	84.83	100.00	98.80	96.25	95.33	94.33	93.28

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Tick	Mat	3	4	5	6	7	8	9	10
34.CEG	Mean	0.49	0.13	0.00	-0.12	-0.37	-0.42	0.35	1.84
	Std	6.62	4.28	0.01	2.55	3.32	3.76	4.51	5.32
	Auto	0.78	0.71	-0.01	0.56	0.65	0.75	0.80	0.83
	Max	23.67	22.28	0.07	13.74	14.38	14.34	13.58	12.09
	VR	13.44	65.63	100.00	93.34	89.96	87.56	82.89	77.54
35.CFC	Mean	-4.21	-1.95	0.00	-1.26	-1.98	-1.16	0.15	2.01
	Std	5.11	3.96	0.01	2.69	4.05	3.38	3.36	4.34
	Auto	0.59	0.51	-0.01	0.42	0.45	0.41	0.38	0.49
	Max	21.34	17.52	0.07	14.30	17.08	14.53	13.82	20.62
	VR	48.51	79.24	100.00	94.20	87.66	92.28	92.88	88.75
36.DE	Mean	-0.22	0.25	-0.00	-0.09	-0.12	-0.08	0.02	0.28
	Std	1.98	1.10	0.01	1.19	1.99	2.18	2.45	2.78
	Auto	0.53	0.48	-0.01	0.34	0.37	0.45	0.50	0.52
	Max	6.62	3.19	0.11	3.75	5.90	5.97	6.47	7.37
	VR	46.36	89.47	100.00	93.19	84.25	83.65	82.44	80.35
37.DVN	Mean	-1.32	-0.16	0.00	-0.07	-0.10	-0.32	-0.19	0.28
	Std	4.38	2.88	0.01	0.98	1.94	2.04	2.33	2.76
	Auto	0.63	0.49	-0.01	0.29	0.30	0.46	0.55	0.58
	Max	21.80	17.32	0.08	3.69	7.24	7.05	6.47	8.02
	VR	47.85	84.39	100.00	98.81	95.56	95.47	94.53	92.95
38.D	Mean	-0.82	-1.04	0.00	-0.83	-1.08	-0.86	-0.17	1.11
	Std	4.71	3.64	0.01	3.11	4.11	4.85	5.62	6.39
	Auto	0.70	0.63	-0.01	0.68	0.74	0.78	0.80	0.80
	Max	14.09	18.77	0.07	22.38	26.01	28.93	31.11	32.58
	VR	51.49	78.91	100.00	90.78	85.95	81.95	77.70	73.39
39.DUK	Mean	-1.29	-1.11	0.00	-0.01	0.59	0.94	1.48	2.30
	Std	4.17	2.70	0.01	1.96	3.29	3.92	4.58	5.25
	Auto	0.83	0.67	-0.01	0.66	0.70	0.77	0.78	0.77
	Max	12.23	11.48	0.09	6.70	9.65	12.39	15.56	18.85
	VR	50.13	86.06	100.00	96.38	91.55	89.51	87.20	84.77
40.DD	Mean	0.40	0.12	-0.00	0.12	-0.09	0.38	0.01	-0.41
	Std	3.69	1.94	0.03	2.03	4.01	2.49	2.88	3.32
	Auto	0.72	0.34	-0.02	0.67	0.67	0.58	0.65	0.68
	Max	14.50	6.94	0.22	8.29	16.38	7.80	7.40	7.27
	VR	1.71	79.58	100.00	86.86	66.63	83.87	80.79	77.24
41.EMN	Mean	-0.20	-0.25	-0.00	-0.11	-0.03	-0.42	-0.27	0.51
	Std	3.62	2.98	0.01	1.56	2.89	2.83	3.12	3.52
	Auto	0.46	0.32	-0.01	0.37	0.38	0.42	0.41	0.40
	Max	8.85	9.63	0.07	5.42	9.23	8.49	9.23	10.46
	VR	78.67	87.07	100.00	97.36	92.47	92.89	91.82	90.13

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Tick	Mat	3	4	5	6	7	8	9	10
42.FD	Mean	0.41	0.58	-0.00	0.26	0.36	-0.42	-0.83	-0.78
	Std	3.87	3.09	0.00	2.52	4.56	5.81	6.62	7.36
	Auto	0.72	0.57	0.93	0.70	0.76	0.79	0.85	0.87
	Max	9.95	10.54	0.00	8.52	16.14	21.22	20.66	22.93
	VR	22.00	68.48	100.00	91.81	81.51	75.98	73.14	70.67
43.FE	Mean	-1.26	-1.31	-0.00	-0.66	-0.51	-0.49	0.30	1.80
	Std	5.56	3.71	0.01	2.06	3.14	3.80	4.53	5.33
	Auto	0.65	0.48	-0.01	0.43	0.61	0.69	0.67	0.62
	Max	20.97	18.50	0.07	12.34	15.81	16.42	16.20	15.15
	VR	53.52	86.35	100.00	97.46	95.14	93.51	91.66	89.43
44.FHLMC	Mean	-0.90	-8.25	-0.00	-10.84	-0.24	-12.26	-12.54	1.63
	Std	4.15	4.77	0.01	3.97	2.00	3.53	3.42	3.56
	Auto	0.83	0.86	0.00	0.94	0.53	0.90	0.90	0.83
	Max	10.76	27.14	0.12	26.43	6.00	26.81	26.67	13.22
	VR	4.50	-58.96	100.00	16.97	95.34	58.57	67.70	89.87
45.GPS	Mean	2.91	-0.38	0.00	-3.15	-4.03	-4.27	-1.84	3.17
	Std	13.29	6.60	0.00	5.49	10.14	12.23	14.01	15.56
	Auto	0.84	0.60	0.02	0.80	0.82	0.87	0.90	0.92
	Max	31.91	20.09	0.04	16.00	29.37	34.48	42.50	52.56
	VR	-0.73	88.19	100.00	95.96	89.01	85.98	83.43	81.23
46.GE	Mean	-1.73	-0.71	0.00	-0.04	-0.14	0.06	0.49	0.69
	Std	2.55	1.39	0.02	0.67	1.27	2.03	2.72	3.46
	Auto	0.85	0.71	-0.00	0.68	0.67	0.84	0.88	0.93
	Max	9.60	4.29	0.17	1.45	2.86	4.34	6.34	8.28
	VR	22.62	88.84	100.00	98.69	96.11	92.21	88.31	84.71
47.GIS	Mean	-0.28	-0.43	-0.00	-0.11	-0.31	-0.44	-0.28	0.18
	Std	3.69	2.83	0.01	1.50	2.82	3.24	3.69	4.19
	Auto	0.86	0.73	-0.01	0.56	0.59	0.71	0.77	0.79
	Max	8.22	6.68	0.09	4.78	9.41	9.35	8.91	10.06
	VR	41.43	81.71	100.00	97.12	91.51	90.35	88.90	87.14
48.GR	Mean	-1.66	-0.43	-0.00	-0.14	-0.08	-0.42	-0.19	0.64
	Std	6.81	3.76	0.01	1.80	3.46	3.83	4.39	5.06
	Auto	0.67	0.62	-0.01	0.32	0.29	0.44	0.53	0.59
	Max	41.68	22.09	0.07	9.75	19.06	18.69	18.50	18.61
	VR	40.78	89.58	100.00	98.64	95.44	94.63	93.23	91.33
49.HAL	Mean	-0.56	0.11	-0.00	-0.07	-0.23	-0.25	-0.04	0.46
	Std	3.30	2.15	0.00	1.46	2.25	2.53	2.91	3.34
	Auto	0.54	0.42	0.96	0.26	0.40	0.49	0.56	0.61
	Max	10.39	8.46	0.00	7.18	9.09	10.04	11.15	12.51
	VR	50.32	82.54	100.00	94.66	88.54	87.78	86.23	84.32

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Tick	Mat	3	4	5	6	7	8	9	10
50.HIG	Mean	-1.45	-0.36	0.00	-0.09	-0.20	-0.15	0.11	0.63
	Std	3.71	1.78	0.01	1.21	2.25	2.38	2.72	3.16
	Auto	0.82	0.78	-0.01	0.61	0.61	0.74	0.82	0.84
	Max	11.57	6.35	0.10	3.78	5.47	5.07	6.33	8.39
	VR	48.83	93.21	100.00	98.11	93.89	94.16	93.32	92.01
51.HPQ	Mean	1.23	0.82	-0.00	0.92	1.57	0.85	0.13	-0.55
	Std	2.79	1.87	0.01	1.71	3.25	4.09	5.03	6.04
	Auto	0.69	0.68	-0.01	0.73	0.72	0.82	0.84	0.83
	Max	7.20	6.55	0.13	4.58	8.55	8.83	13.16	17.39
	VR	88.08	95.46	100.00	97.50	92.57	89.88	86.48	82.73
52.HON	Mean	0.11	0.57	-0.00	0.39	0.47	0.53	0.39	0.22
	Std	2.08	1.18	0.02	1.06	2.02	2.39	3.09	3.89
	Auto	0.58	0.49	-0.03	0.50	0.50	0.69	0.77	0.78
	Max	7.54	4.38	0.20	3.02	5.55	6.69	8.10	10.49
	VR	32.23	86.23	100.00	93.94	82.82	80.41	73.55	66.03
53.IR	Mean	-0.51	0.36	-0.00	0.07	-0.06	-0.13	-0.15	-0.05
	Std	2.91	1.50	0.00	1.72	3.21	3.70	4.23	4.74
	Auto	0.73	0.52	0.90	0.78	0.78	0.80	0.80	0.79
	Max	9.38	5.96	0.00	5.47	10.16	12.47	14.52	16.64
	VR	35.57	89.29	100.00	93.45	83.22	80.24	76.94	73.91
54.IBM	Mean	1.54	0.89	-0.00	0.34	0.42	-0.13	-0.73	-1.33
	Std	2.35	1.47	0.02	1.39	2.62	3.64	4.69	5.74
	Auto	0.70	0.36	0.06	0.75	0.73	0.81	0.82	0.81
	Max	6.70	7.94	0.17	3.68	7.09	8.20	10.02	12.75
	VR	65.07	89.32	100.00	94.90	86.44	79.79	73.24	67.34
55.ILFC	Mean	-1.95	-0.98	-0.00	-0.29	-0.27	1.18	3.00	5.25
	Std	3.87	2.51	0.01	1.11	2.04	2.25	2.61	3.06
	Auto	0.65	0.34	-0.01	0.27	0.21	0.50	0.70	0.79
	Max	21.92	20.52	0.08	6.69	13.24	9.33	8.73	11.61
	VR	69.42	91.65	100.00	98.98	96.83	96.61	95.87	94.86
56.IP	Mean	-2.02	-1.94	-0.00	-0.44	-0.59	-0.93	-0.38	1.10
	Std	7.10	4.90	0.01	3.22	5.44	4.70	4.28	4.26
	Auto	0.73	0.72	-0.01	0.15	0.20	0.34	0.48	0.54
	Max	20.68	15.23	0.06	23.68	46.43	34.10	20.71	13.81
	VR	63.61	86.62	100.00	96.82	91.99	93.91	94.90	94.94
57.JNY	Mean	-0.54	-1.70	-0.00	-2.07	-3.36	-3.23	-0.91	3.33
	Std	20.79	11.20	0.00	6.43	9.72	11.35	12.62	13.28
	Auto	0.91	0.86	0.01	0.71	0.78	0.82	0.84	0.85
	Max	56.49	30.96	0.04	24.40	34.56	37.59	37.69	35.03
	VR	7.66	86.18	100.00	97.82	95.45	94.00	92.74	91.93

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Tick	Mat	3	4	5	6	7	8	9	10
58.KFT	Mean	0.89	-0.05	0.00	0.02	-0.08	-0.20	-0.22	-0.01
	Std	2.90	2.50	0.01	1.23	2.09	2.68	3.16	3.65
	Auto	0.77	0.50	-0.01	0.35	0.46	0.51	0.56	0.58
	Max	7.77	7.10	0.10	5.52	6.02	8.95	9.36	10.04
	VR	22.46	67.56	100.00	95.78	90.19	86.10	82.84	79.29
59.KR	Mean	-0.37	-1.03	-0.00	-0.16	-0.20	-0.72	-0.55	0.35
	Std	7.00	3.37	0.00	1.64	2.87	3.25	3.78	4.38
	Auto	0.86	0.66	-0.02	0.53	0.53	0.65	0.69	0.68
	Max	20.80	11.22	0.00	5.15	8.24	8.46	10.82	14.03
	VR	39.11	93.03	100.00	98.86	96.79	96.19	95.17	93.88
60.LEN	Mean	-0.03	-0.94	-0.01	-1.59	-2.11	-1.90	-0.34	2.56
	Std	4.99	4.08	0.00	1.75	3.33	4.02	4.77	5.50
	Auto	0.54	0.33	0.84	0.57	0.55	0.66	0.72	0.75
	Max	21.20	15.80	0.02	7.48	13.37	14.99	15.77	15.24
	VR	75.11	88.01	100.00	98.28	94.23	91.85	88.98	85.98
61.LMT	Mean	0.32	0.44	-0.00	0.03	0.16	0.09	0.38	1.05
	Std	4.69	2.58	0.01	1.40	2.68	3.20	3.85	4.52
	Auto	0.80	0.64	-0.01	0.74	0.72	0.78	0.81	0.81
	Max	22.57	17.26	0.09	3.42	6.42	7.60	8.39	10.96
	VR	8.89	86.97	100.00	98.30	94.90	93.41	91.33	89.03
62.LTD	Mean	-3.14	-1.75	-0.00	-0.33	-0.52	-0.80	-0.28	1.14
	Std	7.73	4.46	0.01	2.97	4.48	4.77	5.08	5.38
	Auto	0.70	0.28	-0.00	0.06	0.17	0.22	0.28	0.31
	Max	20.87	23.02	0.06	19.50	19.12	19.18	20.23	22.27
	VR	71.35	93.96	100.00	97.93	95.53	95.03	94.41	93.76
63.MAR	Mean	-0.48	-0.17	-0.00	-0.05	-0.19	-0.41	-0.18	0.76
	Std	3.67	2.24	0.00	1.57	2.83	3.57	4.41	4.65
	Auto	0.58	0.42	0.93	0.18	0.20	0.35	0.41	0.59
	Max	15.09	6.25	0.00	5.71	11.44	16.99	22.26	15.75
	VR	9.63	79.93	100.00	95.10	87.69	82.74	77.00	74.03
64.MMC	Mean	-1.24	0.27	-0.00	0.21	-0.09	0.22	0.42	0.80
	Std	5.21	2.69	0.01	1.69	2.98	4.15	4.91	5.76
	Auto	0.66	0.61	-0.01	0.45	0.52	0.48	0.59	0.63
	Max	24.12	13.41	0.09	6.28	9.95	19.40	16.97	15.19
	VR	87.88	96.85	100.00	98.94	96.92	94.62	92.79	90.53
65.MCD	Mean	1.90	0.63	-0.01	-0.23	-0.19	0.19	1.03	2.35
	Std	4.42	2.64	0.02	1.42	2.71	3.48	4.30	5.12
	Auto	0.90	0.80	0.81	0.76	0.78	0.87	0.91	0.92
	Max	9.98	6.04	0.08	4.26	8.53	8.96	10.63	13.92
	VR	1.50	83.09	100.00	97.96	94.15	91.79	89.15	86.43

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Tick	Mat	3	4	5	6	7	8	9	10
66.MCK	Mean	-0.76	0.62	-0.00	-0.18	-0.44	-0.44	-0.20	0.42
	Std	5.39	3.58	0.01	2.23	4.12	4.95	5.87	6.74
	Auto	0.77	0.66	-0.00	0.67	0.65	0.79	0.83	0.85
	Max	17.65	17.54	0.08	6.60	13.22	13.22	15.79	18.72
	VR	76.48	93.03	100.00	98.12	94.33	92.42	90.04	87.65
67.MOT	Mean	3.56	1.31	-0.00	0.08	0.49	-0.54	-0.94	-0.69
	Std	4.61	3.01	0.01	1.71	3.17	3.80	4.71	5.77
	Auto	0.74	0.73	-0.03	0.50	0.46	0.61	0.64	0.64
	Max	12.17	8.88	0.07	5.14	9.89	12.00	14.31	16.96
	VR	33.04	83.92	100.00	97.42	92.58	90.61	87.18	83.00
68.NRUC	Mean	-0.80	0.07	-0.00	0.05	-0.08	0.87	1.12	1.36
	Std	3.00	2.70	0.02	1.69	2.29	3.87	4.49	5.22
	Auto	0.84	0.85	-0.01	0.52	0.55	0.83	0.83	0.82
	Max	7.67	7.81	0.17	5.94	6.07	13.58	13.96	14.28
	VR	28.83	69.80	100.00	93.53	89.88	79.94	77.31	73.89
69.NWL	Mean	-0.28	-0.82	0.00	-0.01	0.11	-0.24	-0.14	0.47
	Std	5.69	3.77	0.01	1.39	2.71	2.95	3.34	3.83
	Auto	0.71	0.60	-0.01	0.35	0.34	0.37	0.39	0.39
	Max	22.20	11.15	0.07	3.80	7.87	7.92	8.22	8.62
	VR	61.75	88.62	100.00	99.02	96.50	96.14	95.34	94.23
70.JWN	Mean	0.28	0.76	-0.00	0.14	-0.11	0.14	0.53	1.13
	Std	5.08	2.60	0.01	1.96	2.75	3.26	4.05	4.96
	Auto	0.79	0.57	-0.30	0.26	0.41	0.63	0.71	0.71
	Max	20.34	8.23	0.10	16.41	13.94	15.98	17.74	19.36
	VR	21.62	90.95	100.00	97.13	94.86	93.83	91.74	89.10
71.NSC	Mean	1.38	0.71	-0.00	-0.06	-0.12	-0.34	-0.31	0.03
	Std	3.92	2.35	0.01	1.81	3.07	3.67	4.28	4.84
	Auto	0.72	0.58	-0.02	0.62	0.67	0.74	0.77	0.77
	Max	14.30	8.73	0.09	5.21	9.14	11.02	12.82	14.69
	VR	-17.93	81.94	100.00	95.24	89.33	86.71	84.02	81.52
72.NOC	Mean	0.11	0.49	0.00	0.02	0.06	-0.07	0.08	0.55
	Std	4.30	2.25	0.01	1.36	2.60	3.19	3.87	4.59
	Auto	0.79	0.69	-0.01	0.75	0.74	0.82	0.83	0.81
	Max	22.19	13.64	0.09	4.26	8.17	9.25	10.40	13.20
	VR	21.27	89.42	100.00	98.20	94.55	92.59	90.04	87.14
73.OLN	Mean	-0.17	0.35	-0.00	-1.12	-1.06	-0.77	1.10	4.58
	Std	6.86	4.93	0.00	3.71	6.34	8.70	10.78	12.57
	Auto	0.49	0.35	-0.01	0.70	0.75	0.81	0.85	0.87
	Max	26.23	24.54	0.04	13.81	16.47	29.56	36.16	34.62
	VR	48.23	80.72	100.00	94.62	87.95	82.23	77.52	73.81

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Tick	Mat	3	4	5	6	7	8	9	10
74.OMC	Mean	0.96	0.61	-0.00	0.32	0.51	-0.07	-0.45	-0.57
	Std	4.30	2.52	0.01	1.79	3.43	4.02	4.79	5.63
	Auto	0.82	0.65	0.01	0.63	0.61	0.71	0.74	0.73
	Max	8.19	6.35	0.09	4.45	8.53	9.79	12.53	15.41
	VR	-19.19	80.04	100.00	95.17	85.01	82.05	77.64	72.72
75.PGN	Mean	-2.51	-1.78	-0.00	-0.34	-0.38	-0.17	0.36	1.34
	Std	10.10	9.15	0.01	3.29	4.35	4.96	5.62	6.20
	Auto	0.87	0.85	-0.01	0.23	0.44	0.53	0.59	0.62
	Max	60.27	58.77	0.08	19.69	18.91	18.13	17.23	16.48
	VR	-8.66	38.46	100.00	96.04	94.06	92.99	91.69	90.55
76.PHM	Mean	-2.40	-1.81	0.00	-0.80	-1.09	-1.02	0.01	2.22
	Std	5.30	3.95	0.00	3.22	2.75	3.23	3.75	3.98
	Auto	0.53	0.50	-0.01	0.34	0.31	0.45	0.51	0.57
	Max	20.28	14.84	0.05	19.67	11.08	11.14	13.21	16.55
	VR	76.92	90.33	100.00	94.79	96.38	95.11	93.50	92.67
77.RSH	Mean	2.98	-0.63	-0.00	-3.69	-4.47	-5.12	-2.55	2.71
	Std	16.96	9.58	0.00	6.91	12.72	15.14	17.00	18.52
	Auto	0.88	0.79	0.04	0.78	0.86	0.87	0.91	0.92
	Max	49.58	26.68	0.03	20.29	30.57	34.33	37.14	45.12
	VR	52.72	90.37	100.00	97.45	93.03	90.75	89.02	87.61
78.RTN	Mean	-0.67	0.15	-0.00	-0.12	-0.11	-0.21	0.06	0.74
	Std	6.10	2.94	0.01	1.42	2.65	3.34	4.05	4.77
	Auto	0.83	0.80	-0.01	0.77	0.73	0.79	0.79	0.76
	Max	29.29	13.30	0.08	3.33	6.39	7.27	9.38	12.90
	VR	1.37	89.86	100.00	98.86	96.57	95.04	93.24	91.24
79.RESCAP	Mean	5.62	1.27	-0.01	-1.89	-1.25	-0.22	2.23	6.02
	Std	15.58	9.27	0.01	5.99	7.85	9.84	11.39	12.66
	Auto	0.81	0.63	0.52	0.50	0.65	0.69	0.70	0.69
	Max	41.36	28.38	0.05	30.98	25.73	41.65	46.41	45.96
	VR	77.14	93.68	100.00	98.15	97.02	95.59	94.33	93.19
80.ROH	Mean	0.27	0.47	-0.00	0.21	0.36	-0.05	-0.24	-0.16
	Std	3.02	1.47	0.01	1.20	2.27	2.47	2.76	3.12
	Auto	0.62	0.42	-0.01	0.46	0.47	0.57	0.60	0.59
	Max	9.85	4.26	0.09	3.07	6.00	6.63	7.78	8.54
	VR	60.81	93.91	100.00	97.26	91.68	90.54	88.66	86.16
81.SWY	Mean	-2.89	-2.68	-0.00	-0.14	-0.09	-0.38	-0.06	0.94
	Std	7.33	4.19	0.01	1.55	2.94	3.49	4.23	5.05
	Auto	0.84	0.63	-0.01	0.46	0.43	0.57	0.64	0.68
	Max	23.36	16.09	0.06	4.87	9.45	11.69	14.90	18.73
	VR	52.23	91.35	100.00	99.20	97.33	96.58	95.39	93.95

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Tick	Mat	3	4	5	6	7	8	9	10
82.SLE	Mean	0.58	-0.38	-0.00	-1.00	-1.02	-1.17	-0.36	1.49
	Std	9.80	5.87	0.00	4.85	7.30	8.73	10.11	11.40
	Auto	0.80	0.69	-0.01	0.62	0.73	0.78	0.81	0.82
	Max	32.09	15.97	0.05	34.22	38.10	40.96	42.71	43.35
	VR	2.06	82.23	100.00	93.67	88.27	84.70	81.16	77.85
83.SRE	Mean	-1.19	-1.69	-0.00	-0.89	-0.90	-0.66	0.67	2.70
	Std	8.49	7.62	0.01	4.04	4.72	6.59	7.22	7.95
	Auto	0.89	0.85	-0.01	0.64	0.66	0.78	0.78	0.79
	Max	46.37	45.82	0.07	31.00	31.72	38.61	36.69	34.09
	VR	-23.91	37.08	100.00	91.33	89.76	82.62	81.65	80.22
84.SHW	Mean	-1.08	-0.10	-0.00	-0.71	-0.96	-0.93	-0.37	0.78
	Std	7.66	5.35	0.01	2.51	4.13	4.58	4.95	5.27
	Auto	0.65	0.38	-0.01	0.69	0.68	0.70	0.68	0.63
	Max	33.09	37.12	0.07	11.69	14.96	16.18	16.47	15.86
	VR	67.42	88.47	100.00	98.26	95.73	94.84	94.02	93.22
85.S	Mean	-0.02	0.33	0.00	0.21	0.33	-0.67	-1.46	-1.75
	Std	4.67	2.33	0.01	2.55	4.42	5.68	6.93	8.10
	Auto	0.72	0.33	-0.01	0.66	0.78	0.85	0.88	0.90
	Max	12.68	5.47	0.09	9.22	16.96	20.44	23.39	26.06
	VR	-6.84	89.34	100.00	92.52	83.77	77.19	71.33	66.79
86.HOT	Mean	0.86	1.42	0.00	-2.12	-2.13	-2.62	-1.00	2.73
	Std	13.75	9.69	0.00	6.44	10.97	13.60	16.01	18.25
	Auto	0.78	0.77	0.87	0.72	0.83	0.88	0.90	0.92
	Max	41.39	32.56	0.00	16.96	24.30	29.00	35.97	40.66
	VR	74.92	83.98	100.00	93.80	83.33	76.66	70.43	64.76
87.TGT	Mean	0.71	0.39	0.00	-0.09	-0.08	0.61	1.48	2.57
	Std	2.47	1.90	0.01	1.72	2.45	2.88	3.45	4.06
	Auto	0.36	0.23	-0.01	0.17	0.32	0.49	0.62	0.70
	Max	13.19	13.82	0.11	14.10	13.22	11.96	11.06	15.36
	VR	-31.50	54.36	100.00	80.77	70.60	72.85	71.79	69.99
88.TIN	Mean	1.49	-0.06	-0.00	-1.38	-0.88	0.57	4.14	9.84
	Std	11.93	7.77	0.00	3.38	6.26	7.84	9.21	10.38
	Auto	0.61	0.35	-0.01	0.83	0.82	0.87	0.89	0.90
	Max	68.18	54.05	0.04	12.98	23.78	24.09	25.38	34.61
	VR	31.95	73.11	100.00	96.42	89.17	84.28	79.72	75.64
89.TXT	Mean	0.55	0.72	-0.00	0.18	0.25	-0.06	-0.19	-0.07
	Std	4.13	2.03	0.01	1.59	3.00	3.48	4.02	4.55
	Auto	0.84	0.75	-0.02	0.70	0.69	0.78	0.81	0.81
	Max	9.60	6.88	0.09	4.24	8.35	8.41	10.09	10.11
	VR	-80.33	81.60	100.00	95.62	88.35	86.14	83.49	80.74

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Tick	Mat	3	4	5	6	7	8	9	10
90.TWX	Mean	-0.73	-0.53	0.00	-0.14	-0.10	0.01	0.64	1.85
	Std	4.69	3.15	0.01	1.20	2.30	2.63	3.10	3.75
	Auto	0.70	0.65	-0.01	0.27	0.29	0.49	0.65	0.72
	Max	12.02	9.07	0.07	4.29	8.06	10.11	11.44	12.04
	VR	60.78	87.84	100.00	99.00	96.73	96.08	94.94	93.23
91.RIG	Mean	-0.38	0.39	-0.00	0.19	0.22	-0.18	-0.42	-0.42
	Std	2.86	1.82	0.01	1.58	2.95	3.60	4.44	5.34
	Auto	0.52	0.43	-0.01	0.61	0.67	0.80	0.83	0.82
	Max	10.95	7.72	0.09	5.55	10.98	15.72	20.63	25.77
	VR	5.58	69.32	100.00	89.13	73.91	68.73	61.97	55.55
92.UNP	Mean	0.13	-0.06	-0.00	-0.64	-1.01	-1.17	-0.77	0.28
	Std	5.18	2.78	0.01	1.89	3.35	3.97	4.60	5.19
	Auto	0.69	0.58	-0.01	0.55	0.61	0.66	0.68	0.68
	Max	23.10	10.42	0.07	8.13	12.18	15.25	19.43	23.83
	VR	-8.41	84.29	100.00	96.60	91.22	88.92	86.40	84.02
93.VLO	Mean	-2.01	-0.88	-0.00	-0.24	-0.42	-0.49	-0.25	0.46
	Std	6.19	5.25	0.01	1.73	3.33	3.52	3.67	3.98
	Auto	0.57	0.41	-0.01	0.35	0.40	0.46	0.53	0.58
	Max	44.87	46.01	0.07	9.76	19.70	14.43	15.91	17.87
	VR	56.85	76.26	100.00	98.19	93.66	93.82	93.75	93.16
94.WMT	Mean	0.76	0.36	-0.00	0.30	0.46	0.27	0.07	-0.09
	Std	2.09	1.33	0.03	0.99	1.86	2.30	2.82	3.38
	Auto	0.50	0.37	-0.03	0.61	0.64	0.77	0.84	0.87
	Max	7.38	4.55	0.17	4.78	9.42	9.90	10.37	10.89
	VR	1.65	77.06	99.99	93.47	83.14	80.03	75.92	71.79
95.DIS	Mean	1.63	1.06	-0.00	0.31	0.59	0.66	0.94	1.48
	Std	4.69	2.65	0.01	1.69	3.21	4.16	5.14	6.11
	Auto	0.81	0.76	0.01	0.75	0.79	0.85	0.87	0.88
	Max	11.34	7.93	0.10	4.44	8.55	11.98	14.98	17.55
	VR	31.14	88.37	100.00	97.76	93.45	90.61	87.56	84.57
96.WFC	Mean	1.33	-3.10	-0.00	-5.76	-0.73	-6.88	-7.01	-0.02
	Std	2.72	1.77	0.01	1.02	1.51	1.00	1.40	2.40
	Auto	0.84	0.74	0.46	0.46	0.75	0.39	0.68	0.80
	Max	6.42	6.57	0.12	8.79	3.87	9.16	9.55	5.74
	VR	-95.76	63.42	100.00	93.28	93.35	96.16	94.02	86.48
97.WY	Mean	-1.07	-0.75	-0.00	-0.59	-0.77	-0.77	-0.08	1.33
	Std	8.11	5.08	0.00	3.36	5.98	6.74	7.68	8.65
	Auto	0.45	0.25	0.00	0.29	0.29	0.53	0.67	0.74
	Max	29.60	25.94	0.05	18.09	34.92	35.71	36.29	35.92
	VR	43.58	84.33	100.00	95.53	87.44	84.34	80.14	75.37

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Tick	Mat	3	4	5	6	7	8	9	10
98.WHR	Mean	0.39	-0.08	-0.00	-0.64	-1.00	-1.79	-1.90	-1.30
	Std	5.54	3.24	0.00	2.24	3.99	5.50	6.90	8.07
	Auto	0.69	0.44	0.95	0.74	0.75	0.84	0.87	0.89
	Max	14.64	13.31	0.00	8.06	9.75	17.14	22.20	23.59
	VR	61.48	91.57	100.00	97.02	91.15	85.12	79.07	73.85
99.WYE	Mean	-1.17	0.07	-0.00	0.17	-0.03	0.43	0.79	1.09
	Std	3.33	1.69	0.01	1.16	2.12	2.74	3.60	4.56
	Auto	0.78	0.50	-0.01	0.48	0.61	0.80	0.87	0.90
	Max	14.01	7.91	0.16	2.78	5.44	5.48	7.15	8.71
	VR	15.38	89.79	100.00	97.42	93.02	90.75	86.99	82.70
100.XL	Mean	-4.59	-1.55	-0.00	-0.25	-0.68	-0.44	-0.03	0.62
	Std	5.14	2.58	0.01	1.72	3.17	3.31	3.55	3.87
	Auto	0.74	0.64	-0.01	0.41	0.45	0.54	0.62	0.67
	Max	19.20	8.84	0.09	5.05	10.41	9.98	10.61	13.25
	VR	51.60	92.44	100.00	97.92	93.71	93.58	93.04	92.15

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