Segmentation across International Equity, Bond, and Foreign Exchange Markets\textsuperscript{1}

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Abstract

In this paper, we examine the integration of international financial markets. The integration of financial markets across countries and across asset classes is assumed to hold in most empirical studies, but has only been tested for certain countries and certain asset classes. We test for the integration of international equity, bond and foreign exchange markets. Our results indicate that the three classes of assets are segmented. Investigating potential explanations for this segmentation, we find that there are differing degrees of segmentation across these markets and that this is related to the asset returns from each class being explained by different sets of economic risk factors. In pair-wise tests we find that the bond-equity and bond-foreign exchange markets appear to be more segmented than the equity-foreign exchange market.

JEL Classification: G15; G12

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1 Introduction

Although there are a wide variety of assets international investors can choose from in making their portfolio allocation decisions, global investors mainly consider assets from the international equity, bond and foreign exchange markets. Since empirical asset pricing studies often assume that these markets are integrated, this paper investigates the assumption of market integration across these three different asset classes.

We are not the first to test for market integration. However, the literature has been focused on the integration/segmentation within a specific class of assets either within or across different countries. For instance, Campbell and Hamao (1992) can not reject the null of market integration between the United States and Japan after 1980. Griffin (2002) finds that an international version of the Fama-French three factor model is rejected for equities, but its country-specific version works well for the United States, the United Kingdom, Canada, and Japan implying the segmentation of international stock markets. However, using a different methodology, Zhang (2006) finds that the stock markets across the US, UK and Japan are integrated. Since market integration/segmentation across asset classes has not received much attention despite of its importance in asset allocation and portfolio risk management decisions, our paper addresses this important question.

The importance of the assumption of integration across international asset markets is seen in much of the literature. Studies such as Dumas and Solnik (1995) and De Santis and Gerard (1998) assume the integration of the international equity and foreign exchange markets and Solnik (1993) and Harvey et al (2002) assume the integration of the international
equity and bond markets. In these works, markets are determined to be integrated if assets from multiple markets are explained by the same set of economic risk factors. This definition of market integration is essentially the law of one price, and it is implicitly or explicitly used in all international asset pricing models and their empirical tests (e.g., Ferson and Harvey (1994), Dumas and Solnik (1995), De Santis and Gerard (1998), Fama and French (1998), and Griffin (2002), and Zhang (2006)).

Despite the widespread assumption of international financial market integration, there exists increasing evidence suggesting that equity, bond and foreign exchange markets may not be integrated. For example, Giovannini and Jorion (1987, 1988, and 1989) and Korajczyck and Viallet (1992) find evidence of equity-foreign exchange market segmentation. Ilmanen (1995) and Barr and Priestley (2004) find large segmentation in world stock and bond markets. Because the integration of all financial markets is important to both academics and practitioners, the purpose of this paper is to investigate market integration across all three major asset classes to both verify and extend the previous studies which focus on pair-wise tests. This will provide academics with a basis upon which to build their empirical tests and practitioners insights into the potential value of international diversification across asset classes.

We test the integration across the equity, bond and foreign exchange markets from several of the largest industrialized countries – Germany, Japan, the UK and the US. Because of the liquidity and transparency of these markets, we would expect these markets to be integrated, if any markets were. Therefore these asset markets and countries provide us with the ideal
environment within which to test for global financial market integration — if it does not hold here, it is unlikely to hold anywhere.

To test for international market integration, we employ a time varying two-factor international asset pricing model (ICAPM) similar to that in Dumas and Solnik (1995).

To test for market integration we use both Eichenbaum, Hansen and Singleton’s (1988) test (EHS test here after) and the likelihood ratio (LR) test. The idea in the EHS test is to measure the relative pricing differential between the whole set of the assets and a sub set of the assets. If the markets are integrated, the differential should be zero. The advantage of this test is that it allows for the potential misspecification of the model since the test statistic is the differential between the pricing errors and the potential misspecification of the model are cancelled. Thus we avoid the problem of joint test of the model and market integration to a great degree. The LR test is a commonly used test and it can directly test the law of one price in our context. It also has the strength of being easy to understand and implement.

Our results reject the null hypothesis that the international equity, bond and foreign exchange markets are integrated. Because of the importance of this finding of market segmentation, we proceed by further analyzing possible explanations for this observed lack of market integration across asset classes. The rejection of market integration implies that the value of equities, bonds and exchange rates maybe influenced by different types of economic risks. Thus we examine the assets from each market class separately within the context of various asset pricing models. Specifically, we supplement the world market risk and foreign
exchange rate risk at the heart of the Dumas and Solnik (1995) model with economic risk factors that have been shown to be important in previous studies such as term structure of interest rates and the default premium (see Chen, Roll and Ross (1986), Ferson and Harvey (1994)).

To determine the degree to which the different asset pricing models improve the explanatory power of our original model, we use the Hansen and Jagannathan (1997) distance (HJ-distance hereafter). One of the main advantages of the HJ-distance is that it allows us to examine models without having to assume that they are correct. This measure has been commonly used and thus provides a useful means of comparison across current and past studies\(^1\).

We find significant differences in which risk factors appear to play a role in the different asset markets. For example, the cross sectional returns from the equity market are consistently explained by the term structure of interest rates, the world equity market factor is only significant in explaining equities in a single factor model; returns for the foreign exchange market are priced by the term structure and default premium, and the world equity market risk factor is able to consistently explain the cross sectional returns from the bond market.

\(^1\)Despite its widespread use, Kan and Robotti (2007a and 2007b) argue that HJ-distance approach leads to evidence of more significant risk factors than their demeaned factor approach in misspecified models. However, as pointed out by Jagannathan and Wang (2002) and Cochrane (2001b), Kan and Robotti’s demeaned approach ignores the random errors associated with the sample mean and variance of the factors and treat them as known. Since this could lead to wider standard errors of the parameters than is justified, we use the HJ-distance approach.
Consequently, we conclude that the values for assets from each market class are explained by different risk factors which is consistent with our evidence of market segmentation.

Overall, our results indicate that the international equity, bond and foreign exchange markets are not fully integrated. This result support the findings in the literature that the international financial markets within the same class (e.g., equity markets) are integrated across countries (for example, in Longin and Solnic (1995), Ratanapakorn and Sharma(2002), and more recently in Zhang (2006)). We contribute to the literature by finding that the international financial markets are segmented across different classes, that is, across equity, currency and bond markets. The sources of this segmentation appear to be the varying sensitivity of the prices of these assets to different sets of economic risk factors - there are no common factors that can explain cross sectional returns from bonds, equities, and exchange rates. Interestingly, the bond market appears to be the most segmented from the other two markets. The equity and foreign exchange markets are less segmented since they share a common risk factor with each other: the term structure. These results suggest that investors can take advantage of this segmentation to diversify away some unwanted risks by investing across these asset classes.

The rest of the paper is organized as follows. Section 2 describes the measures and tests of market integration. Section 3 presents the empirical test results on market integration across equity, bond and foreign exchange markets. Section 4 investigates the sources and degree of market segmentation by means of multifactor models. Section 5 concludes.
2 Measuring and Testing Market Integration

The definition of market integration used in our study is based on the law of one price. Specifically, financial markets are defined to be integrated if the returns of assets from different markets can be explained by the same stochastic discount factor and thus the economic risk factors found to be priced are the same across markets. We formally test this by extending the Eichenbaum, Hansen and Singleton (1988) test and Likelihood Ratio (LR) test to the context of market integration across asset classes.

2.1 The Stochastic Discount Factor Method

The stochastic discount factor method has become a common method in the empirical finance literature. As pointed out by Jagannathan and Wang (2002), the stochastic discount factor (SDF) method provides a unified general framework for econometric analysis of asset-pricing models. Cochrane (2001a) stated that the SDF method is sufficiently general that it can be used for analysis of linear as well as nonlinear asset-pricing models, including pricing models for derivative securities. Since we are considering assets from broad classes of markets, we use this method. Next we briefly introduce the method.

Let $r_t$ be the vector of $N$ asset returns in excess of the risk-free return for each of our assets at time $t$. If we assume that we have $k$ risk factors, $f_{k,t}$, the unconditional stochastic discount factor model has the following form:

$$E[r_t m_t] = 0_{N \times 1},$$  \hspace{1cm} (1)
where \( m_t = 1 + \sum_{k=1}^{K} b_k f_{k,t} \) and is known as the stochastic discount factor (SDF). The factors we use are from the model that Dumas and Solnik (1995) call the international model:

\[
m_t = 1 + b_1 r_{equity,t} + b_2 r_{exchange,t},
\]

where \( r_{equity,t} \) is a world equity index return as a proxy for the international equity market risk, and \( r_{exchange,t} \), is the trade weighted exchange rate returns as a proxy of the aggregate foreign exchange risk. We choose this model for several reasons. First, our assets are from several industrialized countries, thus they are exposed to world market risk. Consequently a world stock market risk factor should be included in the model. Second, for international markets, if purchasing power parity (PPP) does not hold, an additional risk, the exchange rate risk, should be considered as argued in Dumas and Solnik (1995). As a result, the two-factor ICAPM with the world stock market risk and the foreign exchange rate risk as factors should capture the main risks to which international investors are exposed and which have been shown to be significant in the literature (see Dumas and Solnik (1995), De Santis and Gerard (1997)).

The sign of \( b_{equity} \) should be negative implying that asset returns increase as the equity market risk increases. This is consistent with the domestic CAPM which argues that investors need to be compensated more as their exposure to equity market risk increases. The foreign exchange risk factor increases when the US dollar appreciates versus other currencies or equivalently when the other currencies depreciate versus the dollar. Since the literature is unclear about the effect of a strong currency on the domestic economy, we are unable to predict the sign for \( b_{exchange} \).
Since investors continually update their expectations based on the information available to them at each point in time, the stochastic discount factor $m_t$ changes over time. Therefore the conditional SDF model is

$$E[r_t m_t | \Omega_{t-1}] = 0_{N \times 1},$$

where $\Omega_{t-1}$ is the set of information available to investors at time $t-1$. As we do not observe the same information as investors, our information set, $I_{t-1}$, is a subset of that used by investors and therefore our models are imperfect. By the law of iterated expectations, it can be shown that the same expectation is obtained using the investors’ detailed information set $\Omega_{t-1}$ and the econometrician’s incomplete information set $I_{t-1}$ (e.g., Cochrane(2001a)). That is

$$E[r_t m_t | \Omega_{t-1}] = E[r_t m_t | I_{t-1}] = 0_{N \times 1}. \quad (4)$$

One way to estimate this type of conditional model is to transform it into an unconditional model which we can estimate. For example, let $Z_{t-1}$ be a vector of key information that summarizes the $I_{t-1}$. Then the model can be rewritten as follows (see Cochrane (2001a, Chapter 10)):

$$E[r_t m_t \otimes Z_{t-1}] = 0_{NL \times 1}, \quad (5)$$

where $Z_{t-1} = \{1, z_1, z_2, \ldots, z_{L-1}\}_{t-1} = \{1, z_{t-1}\}$ is the vector of conditional variables, $L - 1$ is the total number of conditional variables, and $\otimes$ is the Kronecker product.

To estimate the SDF model, the straightforward approach is to use the generalized method of moments (GMM). We use the conditional model to describe briefly how to im-
plement the GMM. Let

\[ g_T = \frac{1}{T} \sum_{t=1}^{T} (r_{it} (1 + \sum_{k=1}^{K} b_k f_{k,t}) \otimes Z_{t-1}), \text{for } i = 1, 2, ..., N. \]  

(6)

We formulate the quadratic form \( J_T = g_T^T W_T^{-1} g_T \), where \( W_T^{-1} \) is the weighting matrix, the inverse of the variance-covariance matrix of errors. The value for each \( b_k \) is chosen to make the pricing errors \( g_T \) as small as possible, by minimizing the quadratic form \( g_T^T W_T^{-1} g_T \).

2.2 Testing for Market Integration - Eichenbaum, Hansen and Singleton’s Test

Eichenbaum, Hansen, and Singleton (1988) develop a test which measures the differential between the pricing errors for a whole set of assets and for the sub set of assets. We extend their measure to analyze market integration in the context of diverse asset classes. The law of one price implies that the same stochastic discount factor should be able to price all assets from an integrated market. Thus if the markets for all asset classes are integrated, the pricing errors for the assets from all classes should be the same as those from every subset of the assets. Consequently the difference in the pricing errors for the full set of assets (for example, equities, bonds and foreign exchange) and each subset of assets (for instance, equities only) should not be statistically different from zero (i.e., the model should not perform better after removing one asset class if markets are integrated).

Formally, to test the null hypothesis that financial market 1 (with \( N_1 \) assets) is integrated with financial market 2 (with \( N_2 \) assets), one chooses coefficients to minimize the GMM quadratic form \( g_T^T W_T^{-1} g_T \) for the entire set of \( N \) (\( N=N_1+N_2 \)) assets. This is the unrestricted
model. Next, the model is estimated using only the first \( N_1 \) assets, which is the restricted model. By using the same weighting matrix for the restricted and unrestricted models, Eichenbaum, Hansen and Singleton (1988) formulate the following test statistic:

\[
C_T = T(g'_T W^{-1}_T g_T) - T(g'_{r,T} W^{-1}_T g_{r,T})
\] (7)

Under the null hypothesis of market integration, the asymptotic distribution of \( C_T \) is \( \chi^2 \) with degrees of freedom \( [(N - N_1) \times L] \), where \( L \) is the number of instruments. If \( C_T \) is significantly different from 0, the null hypothesis is rejected. This means that the stochastic discount factors used to price the two groups of assets are significantly different. In the context of market segmentation, this means that market 2 is segmented from market 1.

As a robustness check, we reverse the null and alternative hypotheses to create a test with the null hypothesis of market segmentation. The null is that these two groups of assets are being priced differently. If we can not reject the null, that indicates the two groups of assets are described by different stochastic discount factor, hence market segmentation.

Since the test statistic is the difference between the two quadratic terms (pricing errors), the potential misspecification of the models may cancel out. Thus using this test should minimize the possibility of model misspecification influencing our results.

2.3 Testing for Market Integration - Likelihood Ratio Test

To make sure the result is robust, we also use a standard test in statistics: the likelihood ratio test. Market integration requires that the coefficients in the models are the same for all
assets across markets. To test this, the null hypothesis of market integration can be written as:

$$(1) \quad H_0 : \ b^{eq} = b^{ex}$$

$$(2) \quad H_0 : \ b^{bd} = b^{ex}$$

$$(3) \quad H_0 : \ b^{eq} = b^{bd}$$

where $b^{eq}, b^{ex}, b^{bd}$ are factor pricing vectors for equities, currencies and bonds respectively.

The Likelihood Ratio Test can test these hypotheses directly by using both the restricted and the unrestricted models.

The Likelihood Ratio Test statistic is

$$T = -2 \times (\ln L(\hat{b}) - \ln L(\tilde{b}))$$

where $\ln L$ is the computed log likelihood with $\hat{b}$ representing the unconstrained estimate of $b$ and $\tilde{b}$ the constrained estimate of $b$ where the constraint is that $H_0$ is true (the coefficients for integrated markets are the same). Under the null hypothesis the test statistic is asymptotically distributed as a $\chi^2$ random variable with $r$ degrees of freedom, where $r$ is the number of constraints on the null hypothesis.
3 Data and results of market integration test

3.1 Data and summary statistics

We consider assets from the largest and most important international financial markets, namely, the returns from indices of the equities and bonds and foreign exchange from four of the largest and most open industrialized countries – the United States, United Kingdom, Germany and Japan. Therefore, we have the returns from four equity indices, four bond indices, and three exchange rates. All returns are monthly excess returns in US dollars. For example, this means for equities, if the value of the equity index for country \( i \) at time \( t \) is \( p_{i,t} \), and \( r_{risk\,free,t} \) is the one month US dollar risk-free rate return, then the excess return is

\[
\hat{r}_{eq,i,t} = \frac{p_{i,t} - p_{i,t-1}}{p_{i,t-1}} - r_{risk\,free,t}.
\]

Currency returns are defined as:

\[
\hat{r}_{ex,i,t} = \frac{p_{ex,i,t}(1 + r_{deposit,i,t-1}) - p_{ex,i,t-1}}{p_{ex,i,t-1}} - r_{risk\,free,t},
\]

where \( p_{ex,i,t} \) is the exchange rate of country \( i \) relative to the US dollar at time \( t \), and \( r_{deposit,i,t-1} \) is the one month interest rate for depositing currency \( i \) at time \( t-1 \). Bond returns (\( r_{bd} \)) are the excess returns computed from the long term government bond yield (see Hatch and White(1988) for details).

The data are from January 1982 to December 1998 (up to the introduction of the Euro). Our asset returns are from the following sources. The data for equity indices are from Morgan Stanley Capital International (MSCI) and they are all expressed in US dollars. The bond indices are the long term government bond indices calculated by Datastream for each country. These data are from the last day of each month. The monthly exchange rate data are from the Federal Reserve Board.
The risk factors used in our models are constructed as follows: the world market risk

\[ r_{equity} = \frac{p_{equity,t} - p_{equity,t-1}}{p_{equity,t-1}} - r_{riskfree,t}, \]

with \( p_{equity,t} \) being the world equity index from MSCI. The currency risk

\[ r_{exchange} = \frac{p_{G10ex,t} - p_{G10ex,t-1}}{p_{G10ex,t-1}} - r_{riskfree,t} \]

where \( p_{G10ex,t} \) is the US G-10 trade weighted foreign exchange index\(^2\).

The variables used as our conditioning information should summarize the information that international investors use when formulating prices. To accomplish this we select a set of conditional (instrumental) variables that have been found effective for this purpose in the international asset pricing literature (see Harvey(1991), Dumas and Solnik(1995), Santis and Gerard(1998), among others). Specifically we use a constant, the lagged world equity market return in excess of the US short term risk free rate (\( r_{eqlag} \)), the lagged US default premium measured by the return difference between Moody’s Baa and Aaa-rated corporate bond (\( r_{deflag} \)) (both data are from the Federal Reserve Board), the lagged US term premium, measured as the return on the ten-year US Treasury bond (from Datastream) in excess of the US risk free rate \(^3\) (\( r_{termlag} \)) and the lagged one-month Eurodollar rate (\( r_{eurolag} \)).

Though we would ideally use the one month T-bill rate for the US risk free rate, we use the three month T-bill rate from the Federal Reserve Board due to data availability.

\(^2\)A weighted average of the foreign exchange value of the U.S. dollar against a subset of the broad index currencies that circulate widely outside the country of issue. G-10 currency index includes Germany, France, Italy, the Netherlands, Belgium, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden.

\(^3\)We also use GDP weighted risk free rate, default premium, and term premium from the major industrialized countries, the results are not good to interpret. The problem could be from the noise of this type of weighted data.
The descriptive statistics for the returns of our assets are presented in Table 1. Panel A highlights the considerable differences in the average excess returns and standard deviations of these values across the equity, bond, and currency markets. Not surprisingly, the equity indices have the highest average excess returns as well as the highest standard deviation. This is consistent with the financial theory of low (high) risk-low (high) return. The bonds have positive average excess returns, which are lower than those of equity assets but higher than those of currency assets. Bonds also have the lowest standard deviations among the three classes of assets. The currency average excess returns are the lowest, even negative for the German mark and Japanese yen with their standard deviations between those of equities and bonds. The descriptive statistics show the significant differences in the characteristics of our different asset classes.

Panel B provides the corresponding descriptive statistics for our risk factors. The world equity return has a lower standard deviation than returns from any individual country, which indicates the diversification of risk. Similar to the world equity return, the world currency return has the lowest volatility among all currency returns, which again shows the diversification of risk.

Going beyond the means and standard deviations of our variables, Table 1 also indicates that all of our series are stationary and not serially correlated, as required for the implementation of the GMM methodology used in this paper. The autocorrelations of equity returns are not statistically significant. Although bonds and currency returns, the term structure, default premium, and all of our conditional information factors (except the Eurodollar re-
turns) show significant first order autocorrelation, the autocorrelations die out one month later. The Eurodollar returns exhibit significant autocorrelations up to the fourth lag. Since the autocorrelations decay rapidly, we can assume these series are still reasonably stationary. To confirm this, we perform Dicky-Fuller tests for each series. The Dicky-Fuller tests confirm that all of our series are stationary with the p-values for the Dickey-Fuller test statistics being less than 0.01 in all cases. We also compute the correlations between the two global risk factors, which is found to be very small. Thus there is no multicollinearity problem in the model.

3.2 Results on market integration tests

We evaluate the degree of segmentation across different asset classes using the EHS (1988) test and LR test described in Section 2.

It is well documented in the empirical asset pricing literature that the conditional models perform better than the unconditional models. Our estimation results confirmed this\(^4\). Thus we use the conditional model (5) for the EHS test. Table 2 presents the results from the conditional model. For assets from each pair of classes, though we cannot reject the conditional models at 5% level, the p-values for the pricing errors are low ranging from 8.48% to 14.89%. Thus the model does not explain the assets from the pooled pair of classes well.

For assets from the same market, we find that the model is not rejected for equities with the currency factor being a significant pricing factor. Though the model is not rejected for

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\(^{4}\)To conserve space, we do not present the estimation results for the unconditional models. But they are available upon request.
bonds at the 10% level of significance, it is rejected at the 5% level of significance with both factors being priced significantly. As well, the model is rejected for currencies but the world market factor is significant. Thus the conditional models perform quite differently for the three classes of assets. All together, the two-factor SDF models do not perform well. This provides some evidence of market segmentation shown in the different level of explanatory power of the model and the different factors which are significant for the models applied to each of the three classes of assets. We formally test this next.

First we test the null of market integration using EHS test. For integrated markets, the same stochastic discount factor should describe both the pooled set of assets and the subset of the assets. From Panel A of Table 3, we note that the pricing error differential between the pooled equity-bond set and the bond-only assets is 30.31, which corresponds to a p-value of 6.51%, and thus we marginally reject that the equity and bond markets are integrated. The null hypothesis that the equity and currency markets are integrated is strongly rejected with the p-value of the differential in pricing errors being only 2.22%.

We then use EHS approach to test for the null of market segmentation. The results are in Panel B of Table 3. The p-values of the test statistic are quite high: 47.68%, 48.5% and 61.93%. Therefore we do not reject the null hypothesis of market segmentation in all three pairs of market classes.

In summary, both the null hypothesis of market integration and the alternative null hypothesis of market segmentation tests of Eichenbaum, Hansen and Singleton (1988) indicate the segmentation of the three financial markets we considered.
The results from the likelihood ratio test of market segmentation for our three classes of assets are presented in Panel C of Table 3 for the conditional Model. Again we reject the null hypothesis that the equities are priced in the same way as exchange rates with the p-value of the test statistic being less than 0.0001. We also reject the null that the estimated coefficients on our risk factors for bonds and exchange rates are the same (p-value is 0.0002). As well, we reject the equality of the estimated coefficients for the equities and bonds. Together these results imply that the law of one price does not hold across classes of assets. Therefore we reject the null hypotheses that the equity, currency and bond markets are integrated.

Thus the results from both of our tests conclude that the three financial markets are segmented.

4 Analysis of sources of market segmentation

The results from Section 3 indicate that the assets from the equity, bond and foreign exchange markets are segmented. To investigate the possible sources of the market segmentation, we examine international equities, bonds, and currency returns using separate multifactor models in this section.

4.1 Models examined and the estimation method

It is well-documented in the literature that macroeconomic risk factors can play a role in explaining asset prices because they can influence the value of the different investment opportunities faced by investors. Thus, in addition to the world equity market risk and
exchange rate risk, we consider another two major risk factors: the default premium \( r_{\text{default}} \) (see Chen, Roll and Ross (1986), Jagannathan and Wang (1996), Ferson and Harvey (1994)) and the term structure \( r_{\text{term}} \) (as in Chen, Roll and Ross (1986), Ferson and Harvey (1994), and Lettau and Ludvigson (2001)). It has been argued that the default premium captures changes in the risk aversion of investors (see Cochrane (2001a)). An increase in the default premium indicates a worsening of economic conditions. This factor is defined as the difference between Moody’s Baa US corporate bond returns and the US long term government bond returns. The term structure captures investors’ expectations for the US economy. It is defined as the difference between the returns of the seven-year US Treasury bond and 3 month Treasury bill. We use the seven year US Treasury bond instead of the more commonly used long term government bond because the US business cycle usually lasts about five to eight years (based on NBER definitions of business cycle expansions and contractions since 1945). An increase in the term structure implies an increase in the risk of the economy, hence an increase in the cross section of asset returns. These data are also from Datastream.

To have a full picture of how different risk factors impact each class of assets, given the risk factors we considered, we investigate the following five representative models:

**SDF MODEL 1:** \[ m_t = 1 + b_1 r_{\text{equity},t}, \]

**SDF MODEL 2:** \[ m_t = 1 + b_1 r_{\text{equity},t} + b_2 r_{\text{exchange},t}, \]

**SDF MODEL 3:** \[ m_t = 1 + b_1 r_{\text{equity},t} + b_2 r_{\text{exchange},t} + b_3 r_{\text{default},t} + b_4 r_{\text{term},t}, \]

**SDF MODEL 4:** \[ m_t = 1 + b_1 r_{\text{equity},t} + b_3 r_{\text{default},t} + b_4 r_{\text{term},t}, \]

**SDF MODEL 5:** \[ m_t = 1 + b_3 r_{\text{default},t} + b_4 r_{\text{term},t}. \]
To investigate which specification of the SDF model best explains assets from each market, we use the Hansen and Jagannathan distance. A major concern with the standard GMM approach is that the weighting matrix changes with the factors included in the model. This makes it difficult to compare competing models. To avoid this problem, Hansen and Jagannathan (1997) developed a method commonly referred to as the Hansen-Jagannathan distance which uses a common weighting matrix across model specifications, that is, the inverse of the matrix of the second moments of the asset returns: $G^{-1} = E[r_t r_t]'^{-1}$. A fixed weighting matrix allows us to compare the performance of competing models by using the value of this quadratic form $g_T' G^{-1} g_T$, whose square root is called the Hansen-Jagannathan distance (HJ-distance). Hansen and Jagannathan (1997) show that the value of this quadratic form is the squared distance from the candidate stochastic discount factor of the given model to the set of all the discount factors that price the N assets correctly. Therefore, we do not need to assume that the model is correct and we can use the HJ-distance to study the misspecification of each of the estimated stochastic discount factors. A smaller HJ-distance indicates a better fit of the model.

Since the common weighting matrix is not optimal, $T^*(HJ$-distance)$^2$ is not $\chi^2_{(N_L-K)}$ distributed. Jagannathan and Wang (1996) show that $T^*(HJ$-distance)$^2$ is asymptotically distributed as the weighted sum of randomly selected $\chi^2$ variables. Based on this, we can compute p-values of the HJ-distance and make inferences accordingly. Details can be found in Jagannathan and Wang (1996, appendix C).

Note that, since $E[r_t r_t]'^{-1}$ is a $N \times N$ matrix and our conditional model has $NL$ moments,
we can not use $E[r_t^r r_t^{-1}]$ as the weighting matrix for the conditional models. Neither can we use the stack of $E[r_t^r r_t^{-1}]$ to construct the NL×NL weighting matrix since this would suffer from singularity. Therefore we use $G^{-1} = E[(r_t \otimes Z_{t-1})'(r_t \otimes Z_{t-1})]^{-1}$ as the common weighting matrix for the conditional models. So, we are not able to directly compare the HJ-distance for the unconditional model with that of the conditional model for the same set of assets. Given that the unconditional model is a special case of conditional model, we only present and discuss the results from the conditional models\(^5\).

### 4.2 International equities

First we examine the SDF models for the returns from the class of global equity market.

Panel A of Table 4 presents the conditional models for the set of equities. We can not reject the null hypothesis that the HJ-distance equals zero, indicating correct pricing. The p-values for the HJ-distances range from 55.79% to 92.89%. Looking at our set of economic risk factors, we find that the term structure is always significant when included in models. The estimated coefficients for the term structure are negative indicating that excess equity returns increase as the term structure risk increases. An increase of the term structure indicates a worse economy, which, in turn, increases the excess returns of stocks. This is consistent with Fama and French (1989) who find that expected returns are lower when economic conditions are strong and higher when conditions are weak. However, the default premium is not significant in our models. But their signs are negative as expected. The results for unconditional models are available upon request.
world market risk factor plays a significant role in the one factor model (Model 1). However, when the macroeconomic factors are added to the model, the market risk no longer plays a significant role. Therefore the market factor is not a pervasive factor in explaining returns from the equity class. The world exchange rate risk is not significant in any models.

Overall we find that we can not reject the conditional models. The world equity risk factor plays a significant role in the stochastic discount factor for the one factor model but it is silent in the multifactor models. Only the term structure factor is a pervasively significant component in the SDF. The finding of the significant role of the term structure factor and the inconsistent significance of the market risk factor in explaining equity returns in the multifactor models confirmed Chen, Roll and Ross’ (1986) result for domestic equity returns. They argue that the market risk factor may be captured by significant macroeconomic factors. Our finding supports the view of the endogenous equity market and the theoretical based asset pricing model.

4.3 International bonds

The results for bonds are provided in Panel B of Table 4. We can not reject any of the conditional models for our set of global bonds. This indicates that the conditional models generally perform well in explaining the bond returns. The equity market risk factor is strongly significant (at 1% significance level) in both Models 1 and 2, but the significance of

---

6We exclude the invalid instrumental variables, the lagged term structure, from our set of conditional variables since it has significantly high correlation with the model residuals, which makes it an invalid conditional variable or instrumental variable (see Hansen (1982) and Greene (2003)).
this factor is decreased when the term structure and default premium are added, however, even in these models, it is significant at around 10% significance level. None of the other three risk factors are significant for bonds in any of the models.

Overall, we find significant relationships between the equity market risk factor and bond returns using our conditional models. This result is consistent with Fama and French (1993), who document that the bond returns can be explained by the equity market risk factor. However this result is quite different from the pricing of the equity assets where we find a significant role for the term structure. These differences suggest that bonds are priced differently from equities. The result that they do not share a common explanatory risk factor indicate a high degree of inter equity-bond market segmentation.

### 4.4 Foreign Exchange

Finally, we analyze results for the foreign exchange rates in Panel C of Table 4. First, we can not reject any models that include both the default premium and term structure factors, and we reject all models that do not include these two factors. Therefore, neither world market risk nor world currency risk are sufficient to describe foreign exchange returns. Since both the default premium and term structure factors are significant in all models, this is strong evidence that the foreign exchange returns are impacted by risks associated with these two fundamental economic variables. The negative sign for the coefficients of these two factors indicates that the increase of exposure to these fundamental economic risks requires higher compensation for returns of exchange rates.
The cross section of foreign exchange returns are priced by systematic economic forces in the form of shift of the term structure and a change of the default premium. The increase of this two factors indicates “bad” state of the US economy and an increase in the risk of economy, therefore an increase in the exchange rate returns. This finding implies that the foreign exchange market is an endogenous market and only economic state variables that affect the state of the economy will influence the pricing of assets in this endogenous market.

In summary, our results show that foreign exchange market is segmented from the equity market in that it is explained by both the default premium and the term structure, while the equities are explained by the term structure. Thus exchange rate and equities have a common risk factor: the term structure. The bond market is segmented from the above two markets in that bonds are priced by the world equity risk factor, which is not a common factor in explaining either equities or exchange rates. This indicates a higher degree of the bond-equity or bond-foreign exchange market segmentation than equity-foreign exchange market segmentation.

5 Conclusion

Market integration is a key assumption in finance. Literature has been focused on the market integration across countries. This paper study the market integration across asset classes, in particular, the inter equity-bond-foreign exchange market integration. We test the inter class market integration based on the law of one price. Our test results indicate the segmentation of all three classes of markets. By investigating the sources and degree of
market segmentation, we find that the inter class segmentation is caused by the fact that assets from each class is explained by different sets of risk factors (with or without common factors). More specifically, we find that the term structure factor is significant in explaining equity returns, the equity market risk factor explains bond returns, while the fundamental economic state variables, the term structure and the default premium, are significant factors in explaining the across section of foreign exchange returns. These results also imply a higher degree of segmentation between the bond and equity or currency markets than between the equity and currency markets.
References


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Charlottesville, Virginia.

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[27] Kan R., Robotti C., 2007a, Specification tests of asset pricing models using excess
returns, working paper, University of Toronto and Federal Reserve Bank of Atlanta.

[28] Kan R., Robotti C., 2007b, Model comparison using the Hansen-Jagannathm distance,
working paper, University of Toronto and Federal Reserve Bank of Atlanta.


Table 1 Summary Statistics

Panel A: Excess Returns of Assets

<table>
<thead>
<tr>
<th>variable</th>
<th>mean</th>
<th>Standard deviation</th>
<th>ρ1</th>
<th>ρ2</th>
<th>ρ3</th>
<th>ρ4</th>
<th>ρ12</th>
<th>ρ24</th>
</tr>
</thead>
<tbody>
<tr>
<td>r_equs</td>
<td>0.0059705</td>
<td>0.04192</td>
<td>-0.04665</td>
<td>-0.00311</td>
<td>-0.08244</td>
<td>-0.14500</td>
<td>-0.01722</td>
<td>0.12170</td>
</tr>
<tr>
<td>r_equk</td>
<td>0.0072959</td>
<td>0.05537</td>
<td>-0.05567</td>
<td>-0.06790</td>
<td>-0.04553</td>
<td>0.00292</td>
<td>-0.08662</td>
<td>0.07093</td>
</tr>
<tr>
<td>r_eqgm</td>
<td>0.0081282</td>
<td>0.06027</td>
<td>-0.1547</td>
<td>0.04505</td>
<td>0.04073</td>
<td>0.08924</td>
<td>-0.1936</td>
<td>0.01880</td>
</tr>
<tr>
<td>r_eqjp</td>
<td>0.0062159</td>
<td>0.07055</td>
<td>0.07594</td>
<td>-0.08691</td>
<td>0.06008</td>
<td>0.07157</td>
<td>0.01323</td>
<td>0.04844</td>
</tr>
<tr>
<td>r_bdus</td>
<td>0.0048974</td>
<td>0.02042</td>
<td>0.39383*</td>
<td>0.01632</td>
<td>0.01809</td>
<td>0.01529</td>
<td>-0.07637</td>
<td>0.02455</td>
</tr>
<tr>
<td>r_bduk</td>
<td>0.0058049</td>
<td>0.01904</td>
<td>0.28837*</td>
<td>0.02746</td>
<td>-1.2576</td>
<td>-0.7233</td>
<td>-0.0114</td>
<td>0.05091</td>
</tr>
<tr>
<td>r_bdgm</td>
<td>0.0026792</td>
<td>0.01542</td>
<td>0.35552*</td>
<td>0.06628</td>
<td>0.06983</td>
<td>0.01771</td>
<td>-0.2681</td>
<td>-0.9177</td>
</tr>
<tr>
<td>r_bdjp</td>
<td>0.0011409</td>
<td>0.02375</td>
<td>0.14799*</td>
<td>0.08736</td>
<td>-0.6910</td>
<td>-1.1418</td>
<td>0.08223</td>
<td>-0.02379</td>
</tr>
<tr>
<td>r_exuk</td>
<td>0.0035409</td>
<td>0.02729</td>
<td>0.32381*</td>
<td>-0.05892</td>
<td>0.04698</td>
<td>0.01969</td>
<td>0.06728</td>
<td>-0.2008</td>
</tr>
<tr>
<td>r_exgm</td>
<td>-0.0018599</td>
<td>0.02744</td>
<td>0.30744*</td>
<td>0.01475</td>
<td>0.07514</td>
<td>0.03425</td>
<td>0.06359</td>
<td>-0.0893</td>
</tr>
<tr>
<td>r_exjp</td>
<td>-0.0047444</td>
<td>0.02944</td>
<td>0.33443*</td>
<td>0.02186</td>
<td>0.03880</td>
<td>-0.04972</td>
<td>0.02298</td>
<td>-0.02392</td>
</tr>
</tbody>
</table>

Panel B: Risk Factors

<table>
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<tr>
<th>variable</th>
<th>mean</th>
<th>Standard deviation</th>
<th>ρ1</th>
<th>ρ2</th>
<th>ρ3</th>
<th>ρ4</th>
<th>ρ12</th>
<th>ρ24</th>
</tr>
</thead>
<tbody>
<tr>
<td>r_equity</td>
<td>0.0061388</td>
<td>0.04063</td>
<td>0.01196</td>
<td>-0.03524</td>
<td>-0.05235</td>
<td>-0.04655</td>
<td>0.01047</td>
<td>0.14834</td>
</tr>
<tr>
<td>r_exchange</td>
<td>-0.0057908</td>
<td>0.02239</td>
<td>0.31905*</td>
<td>0.00624</td>
<td>0.07467</td>
<td>0.01404</td>
<td>0.06217</td>
<td>-0.7850</td>
</tr>
<tr>
<td>r_term</td>
<td>0.004824</td>
<td>0.021337</td>
<td>0.40795*</td>
<td>0.02056</td>
<td>0.01170</td>
<td>-0.00456</td>
<td>-0.06258</td>
<td>0.03545</td>
</tr>
<tr>
<td>r_default</td>
<td>0.00097</td>
<td>0.00558</td>
<td>0.29563*</td>
<td>-0.04098</td>
<td>0.04080</td>
<td>-0.02898</td>
<td>-0.04828</td>
<td>0.01577</td>
</tr>
</tbody>
</table>

Panel C: Instruments

<table>
<thead>
<tr>
<th>variable</th>
<th>mean</th>
<th>Standard deviation</th>
<th>ρ1</th>
<th>ρ2</th>
<th>ρ3</th>
<th>ρ4</th>
<th>ρ12</th>
<th>ρ24</th>
</tr>
</thead>
<tbody>
<tr>
<td>r_eqlag</td>
<td>0.0004196</td>
<td>0.04118</td>
<td>0.02978</td>
<td>-0.03445</td>
<td>-0.03519</td>
<td>-0.02019</td>
<td>0.00944</td>
<td>0.15097</td>
</tr>
<tr>
<td>r_termlag</td>
<td>0.0048692</td>
<td>0.02041</td>
<td>0.39876*</td>
<td>0.01401</td>
<td>0.01424</td>
<td>0.01284</td>
<td>-0.07751</td>
<td>0.02523</td>
</tr>
<tr>
<td>r_deflag</td>
<td>0.0010109</td>
<td>0.005566</td>
<td>0.23704*</td>
<td>-0.06836</td>
<td>-0.10724</td>
<td>-0.01471</td>
<td>-0.10823</td>
<td>0.03125</td>
</tr>
<tr>
<td>r_eurolag</td>
<td>0.0004516</td>
<td>0.000421</td>
<td>0.69591*</td>
<td>0.61132*</td>
<td>0.59173*</td>
<td>0.45857*</td>
<td>0.26146</td>
<td>0.22608</td>
</tr>
</tbody>
</table>

r_equs, r_equk, r_eqgm and r_eqjp are excess equity index returns from U.S., United Kingdom, German and Japan. R_bdus, r_bduk, r_bdgm, and r_bdjp are excess bond returns calculated from long-term government yields from these countries. r_exuk, r_exgm, and r_exjp are excess exchange returns of British pound, German deutsche mark, Japanese yen (defined by the currency one month deposit return compounded with variation of exchange rates). r_equity is the excess world equity index return. r_exchange is the G-10 trade weighted exchange index return excess of risk free rate. R_eqlag is the lagged term of r_equity. r_deflag is the lagged default premium defined as the difference between the US Baa and Aaa corporate bond returns. r_termlag is the lagged term premium defined by the difference between ten year t-bill note return and three month t-bill return. r_eurolag is the lagged one month r_eurodollar rate in excess of risk free rate. r_term is the default premium defined as the difference between the US Baa corporate bond returns and the US long term government bond returns. r_equit is the term premium defined as seven year Treasury bill return in excess of three month t-bill rate. The ρ_i's are autocorrelations lagged by i. Number of Observations=202 (March 1982-December 1998).
Table 2 Conditional International Discount Factor Model (GMM)

<table>
<thead>
<tr>
<th></th>
<th>Equities &amp; Bonds</th>
<th>Equities &amp; Currencies</th>
<th>Bonds &amp; Currencies</th>
<th>Equities</th>
<th>Bonds</th>
<th>Currencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_{equity}$</td>
<td>-1.06273</td>
<td>-4.4538</td>
<td>-20.1681</td>
<td>-2.72981</td>
<td>-16.3543</td>
<td>-16.2093</td>
</tr>
<tr>
<td></td>
<td>(0.78)</td>
<td>(-2.76)**</td>
<td>(-8.22)**</td>
<td>(-1.67)</td>
<td>(-4.41)**</td>
<td>(-3.33)**</td>
</tr>
<tr>
<td>$r_{exchange}$</td>
<td>21.93377</td>
<td>9.4983</td>
<td>-2.8416</td>
<td>13.8569</td>
<td>19.50077</td>
<td>-0.3790</td>
</tr>
<tr>
<td></td>
<td>(6.46)**</td>
<td>(3.08)**</td>
<td>(-0.78)</td>
<td>(2.49)**</td>
<td>(2.69)**</td>
<td>(-0.08)</td>
</tr>
<tr>
<td>Chi-sqr</td>
<td>47.0544</td>
<td>44.6509</td>
<td>42.5942</td>
<td>16.7476</td>
<td>27.3589</td>
<td>25.0789</td>
</tr>
<tr>
<td>df</td>
<td>38</td>
<td>33</td>
<td>33</td>
<td>18</td>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>p-value</td>
<td>14.89%</td>
<td>8.48%</td>
<td>12.24%</td>
<td>54.05%</td>
<td>7.25%</td>
<td>2.25%</td>
</tr>
</tbody>
</table>

Note: Numbers in brackets are t values. ** significant at 5% level.
Table 3 Market Integration Tests

Panel A: EHS test 1: H0: Market Integration

<table>
<thead>
<tr>
<th>Panel</th>
<th>Test</th>
<th>H0</th>
<th>Market Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N=equities &amp; bonds, N1=equities</td>
<td>N=equities &amp; currencies, N1=equities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=equities &amp; bonds, N1=equities</td>
<td>N=equities &amp; currencies, N1=equities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C_T = T(g^'T W T^{-1} g_T) - T(g^'T W T^{-1} g_T)</td>
<td>p-value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30.31</td>
<td>27.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.22%</td>
<td>Equities are segmented from currencies</td>
</tr>
</tbody>
</table>

Panel B: EHS test 2: H0: Market Segmentation

<table>
<thead>
<tr>
<th>Panel</th>
<th>Test</th>
<th>H0</th>
<th>Market Segmentation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N=equities &amp; bonds</td>
<td>N=equities &amp; currencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N1=bonds</td>
<td>N1=currencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C_T = T(g^'T W T^{-1} g_T) - T(g^'T W T^{-1} g_T)</td>
<td>p-value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19.69</td>
<td>19.57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.50%</td>
<td>Can not reject H0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can not reject H0</td>
<td>Currencies are segmented from equities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Currencies are segmented from equities</td>
<td>Currencies are segmented from bonds</td>
</tr>
</tbody>
</table>

Panel C: Likelihood Ratio Test: H0: Market Integration

<table>
<thead>
<tr>
<th>Panel</th>
<th>Test</th>
<th>H0</th>
<th>Market Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N=equities &amp; bonds</td>
<td>N=equities &amp; currencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N1=bonds</td>
<td>N1=currencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Null Hypothesis(H0)</td>
<td>Chi-square</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b^eq_i = b^ex_i, i=1,2</td>
<td>18.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b^bd_i = b^ex_i, i=1,2</td>
<td>17.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b^eq_i = b^bd_i, i=1,2</td>
<td>29.77</td>
</tr>
</tbody>
</table>

The parameters have superscript of eq, ex, bd when the asset groups are equities, foreign exchanges and bonds respectively.
Table 4 Multifactor Models

Panel A  Conditional SDF Models for Equities

<table>
<thead>
<tr>
<th>Models</th>
<th>r_equity</th>
<th>r_exchange</th>
<th>r_default</th>
<th>r_term</th>
<th>HJ-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-3.9645</td>
<td></td>
<td></td>
<td></td>
<td>4.1801</td>
</tr>
<tr>
<td></td>
<td>(-2.28)**</td>
<td></td>
<td></td>
<td></td>
<td>(55.79%)##</td>
</tr>
<tr>
<td>2</td>
<td>-2.53524</td>
<td>9.868144</td>
<td></td>
<td></td>
<td>3.9297</td>
</tr>
<tr>
<td></td>
<td>(1.26)</td>
<td>(1.42)</td>
<td></td>
<td></td>
<td>(63.13%)##</td>
</tr>
<tr>
<td>3</td>
<td>1.54422</td>
<td>10.58902</td>
<td>-33.4578</td>
<td>-25.1567</td>
<td>2.9330</td>
</tr>
<tr>
<td></td>
<td>(0.60)</td>
<td>(1.53)</td>
<td>(-0.71)</td>
<td>(-2.62)**</td>
<td>(92.92%)##</td>
</tr>
<tr>
<td>4</td>
<td>-0.05623</td>
<td>-29.3933</td>
<td>4.34</td>
<td></td>
<td>3.0682</td>
</tr>
<tr>
<td></td>
<td>(-0.02)</td>
<td>(-0.63)</td>
<td></td>
<td></td>
<td>(86.01%)##</td>
</tr>
<tr>
<td>5</td>
<td>-29.4322</td>
<td>-24.7276</td>
<td>-33.4578</td>
<td>-25.1567</td>
<td>3.063</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.63)</td>
<td>(-3.9)</td>
<td></td>
<td>(89.92%)##</td>
</tr>
</tbody>
</table>

Panel B  Conditional Models for Bonds

<table>
<thead>
<tr>
<th>Models</th>
<th>r_equity</th>
<th>r_exchange</th>
<th>r_default</th>
<th>r_term</th>
<th>HJ-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-13.26</td>
<td>-4.246</td>
<td></td>
<td></td>
<td>4.34</td>
</tr>
<tr>
<td></td>
<td>(-3.26)**</td>
<td>(-0.38)</td>
<td></td>
<td></td>
<td>(21.9%)##</td>
</tr>
<tr>
<td>2</td>
<td>-14.45</td>
<td>-11.31</td>
<td>98.03</td>
<td>1.16</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>(-2.98)**</td>
<td>(-0.98)</td>
<td>(1.51)</td>
<td>(0.14)</td>
<td>(17.8%)##</td>
</tr>
<tr>
<td>3</td>
<td>-12.40</td>
<td>-9.31</td>
<td>92.45</td>
<td>2.42</td>
<td>3.63</td>
</tr>
<tr>
<td></td>
<td>(-1.67)*</td>
<td>(-0.98)</td>
<td>(1.61)</td>
<td>(0.31)</td>
<td>(43.6%)##</td>
</tr>
<tr>
<td>4</td>
<td>-10.42</td>
<td></td>
<td></td>
<td></td>
<td>4.23</td>
</tr>
<tr>
<td></td>
<td>(-1.53)</td>
<td></td>
<td>(1.65)</td>
<td>(-0.68)</td>
<td>(21.36%)##</td>
</tr>
<tr>
<td>5</td>
<td>84.89</td>
<td>-4.28</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C  Conditional SDF Models For Foreign Exchange Returns

<table>
<thead>
<tr>
<th>Models</th>
<th>r_equity</th>
<th>r_exchange</th>
<th>r_default</th>
<th>r_term</th>
<th>HJ-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-12.5114</td>
<td>-1.43661</td>
<td>-84.0461</td>
<td>-37.0173</td>
<td>3.7661</td>
</tr>
<tr>
<td></td>
<td>(-3.00)**</td>
<td>(-0.38)</td>
<td>(-2.11)**</td>
<td>(-4.12)**</td>
<td>(22.23%)##</td>
</tr>
<tr>
<td></td>
<td>(-2.66)**</td>
<td>(-1.83)*</td>
<td>(-2.30)**</td>
<td>(-3.70)**</td>
<td>(13.10%)#</td>
</tr>
<tr>
<td></td>
<td>(-2.23)**</td>
<td>(-1.51)</td>
<td>(-2.30)**</td>
<td>(-3.70)**</td>
<td>(10.04%)#</td>
</tr>
</tbody>
</table>

Numbers below the coefficients are t statistics. Numbers below the Objective*T is the p-value.
* significant at 10%; ** significant at 5%.
† the model is marginally not rejected. ‡ the model is not rejected.