

Finance & Banking Studies

IJFBS ISSN: 2147-4486

Contents available at www.ssbfnet.com/ojs DOI:

Bond Portfolio Allocations in South

Africa Emerging Markets

Jinghua Wang

School of Business, Stockton University, USA

Corresponding Author: Tel- +1-609-626-3810, Email- wangj4@stockton.edu

John Bilson

Stuart School of Business, Illinois Institute of Technology, USA

Abstract

Over the past fifty years, economic growth in emerging markets has been supported by investments in capital and technology from the developed world. The benefit of this development for the emerging markets, as measured by growth in income, employment, and wealth, is immediately apparent. There have also been significant advantages for the developed world through opportunities for higher risk adjusted returns from investments in emerging markets. This study explores the benefits of the diversification of global government bond portfolio, and provides complete performance evaluations of DMs with or without South Africa emerging market (SAEM) bonds. The study examines the benefits of inclusion of SAEM bonds in DMs, the degrees of financial integration among the research markets, the relative bond returns of dynamic factor models with time-varying coefficients and the robust tests of bond portfolio performance between DMs with SAEM and bond index. The results of this study provide important implications for global investors by identifying diversification gains in SAEM.

Key Words: African Bond Market, Portfolio Diversification

JEL classification: F3

Introduction

By allocating capital to fixed income instruments issued by emerging markets (EMs), governments may provide significant benefits to both the investors and issuers of these instruments. For investors, emerging market instruments may offer a significant risk premium relative to conventional investments in developed markets (DMs) bonds. Furthermore, EMs bonds offer potential diversification (Mann, 1996) benefits because these bonds are not strongly correlated with DMs instruments. This paper focuses on the SAEM. For emerging market government issuers, access to global fixed income markets is likely to improve liquidity and offer lower borrowing costs relative to a strategy focused purely on the domestic market. Access to global capital provides these governments with the opportunity to invest in infrastructure projects that promote economic growth and development.

The motivation of the paper is to identify the performance benefits of exposure to SAEM bonds combined with DMs bonds. We first test the potential diversification and identify the degree of financial integration between DMs bonds and SAEM bonds. In the second phase, we use a Bayesian economics approach applied in a dynamic regression framework and construct mean-variance portfolios (Markowitz, 1952) to present the optimal performance of long-term government bond portfolios. The forecasted bond returns are considered outputs in the dynamic regression models and inputs in conjunction with the Markowitz optimal mean-variance portfolio models.

The empirical results of the study show that the returns from DMs portfolios with SAEM bonds are superior to those from DMs portfolios without SAEM bonds. The empirical results can provide theoretical support to global investors in terms of the depth and width of portfolio investments in SAEM bonds. The results also prove that the investors are able to obtain diversification benefits from SAEM bonds even during the period of global financial recession.

Literature Review

The unit root test is used to identify the stationarity of financial series. If the financial series is nonstationary containing a unit root, its first difference is stationary. The Augmented Dickey-Fuller (ADF) Test measures the stationarity on a univariate series.

The cointegration tests are performed to investigate the linkages of the emerging market bonds before and after the recent global financial crisis. The analysis of the cointegration tests implies the opportunities for global bond diversification, particularly, from a long-run investment perspective. Kasa (1992) suggests that the nonexistent cointegration relation among bond markets or stock markets indicates a long-run benefit from global portfolio diversification.

Johnson and Sakoulis (2008) use the advanced econometric approach the Kalman filter (KF) (Kalman, 1960) to predict the stock sector returns. They find that the application of Bayesian parameter estimation results in significantly improved sector return predictability over rolling parameter specifications, while reducing the measurement error and white noise arising from the process of model construction. In this paper we apply the KF (Morrison 1977) in the multi-regression models to estimate the relative bond returns in SAEM and DMs.

The KF was originally developed in control theory to remove noise from the true states in the dataset. Finance researchers later found that this approach can effectively predict the price of assets by separating noise from the forecast model. Although the KF itself does not estimate the model, it can help forecast the states that carry the true, important information, while observations carry noise. The KF procedure minimizes the posteriori error covariance through both prediction and updating steps in order to obtain the efficient forecasting parameters (Wegman, 1982).

Michaud and Michaud (1998) claim that the bootstrapping and resampled approach provides efficiency in achieving optimal portfolio weights and returns. The optimal portfolio weights obtained from the average of the bootstrapping optimal portfolio weight vectors and their corresponding optimal portfolio returns set a resampled efficient frontier. Using the forecasting returns to generate the predicted covariance return matrices, we are able to obtain the efficient frontier from the bootstrapping minimum-variance sets

 $_{Page}74$

(Kleeberg 1995).

Empirical Data and Methodology

Data consists of the yield on long term government bonds. The portfolio in DMs is based on three countries including Austria, Canada and the U.K. We add the SAEM bonds to the DMs bonds to verify the diversification benefits of bond portfolio in DMs with and without SAEM. The empirical analysis employs weekly data frequency. The data of bond yields and macroeconomic in both DMs and SAEM are from Bloomberg and International Monetary Fund. The bond yields are converted to the relative bond returns in terms of the US dollar to maintaining the consistent base currency for the empirical analysis.

The empirical application consists of the unit root test, multi-variable dynamic regression models, meanvariance bond portfolios for DMs with SAEM and DMs without SAEM and last robust test. The unit root test is used to test the stationarity of a series. To be analyzed, the series must be stationary. We use ADF methodology to test for the presence of a unit root and specify unit root tests both in the level and first difference level. We use the KF procedure to estimate the time-varying parameters in the multi-factor models (Dungey 2000), and then forecast the relative bond returns for the countries in SAEM and their corresponding countries in DMs.

A KF approach is an optimal recursive data processing algorithm. The most obvious characteristic of optimality using KF is that this approach incorporates the previous state information to predict the next state, so that the parameters in the model are time-varying. Thus the KF can combine all the available information about initial conditions rather than ignoring any of these inputs. The other aspect of the characteristics is recursion which occurs in the process of simulation. The KF requires only the inputs from the previous step, and not from the whole history of inputs. Under the circumstances of a linear model with white noise and Gaussian probability distribution, a KF shows conditional probability density propagation for problem.

To conduct the robustness tests, we use the Sharpe ratio (Sharpe 1994) of DMs with and without SAEM in conjunction with the Jobson-Korkie test (Jobson and Korkie, 1981) in investigation of the equality of the Sharpe ratios. The U.S. 7-10 year government bond is the index that we use to make the performance analysis. The empirical Z-statistic indicates whether the Sharpe ratio of the portfolio of DMs with SAEM is superior to the bond index.

Empirical Investigation

The report of the correlation coefficient among the yields of long-term government bonds shows from a short-run perspective in Table 1. SAEM has positive relationships with the countries in DMs. It demonstrates that the relationship coefficient is relatively quite small, indicating a low level of international financial integration in bond markets among these countries from DMs and SAEM. All the values of correlation are below 0.8000 both at the regional and cross-regional levels. DMs have potential investment benefits from diversifying their portfolio in SAEM.

Wang & Bilson / International Journal of Finance & Banking Studies Vol 5, No 1, 2016 ISSN: 2147-4486

	CA	UK	AUS	S.Africa
Panel (a): For the whole period				
Canada	1.0000	0.7987	0.6374	0.7859
		<.0001	<.0001	<.0001
UK		1.0000	0.7937	0.6212
			<.0001	<.0001
Australia			1.0000	0.4362
				<.0001
S. Africa				1.0000
Panel (b): Before the fi	nancial crisis	•		
Canada	1.0000	0.5394	0.4798	0.6579
		<.0001	<.0001	<.0001
UK		1.0000	0.624	0.4351
			<.0001	<.0001
Australia			1.0000	0.2763
				<.0001
S. Africa				1.0000
Panel (c): During the fin	nancial crisis			
Canada	1.0000	0.6021	0.4253	0.5947
		<.0001	<.0001	<.0001
UK		1.0000	0.5861	0.4489
			<.0001	<.0001
Australia			1.0000	0.2837
				<.0001
S. Africa				1.0000

Table 1: Correlations amongst the Log Bond Yields: DMs vs. SAEM

Notes: In panel (a), the number of observations is 682. The research period is from 1/10/1997 to 1/29/2010. In panel (b), the number of observations is 573. The period is from 1/10/1997 to 12/28/2007. In panel (c), the number of observations is 109, from 1/4/2008 to 1/29/2010.

In Table 2, the null hypothesis of a unit root is that the series is non-stationary. If the test fails to reject the hypothesis in levels, but rejects the hypothesis in the first difference level, then the series contains a unit root that is integrated of order one I(1).

Country	Whole period	ble period Before financial crisis		ial crisis	During financial crisis	
	Level ADF Statistic	First difference ADF	Level ADF Statistic	First difference ADF	Level ADF Statistic	First difference ADF
Canada	-1.33	-7.67*	-1.48	-11.21*	-2.29	-4.75*
UK	-1.79	-7.04*	-2.75	-9.95*	-1.6	-4.62*
Australia	-2.63	-6.71*	-3.16	-10.42*	-1.53	-3.67*
S Africa	-1.12	-7.18*	-1.1	-9.35*	-2.11	-3.36*

Table 2: Unit Root Tests for the Bond Yields: DMs vs. SAEM

* Indicate rejection of a unit root at the 10% level of significance.

The research periods include the whole period, before and during the financial crisis. We test the presence of a unit root for each developing market. The results show all the time series of the government bond yields containing a unit root; however, the summary statistics report the bond yields in first difference ADF indicating the rejection of a unit root at the ten-percent level of significance. Therefore we can conclude that all of these government bond yield series are integrated of order (1) processes.

In general, this study considers the perspective of investors holding U.S. dollars who are contemplating investing in SAEM in order to obtain diversification benefits. From the general statistical analysis, there is a relatively low linkage of long-run bond yields between SAEM and DMs and among themselves. In other

2
 2 2

words, the empirical results show that SAEM bond yields have relatively independent movement paths that could leave a space to obtain the benefits of global diversification.

The cointegration tests are performed to investigate the linkages of the emerging market bonds before and after the recent global financial crisis. The analysis of the cointegration tests implies the opportunities for global bond diversification, particularly, from a long-run investment perspective. Table 3 shows the null hypothesis of no cointegrating vectors cannot be rejected under both trance statistic and maximum tests at the five-percent level of significance in all the panels. This implies a low degree of financial integration amongst countries in the sample.

Hypothesized number of CE(s)	Eigenvalue	Trace statistic	0.05 critical value
Panel (a): For the whole period			
(1): Trace statistic			
None	0.0318	43.0497	47.21
At most 1	0.0206	21.0836	29.38
At most 2	0.007	6.9282	15.34
At most 3	0.0032	2.1793	3.84
(2): Maximum test			
None	0.0318	45.3494	53.42
At most 1	0.0207	23.3667	34.80
At most 2	0.0074	9.1647	19.99
At most 3	0.0060	4.099	9.13
Denal (h): Defere the financial crisis			
(1): Trace statistic			
	0.0206	20 2222	47.01
At most 1	0.0290	30.3323	47.21
At most 2	0.0200	21.2133	29.30
At most 2	0.0124	0.1230	15.34
(2): Maximum toot	0.0017	0.9005	3.04
(2). Maximum test	0 0208	11 556	53.42
At most 1	0.0290	41.000	34.9
At most 2	0.0227	24.2037	10.00
At most 3	0.0124	11.1507	0.13
At most 5	0.007	4.0110	9.13
Panel (c): During the financial crisis			
(1): Trace statistic			
None	0.1947	48.0802	47.21
At most 1	0.1455	25.1244	29.38
At most 2	0.0589	8.4604	15.34
At most 3	0.0189	2.0261	3.84
(2): Maximum test			
None	0.1959	48.672	53.42
At most 1	0.148	25.5652	34.8
At most 2	0.0599	8.5847	19.99
At most 3	0.019	2.0380	9.13

Table 3: Multivariate Cointegration Test: DMs vs. SAEM

*Rejected at 5% level of significance. Notes: In panel (a), the number of observations is 682. The research period is from 1/10/1997 to 1/29/2010. In panel (b), the number of observations is 573. The period runs from 1/10/1997 to 12/28/2007. In panel (c), the number of observations is 109, running from 1/4/2008 to 1/29/2010. In Table 5.15, both trace statistic and max-eigenvalue tests indicate no cointegrating equation at the 5% level.

In Table 4, the macro-economic lag factors are selected based on their availability in the IFS and Bloomberg databases. The number of lag factors is consistent with the bond yields in South Africa. In the circumstance of factor forecasting models, a higher level of correlation among factors indicates that the factor model with unexpected white noise will hardly obtain an accurate forecast price model, while the

lower level of correlation among factors will avoid the problem of common movement pattern in the factor model.

Country	Macro-economic Factors	
South Africa	EG, RMG, SMMR	
Canada	SMMR, EG, IF, CFX	
UK	SMMR, IF, UR, CFX	
Australia	IF, ER, RMG, UR, CFX	

Table 4: Macro-economic Factors Selected for Models

We forecast one-week relative bond returns using the observed weekly relative bond returns and lag macro-economic factors, so the forecasting returns at time t+1 are driven by both the lag macro-economic factors and the observed returns at time t. We construct the multi-factor models in below:

$$R_{UK_{i,t+1}} = \beta_{0,t+1} + \beta_{1,t+1} f_{1,t} (SMMR) + \beta_{2,t+1} f_{2,t} (IF) + \beta_{3,t+1} f_{3,t} (CFX) + \beta_{4,t+1} f_{4,t} (UR) + v_{i,t+1}$$
(1.1)

$$R_{Canada_{t,t+1}} = \beta_{0,t+1} + \beta_{1,t+1} f_{1,t} (SMMR) + \beta_{2,t+1} f_{2,t} (EG) + \beta_{3,t+1} f_{3,t} (IF)$$

 $+\beta_{4,t+1}f_{4,t}(CFX) + v_{i,t+1}$ (1.2)

$$R_{Australia_{i,t+1}} = \beta_{0,t+1} + \beta_{1,t+1}f_{1,t}(IF) + \beta_{2,t+1}f_{2,t}(EG) + \beta_{3,t+1}f_{3,t}(RMG) + \beta_{4,t+1}f_{4,t}(UR)$$

$$+\beta_{5,t+1}f_{5,t}(CFX) + v_{i,t+1}$$
(1.3)

$$R_{SAfrica_{i,t+1}} = \beta_{0,t+1} + \beta_{1,t+1} f_{1,t} (EG) + \beta_{2,t+1} f_{2,t} (RMG) + \beta_{3,t+1} f_{3,t} (SMMR) + v_{i,t+1}$$
(1.4)

The KF algorithm procedure is applied to obtain the dynamic coefficients, β_i (i = 1, 2, 3...) in multi-factor models of (1.1) to (1.4). This recursive data processing algorithm is able to reduce the measurement error and the forecasting bias, since the estimates are based on the previous state information, but not on the whole history data, which results in improving the forecasting efficiency of factor returns.

In the multi-factor models, we use KF to obtain the time-varying coefficients to estimate forecasting bond relative returns. The Spearman test (Table 5) is the common way to evaluate the forecasting returns since it shows the efficiency of the forecasting bond returns and the strength of the linkage between forecasting and observed bond returns. In general, most of the countries have positive Spearman ratios that indicate the significant prediction of bond returns. These positive ratios are all significant at the ten-percent level.

Table 5: Spearman	Testing Result
-------------------	----------------

	Spearman
S Africa*	0.1324
Canada*	0.0937
UK	-0.0139
Australia*	0.0649

*Significant at the 10% level.

In the framework of the mean-variance portfolio, we have the portfolio weight and return in each weekly period, since we use KF algorithm approach to estimate time-varying coefficients in the factor models. The general portfolio weight and return are calculated from the average of the weekly weights and returns. The empirical results in below demonstrate the optimal investment weights for each sample country. A 35.97

2
 2 2

percent investment in South African government bonds would ensure a return of 14.04 percent.

DMs with SAEM:

$0.1404 = 0.4982r_1(Canada) + 0.1197r_2(UK) + 0.0224r_3(Australia) + 0.3597r_4(SouthAfrica)$

In Table 6, the empirical analysis demonstrates that the portfolios of DMs with SAEM have larger Sharpe ratios than the portfolio of DMs without SAEM. This implies that the portfolio performance of DMs with SAEM is better than the portfolio performance of DMs alone. The positive Sharpe ratios of the relative bond portfolios show that their performance is better than the U.S. 10-year government bond. The Jobson-Korkie test demonstrates the positive statistical results. The positive Z-values at the ten-percent level of significance indicate that the bond portfolio of DMs with SAEM outperform the government bond index. The Z-values in the table are significantly different from zero, implying that the Sharpe ratios of DMs with SAEM are significantly different from the Sharpe ratios of the government bond index. Therefore the null hypothesis of the Jobson-Korkie test has to be rejected at the ten-percent level of significance.

Table 6: Robust Performance	Testing Result
-----------------------------	----------------

	SHP	z statistic
DMs with S. African Market	1.9886	7.5888*
DMs without S. African Market	1.8107	
*ladiates 100/ laugh of significance		

*Indicates 10% level of significance.

Notes: z indicates the results of Jobson-Korkie test in the equality of Sharpe ratios between DMs with SAEM and the U.S. 7-10 year government bond index.

Conclusion

The international bond portfolios diversify the country-level risk compared to that of the domestic bond market and enhance the competitiveness of international investment. The empirical analysis shows that DMs have a higher level of relation with each other, and that SAEM have a lower level of relation with the developed market. In the paper, we examine the linkage of financial integration in DMs and SAEM, and then construct the optimal government bond portfolio by comparing of DMs with and without SAEM. This comparison of bond portfolio performance demonstrates that the returns of DMs with SAEM are superior to those from DMs without SAEM.

In this paper we specifically verify the patterns in the government bond market over time among different regions. We focus especially on the long-term government bond market to test the movement patterns from both the short-run and long-run points of view. The degree of integration among the sample bond markets has significance for constructing portfolio. The existence of the close linkages among these markets indicates less opportunity for investors who are seeking diversification in global bond markets. This paper proposes using a Bayesian statistics approach KF for optimization of the bond portfolio. In the framework of the factor models with time-varying coefficients, a KF approach applies a state estimation technique to a dynamic bond portfolio regression model. By applying a mean-variance model, selecting the number of factors and time-varying their coefficients, one can impose reasonable restrictions on bond price dynamics.

Reference

Conte and de Boor. (1981). *Elementary Numerical Analysis: An Algorithmic Approach*, Springer, New York 3rd.

Dungey, M., N. L. Martin, and Pagan, A. R. (2000). A Multivariate Latent Factor Decomposition of International Bond Yield Spreads. *Journal of Applied Econometrics*. 40: 105-112.

http://dx.doi.org/10.1002/jae.584

Engle R. F. and Granger, C. W. J. (1987). Co-integration and Error Correction: Representation, Estimation and Testing. *Econometrica*. 55.2: 251-276. http://dx.doi.org/10.2307/1913236

$$P_{age}79$$

Fama, E.F., and French, K. R. (1989). Business Conditions and Expected Returns on Stocks and Bonds. *Journal of Financial Economics.* 25: 23-49.

http://dx.doi.org/10.1016/0304-405X(89)90095-0

- Greg, W. and Gary, B. (2001). An Introduction to the Kalman Filter. SIGGRAPH.
- Jankus, J. C. (1997). Relating Global Bond Yields to Macroeconomic Forecasts. *The Journal of Portfolio Management*, 96-101. http://dx.doi.org/10.3905/jpm.1997.409607
- Jobson, J. D. and Korkie, B. M. (1981). Performance Hypothesis Testing with the Sharpe and Treynor Measures. *Journal of Finance*, 36: 889-908. http://dx.doi.org/10.1111/j.1540-6261.1981.tb04891.x
- Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. *Journal Economic Dynamics and Control,* 12.2.3: 231–254. http://dx.doi.org/10.1016/0165-1889(88)90041-3
- Johnson, L. D. and Skoulis, G. (2008). Maximizing Equity Market Sector Predictability in a Bayesian Timevarying Parameter Model. *Computational Statistics & Data Analysis*, 52.6: 3083-3106.

http://dx.doi.org/10.1016/j.csda.2007.09.030

- Kasa, K. (1992). Common Stochastic Trends in International Stock Markets. *Journal of Monetary Economy.* 29.1: 95-124.
- Kalman, R. E. (1960). A New Approach to Linear Filtering and Prediction Problem." Transaction of the ASME. *Journal of Basic Engineering*, 35-45. http://dx.doi.org/10.1115/1.3662552
- Kearney, C., and Lucey, B. M. (2004). International Equity Market Integration: Theory, Evidence and Implications. *International Review Financial Analyst*, 13.5: 571-583. http://dx.doi.org/10.1016/j.irfa.2004.02.013
- Kleeberg, J. M. (1995) International minimum-variance strategies: Some Empirical Results. *Barra Newsletter.*
- Levy, H and Lerman, Z. (September-October 1988). The Benefits of International Diversification in Bonds. *Financial Analysts Journal*, 56-64. http://dx.doi.org/10.2469/faj.v44.n5.56
- Mann, D., R. Johnson, and Soenen, L. (1996). International Diversification: Established versus Emerging Markets. *International Journal of Finance*, 8.4: 375-390.
- Markowitz, H. M. (March 1952). Portfolio Selection. *The Journal of Finance*, 7.1 77-91. http://dx.doi.org/10.1111/j.1540-6261.1952.tb01525.x
- Martinelli, R. and Rhoads, N. (2010). Predicting Market Data Using The Kalman Filter. *Technical Analysis* of Stocks and Commodities, 28.2: 46-71.
- Maybeck, P. S., (1979). Stochastic Models, Estimation and Control. Academic Press, 1: 1-16.
- Michaud, R., and Michaud, R. (1998). Efficient Asset Management: A practical Guide to Stock Portfolio Optimization and Asset Allocation. 2nd ed. *Harvard Business School Press*. http://dx.doi.org/10.1093/rfs/14.3.901
- Morrison, G. W., and Pike, D. H. (March 1977). Kalman Filtering Applied to Statistical Forecasting. *Management Science*, 23.7 768-774. http://dx.doi.org/10.1287/mnsc.23.7.768
- Sharpe, W. F. (Fall 1994). The Sharpe Ratio. *Journal of Portfolio Management*, 21.1 49-58. http://dx.doi.org/10.3905/jpm.1994.409501
- Wegman, E. J. (1982). Kalman Filtering. *Encyclopedia of Statistics*, eds. Norman Johnson and Samuel Kotz, New York: John Wiley. http://dx.doi.org/10.1002/0471667196.ess1327