Hedging Currency Risk
in Emerging Markets Portfolios

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ABSTRACT

Hedging Currency Risk in Emerging Markets Portfolios

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It has been demonstrated that hedging foreign exchange risk in portfolios containing the securities of developed countries improves their risk-return performance. It follows that the benefit might extend to portfolios containing the bonds and stocks of emerging markets if the return correlations between developed and emerging markets are sufficiently small. I explore this question by forming portfolios of stocks and bonds from G7 countries and emerging markets in Africa, Asia, Europe, and Latin America over the period 2003 to 2010. Portfolio performance is improved through the inclusion of emerging markets securities, and both unconditional and conditional hedging of foreign exchange risk using currency forwards do the same.

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1. Introduction

While it is well established that international diversification among developed countries improves portfolio performance [Solnik (1974), Solnik and McLeavey (2003)], there is still debate as to whether hedging foreign exchange risk does the same. Is hedging a free lunch that largely reduces risk with little effect on return or is the price to be paid bigger? Much of the early evidence on international diversification leans toward the former. Perold and Schulman (1988) provide evidence that the costs of currency hedging are more than compensated for by the benefits of international asset diversification, while Eun and Resnick (1988) demonstrate that portfolios formed of the stock indices of six major countries can be improved by actively hedging exchange risk through forward markets. Krizman (1993) goes as far as to argue that currency hedging can benefit purely domestic portfolios by exploiting the correlations between the returns on domestic assets and various currencies. The favourable results of international diversification and currency hedging extend to bonds as well. Glen and Jorion (1993) find that US-denominated equity portfolios formed from the stock indices of G5 countries benefit from the inclusion of bond indices of those countries, and that currency hedging in forward markets improves performance further still.

Yet portfolio investment in emerging markets has not received the same academic attention as developed markets, perhaps because of the paucity or unevenness of the data or because the idea of investing in these countries is not yet mainstream. The so-called global financial meltdown of 2008-2009 and the global currency war in 2010, marked as they were by considerable volatility in currency markets, has rekindled discussions on international diversification and the importance of currency hedging [Schmittmann

(2010)]. At the same time, we have been witness to the rapid growth of the real sectors of emerging economies, and suspect that their financial markets are not far behind. The World Bank predicts that real GDP growth in emerging markets will be 6.3 percent in 2011, slightly declining to 6.2 in 2012 and jumping up to 6.3 in 2013, whereas developed markets will grow slower, 2.2 percent in 2011, 2.7 percent in 2012 and decreasing to 2.6 percent in 2013 [World Bank (2011)]. It is for this reason that I examine the performance of international portfolios that include the securities of emerging markets, and whether currency hedging is beneficial in these expanded international portfolios. My sample covers seven developed and 15 emerging markets from Asia, Africa, Europe, and Latin America. I find that the low correlations of emerging markets securities with those of developed markets shift portfolio frontiers favourably. Unconditional currency hedging, achieved through the inclusion of currency forwards significantly improves the performance of portfolios containing stocks and/or bonds of emerging markets, and conditional hedging substantially decreases the risk of the portfolios with given a spot position.

The rest of the paper is organized as follows. Section 2 reviews previous research on international diversification, portfolio investment in emerging markets, and hedging foreign exchange risk. Section 3 provides background on the economic development of emerging markets and international trade during the last nine years. Section 4 reviews the theory of portfolio selection and hedging. Section 5 describes the data and methods. Section 6 reports on the performance of portfolios for conditional and unconditional hedging strategy. Section 7 concludes.

2. Previous Research

2.1 International Diversification

Low international correlations between countries enable global investors not only to reduce the volatility of portfolios but also to offer opportunities for profit [Solnik and McLeavey (2003)]. Solnik (1974) studies the weekly stock returns of eight countries over the period 1966-1971, and finds that risk reduction is achieved by international portfolios, and that as the number of securities increases, international currency-hedged portfolios reduce more risk than domestic portfolios or international currency-unhedged portfolios. Solnik, Boucrelle, and Le Fur (1996) examine the correlations of six major foreign stock and bond markets and find that return correlations have varied widely over the 37 years spanning 1958-1995, but that the benefits of diversification persist despite a trend to increasingly positive correlatedness. The average return correlation between major equity markets for 1990-2007 was 4.8 percent, up from about 4.0 percent for 1980-1988 [Elton, Gruber, Brown, and Goetzmann (2010)], owing to economic integration and adoption of a common currency in Europe, did not diminish the potential for diversification materially. Chiou (2008), forming risk-adjusted efficient portfolios and minimum-variance portfolios, draws the same favourable conclusion for global portfolios. International diversification still pays despite increasing interdependence and integration of world economies.

2.2 Portfolio Investment in Emerging Markets

Emerging market equities are becoming more attractive not only because their return correlations with developed market are low but also because expected returns are

higher [Bekaert and Harvey (1997)]. Emerging market equities are also riskier. But despite this, Bekaert and Harvey find that world and local factors both affect volatility, and that trends to more openness of real markets, greater political stability, and capital market liberalization have all acted to lower volatility. Erb, Harvey and Viskanta (1999), likewise, report that emerging market bonds also demonstrate high returns, averaging more than the S&P 500 index during the growth period of 1991 to 1997. During the recent economic crisis, the returns of emerging market bonds were negatively skewed and highly correlated with emerging market equities.

Capital flows to emerging markets as of the 1990s have substantially increased due to rapid economic growth. They have also become more stable. Bekaert and Harvey (2003) examine three-year rolling window estimates of the variance of U.S. emerging and developed market equity holdings over the period 1977-2003 and find that the volatility of capital flows to emerging markets is less than that of developed markets. They also demonstrate that this is reflected in superior emerging markets portfolio performance. Emerging market mutual funds consistently outperformed U.S. funds according to size, value, and momentum from 1993 to 2006 [Huij and Post (2011)].

2.3 Hedging Foreign Exchange Risk

Currency hedging reduces the riskiness of international portfolios. Lypny (1988), in a study of three futures hedging strategies on two-currency spot portfolios, finds that even naive hedging — where the spot positions are hedged one-for-one — can substantially reduce risk. Gagnon, Lypny, and McCurdy (1998), in the framework of risk-minimization and utility-maximization, examine the performance of multi-currency spot portfolios dynamically hedged with multi-future contracts and demonstrate that dynamic

hedging leads to more risk reduction than static hedging, and that portfolio effects for multi-currency portfolios result in risk reduction and utility gains.

Campbell, Serfaty-de Medeiros, and Viceira (2010), in a study of seven major developed markets over the period 1975 to 2005, examine the circumstances in which risk-minimizing investors can use currencies to control portfolio risk. They find that the optimal strategy for global bond investors is to avoid taking spot positions in currencies because currencies are almost uncorrelated with bond returns. Schmittmann (2010) similarly analyzes currency hedging in bond and stock portfolios from the perspective of German, Japanese, U.K., and U.S. investors. He concludes that for international bond investors, full hedging is a dominant strategy whereas for equity investors, currency exposure depends on correlations between currencies and equity markets, the conclusion that is consistent with that of Campbell, Serfaty-de Medeiros, and Viceira.

Only a few studies have examined currency hedging in emerging markets. Hauser, Marcus, and Yaari (1994) compare hedged and unhedged equity portfolios in developed and emerging markets and find that hedging currency risk in emerging markets enhances portfolio performance but at the cost of a substantial increase in risk. Bugar and Maurer (2002) contrast the benefits from international diversification in a developed stock market, Germany, with those in an emerging market, Hungary, when multi-currency portfolios are hedged. Hungarian portfolios benefited more from hedging.

3. International Diversification and Emerging Markets

3.1 Foreign Direct Investment

Foreign direct investment (FDI) flows are indicative of a country's economic growth and production potential, and are tied to concurrent or subsequent development of its financial markets and attractiveness to foreign investors. Table 1 shows FDI flows to developed and emerging countries or region from 2001 to 2009. Except for many countries suffering a decline in 2009, in the aftermath of the financial crisis, the average percentage change in FDI for 2006-2008 for eight of the 15 emerging economies increased over that for 2002-2005, whereas three of the five developed markets reported declines.

China, Brazil, India, and Mexico enjoy the biggest flows among the emerging economics which, in turn, attracts or will attract more purely financial investment. All these four emerging countries have their own distinctive features in attracting FDI flows. Because of economic reforms and open policy for world trade, China has attracted large flows in the form of wholly-owned subsidiaries of foreign companies, joint ventures with Chinese firms, and manufacturing, which stimulate rapid economic development. Capital- and technology-intensive industrial production has attracted large FDI inflows to Brazil, resulting in the rapid development. India's FDI inflows are the result of joint ventures, such as generation of electricity and construction of roads and highways. Financial collaborations, such as private equity and joint ventures, are an alternative way to increase FDI inflow. Most of FDI flows to Mexico are from the U.S., Holland, and Spain, and half of the funds are directed to manufacturing, which holds potential for job creation.

Table 1. Foreign Direct Investment Flows

Country	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
A. FDI Flows to Developed Markets									
Canada	27.66	22.16	7.48	-0.45	25.69	59.76	108.41	55.27	18.66
Euroland	91.76	117.10	91.28	39.19	152.36	166.71	212.97	103.72	125.77
Japan	6.24	9.24	6.32	7.82	2.78	-6.51	22.55	24.43	11.94
United Kingdom	52.62	24.03	16.78	55.96	176.01	156.19	186.38	91.49	45.68
United States	159.48	74.50	53.14	135.85	104.81	237.14	265.96	324.56	129.88
B. FDI Flows to Emerging Markets									
Argentina	2.17	2.15	1.65	4.12	5.27	5.54	6.47	9.73	4.89
Brazil	22.46	16.59	10.14	18.15	15.07	18.82	34.58	45.06	25.95
Chile	4.20	2.55	4.31	7.17	6.98	7.30	12.53	15.18	12.70
China	46.88	52.74	53.50	60.63	72.41	72.72	83.52	108.31	95.00
Colombia	2.54	2.13	1.72	3.02	10.25	6.66	9.05	10.58	7.20
Hungary	3.94	2.99	2.14	4.51	7.71	19.80	71.48	61.99	-5.58
India	5.48	5.63	4.32	5.78	7.62	20.33	25.00	40.42	34.61
Mexico	29.77	23.64	16.58	23.81	22.35	19.95	27.44	23.68	12.52
Philippines	0.20	1.54	0.49	0.69	1.85	2.92	2.92	1.54	1.95
Poland	5.70	4.12	4.59	12.87	10.29	19.60	23.56	14.69	11.40
South Africa	6.78	1.57	0.73	0.80	6.65	-0.53	5.69	9.01	5.70
South Korea	4.09	3.40	4.38	9.00	7.06	4.88	2.63	8.41	5.84
Taiwan	4.11	1.45	0.45	1.90	1.63	7.42	7.77	5.43	2.80
Thailand	5.07	3.36	5.22	5.86	8.07	9.52	11.36	8.54	5.95
Turkey	3.35	1.08	1.69	2.78	10.01	20.22	22.02	18.15	7.61

The inward FDI flows, in billions of the U.S. dollars, is taken from the United Nations Conference on Trade and Development. Euroland is the sum of FDI on Germany, France, and Italy.

3.2 International Trade and Exchange Rates

International trade has become more important for all countries. Tables 2 and 3 report the nominal U.S. dollar value of exports and imports from 2002 to 2009 for both developed and emerging markets.

Table 2. Exports and Imports of Merchandise and Services in Developed Markets

Country	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
A. Exports Value of Developed Markets								
Canada	292.87	317.07	354.81	415.26	449.88	481.99	520.17	375.12
Euroland	482.87	578.96	686.45	728.26	813.92	953.59	1042.94	823.89
Japan	482.44	549.44	663.29	705.12	767.23	829.66	935.19	709.18
United Kingdom	414.18	463.55	544.60	592.00	685.65	723.31	746.94	587.05
United States	981.89	1025.82	1168.10	1292.45	1470.40	1663.68	1846.70	1561.52
B. Imports Value of Developed Markets								
Canada	268.96	293.29	334.00	392.04	424.59	465.48	499.37	402.33
Euroland	440.18	535.39	629.51	680.41	764.81	885.07	986.43	781.94
Japan	436.50	485.54	579.21	638.44	704.29	758.17	918.57	687.37
United Kingdom	463.58	515.56	607.70	663.27	762.08	807.55	818.12	632.52
United States	1412.80	1533.35	1793.27	2023.49	2239.11	2365.58	2542.32	1946.34
C. Trade Balance of Developed Markets								
Canada	23.91	23.78	20.81	23.22	25.30	16.51	20.80	-27.21
Euroland	42.70	43.57	56.94	47.85	49.11	68.52	56.51	41.95
Japan	45.94	63.90	84.07	66.68	62.94	71.49	16.61	21.81
United Kingdom	-49.40	-52.02	-63.10	-71.27	-76.43	-84.24	-71.18	-45.47
United States	-430.90	-507.53	-625.17	-731.04	-768.71	-701.91	-695.62	-384.83

Exports and imports, in billions of the U.S. dollars, from the United Nations Conference on Trade and Development. Euroland is the average of imports and exports for Germany, France, and Italy.

Table 3. Exports and Imports of Merchandise and Services in Emerging Markets

Country	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
A. Exports Value of Emerging Markets								
Argentina	29.14	34.07	39.86	46.99	54.59	66.14	82.66	67.02
Brazil	69.99	83.65	109.26	134.58	157.27	184.60	228.39	180.72
Chile	22.57	26.73	38.55	48.40	66.51	76.63	77.24	60.47
China	365.34	484.96	655.76	836.36	1061.38	1340.00	1575.77	1331.29
Colombia	13.78	15.00	18.48	23.81	27.76	33.42	42.40	36.97
Hungary	41.93	51.74	66.24	75.77	88.89	112.55	128.34	101.64
India	69.85	82.86	114.93	152.15	191.54	236.92	297.48	253.73
Mexico	173.42	178.01	203.13	230.03	266.83	289.66	310.31	245.11
Philippines	39.93	39.62	43.72	44.40	53.86	60.04	58.92	48.41
Poland	51.05	64.71	88.38	105.66	131.27	168.87	205.34	162.86
South Africa	36.76	47.14	58.11	67.56	78.04	89.74	98.92	78.55
South Korea	190.86	226.77	295.73	329.55	375.36	434.84	499.19	420.13
Taiwan	152.09	167.07	199.70	223.61	252.93	277.69	288.94	234.69
Thailand	83.50	96.12	115.29	130.34	155.63	183.48	206.24	182.27
Turkey	50.11	65.27	86.13	100.25	111.13	136.30	167.02	135.35
B. Imports Value of Emerging Markets								
Argentina	13.55	19.07	28.53	35.71	42.00	54.71	69.46	49.88
Brazil	63.07	65.03	82.31	100.04	122.62	160.76	225.73	176.77
Chile	21.77	24.55	31.03	39.87	46.19	56.32	72.63	50.18
China	337.98	463.64	627.59	737.04	884.37	1075.96	1277.83	1150.36
Colombia	15.75	16.98	20.37	25.59	31.10	38.91	45.93	39.22
Hungary	44.09	56.02	69.79	77.06	89.36	110.02	125.81	92.70
India	75.87	95.45	132.56	186.35	232.47	293.59	401.65	318.02
Mexico	192.85	195.19	224.82	251.55	289.18	318.72	348.37	267.46
Philippines	42.18	44.43	47.69	52.36	59.88	64.62	68.36	53.61
Poland	63.63	78.06	101.86	115.88	145.14	187.71	236.07	168.22
South Africa	35.51	49.64	64.36	75.44	94.81	105.55	111.79	88.33
South Korea	185.78	215.98	270.40	315.32	372.73	433.31	521.62	392.50
Taiwan	135.50	150.95	196.36	212.45	233.15	251.95	272.48	201.99
Thailand	80.03	92.54	115.64	143.02	159.10	176.15	221.33	169.83
Turkey	57.22	76.24	106.89	127.36	150.61	184.49	218.41	156.48
C. Trade Balance of Emerging Markets								
Argentina	15.60	14.99	11.33	11.28	12.59	11.43	13.20	17.14
Brazil	6.92	18.62	26.95	34.54	34.65	23.84	2.66	3.95
Chile	0.79	2.18	7.52	8.53	20.32	20.31	4.61	10.29
China	27.36	21.32	28.17	99.31	177.01	264.04	297.94	180.93
Colombia	-1.97	-1.98	-1.89	-1.78	-3.34	-5.49	-3.53	-2.24
Hungary	-2.16	-4.28	-3.56	-1.29	-0.46	2.54	2.53	8.93
India	-6.02	-12.58	-17.64	-34.20	-40.94	-56.67	-104.17	-64.29
Mexico	-19.43	-17.18	-21.69	-21.52	-22.34	-29.05	-38.07	-22.35
Philippines	-2.25	-4.81	-3.97	-7.96	-6.02	-4.59	-9.44	-5.20
Poland	-12.59	-13.35	-13.47	-10.22	-13.87	-18.84	-30.73	-5.36
South Africa	1.25	-2.50	-6.25	-7.88	-16.77	-15.81	-12.86	-9.78
South Korea	5.07	10.80	25.33	14.23	2.63	1.52	-22.43	27.63
Taiwan	16.59	16.12	3.34	11.15	19.78	25.75	16.46	32.70

Thailand	3.47	3.58	-0.35	-12.68	-3.47	7.33	-15.08	12.44
Turkey	-7.12	-10.98	-20.76	-27.11	-39.47	-48.19	-51.39	-21.13

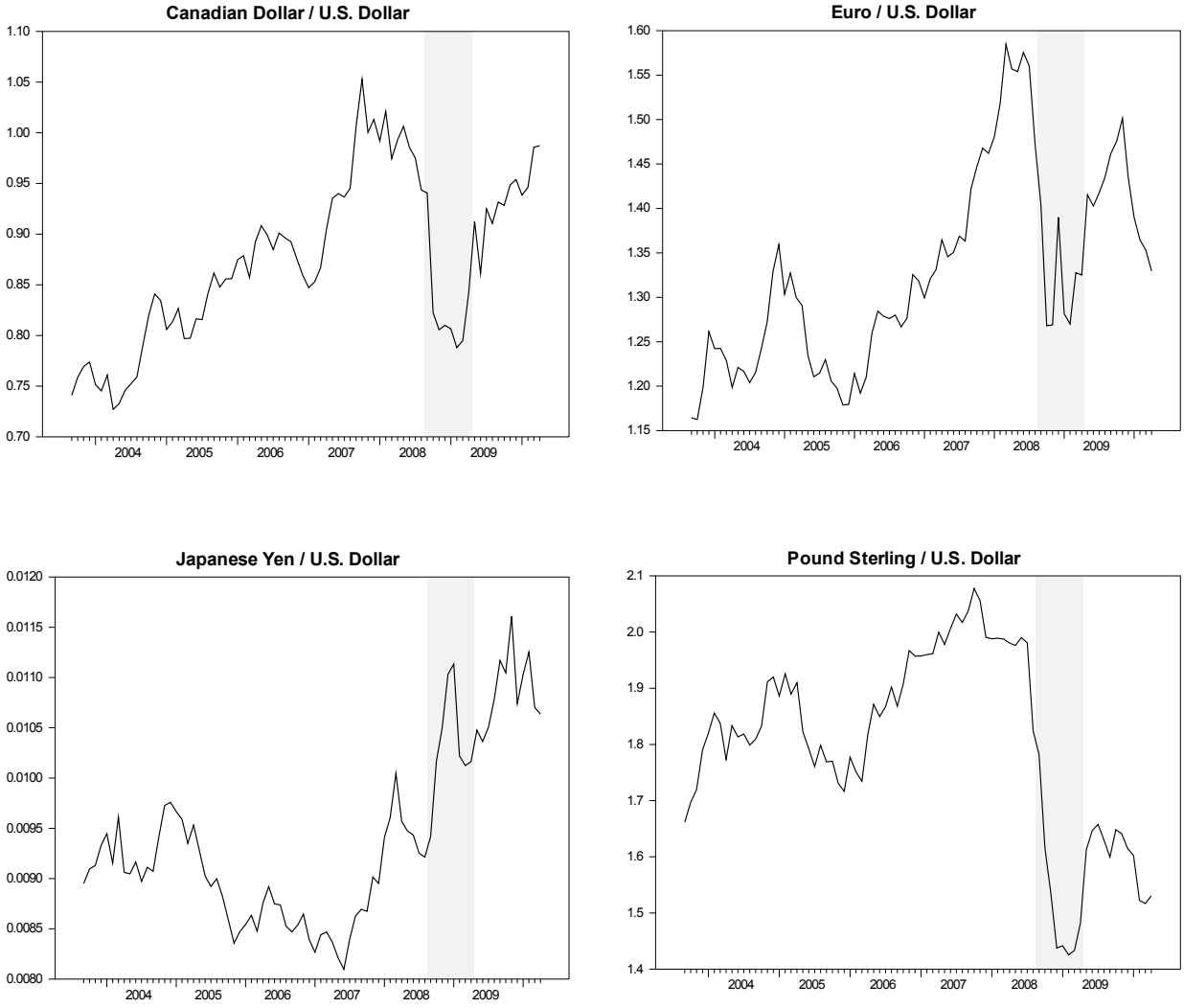
Exports and imports, in billions of the U.S. dollars, from the United Nations Conference on Trade and Development.

The average net trade balance for 2006-2009 of all four developed countries declined compared to 2002-2005, and for most of these the change was driven by an increase in imports. The picture for emerging markets is mixed, and over the two periods the change in the value of net trade for some markets dramatically decline while others increase. Countries such as Argentina, Chile, and China showed an increasing net trade balance largely because of growth in exports which necessarily results in increased demand for financing.

Rapid changes in real economies are often accompanied by increased volatility in currency prices, as depicted in Figure 1 and Figure 2.[1] With the exception of the Chinese yuan and Japanese yen, all currencies appreciated during 2004-2005 and 2007-2008, but depreciated dramatically during 2008-2009. This also illustrates the differences, at present, in the effects of global systematic risk on different countries.

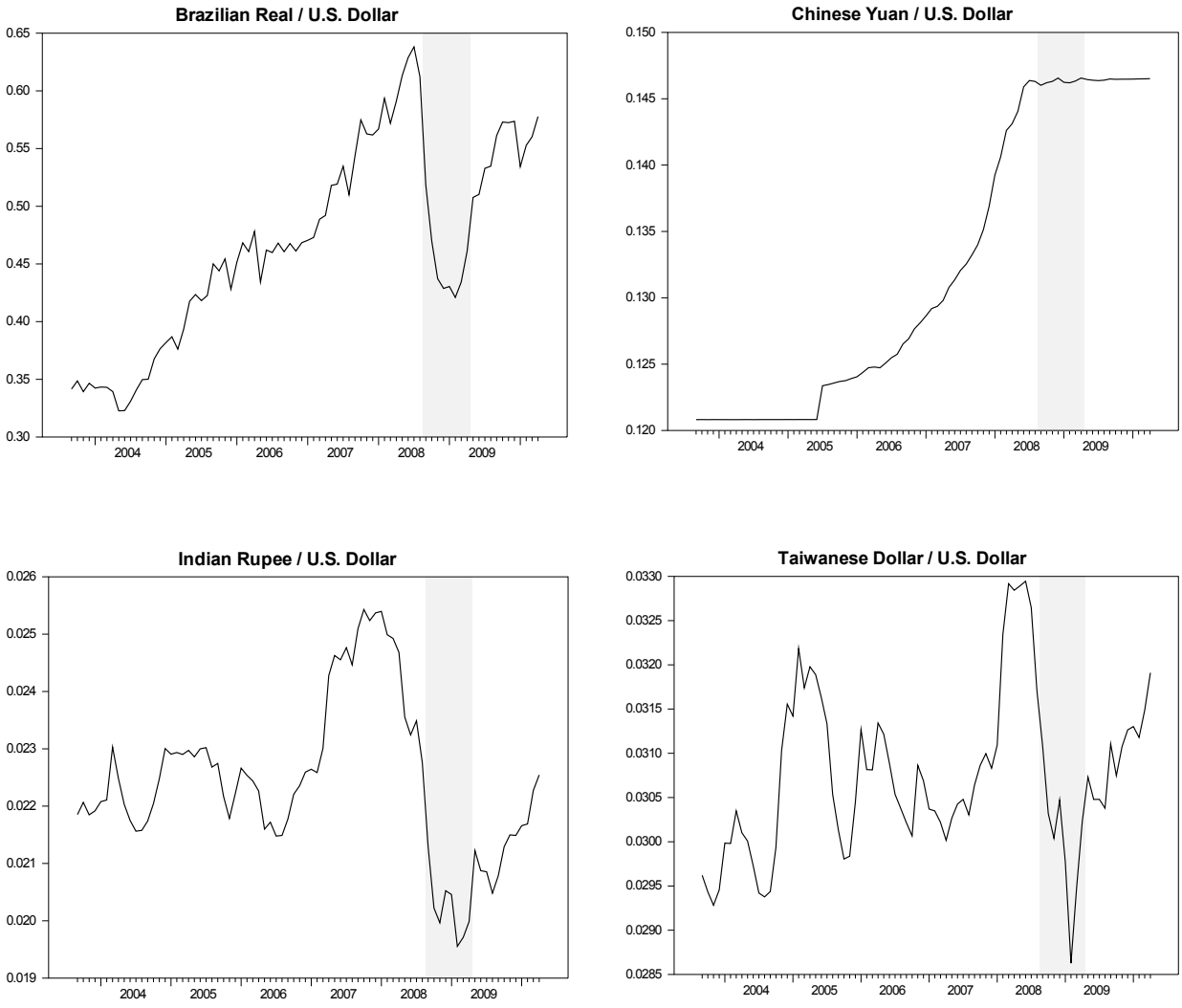
[1] In order to save space, Figure 2 exhibits only the four most actively traded emerging currencies.

Figure 1. Percentage Change in Exchange Rates in Developed Markets



Exchange rates in U.S. dollars, September, 2003 to April, 2010

Figure 2. Percentage Change in Exchange Rates in Emerging Markets



Exchange rates in U.S. dollars, September, 2003 to April, 2010.

Both importers and exporters are exposed to greater exchange rate risk, with small-to-medium size enterprises being the most vulnerable as they often lack the bargaining power to dictate the currency used in their transactions. Risk management becomes paramount.

4. Portfolio Selection

Here I review the portfolio formation problem in the utility-theoretic framework. The results are well known and the presentation follows, with some modification, expositions that can be found in, among others, Arrow (1965), Solnik (1974), Glen and Jorion (1993), and Jorion and Khoury (1996).

4.1 Portfolio Return

The one-period return on a security for a U.S. investor is

$$R_{i,t+} = \frac{P \quad S}{P_{i,t} S_{i,t}} -$$

where $S_{i,t}$ is the U.S. dollar spot price of currency *i* at time *t*, and $P_{i,t}$ the value of the security in local currency. The payoff on a forward position in a currency is

$$f_{i,t+} = \frac{F}{S_{i,t}} —$$

where $F_{i,t+}$ is the U.S. dollar forward price of currency *i* at time *t+1*. The one-period return on a one-asset portfolio is therefore given by

$$R^h_{t+} = \quad +$$

where *h* is the investment weight in currency forwards or the *hedge ratio*. For an unhedged portfolio, *h* is 0, whereas for a fully, although sub-optimally or *naively*, hedged portfolio, it is -1. For a portfolio of many assets, R_{t+} is an *n*-vector of random returns, each multiplied by its respective investment weight (not shown in the equation); $h_t \cdot$

is the dot product of the *n*-vector of hedge ratios with the corresponding vector of forward currency payoffs.

4.2 Portfolio Formation under Expected Utility

Consider a person who invests in one risky asset, such as a stock, with a market value *S,* and a safe asset, such as a riskless government bond, with market value *M*. The person's current wealth is

$$W_0 = \quad +$$

Let $\tilde{\imath}$ be the random return on the stock and *r* the return on the riskless bond. The person's random income, $\tilde{\ }$, at the end of one period is

$$\tilde{\ } \qquad \tilde{\ }$$

which can be interpreted as a sure income of rW_0 plus a risk premium of $S\ \tilde{\imath}$ for every dollar invested in the stock. Assuming that the person is a one-period, expected utility of income maximizer, the objective function for the amount *S* invested in the risky asset is

$$\underset{S}{Max}\, E\left[\quad \tilde{\ }\right] \quad \left[\qquad \cdot \tilde{\ }\right]$$

with the first-order condition

$$E\left[\ ' \tilde{\ }\right]$$

or

$$E\left[\quad\right]$$

that yields the well-known pricing equation

$$E\ \tilde{r}_{\quad} = \quad + \frac{\mathrm{cov}\left[\quad\right]}{E\left[\quad\right]} \qquad (1)$$

The required return on the stock is equal to the riskless rate plus a risk premium that depends on their risk preference: it is specific to the person. If the person is risk-averse, the premium is positive because marginal utility, $u'(\tilde{\ })$, will co-vary negatively with the $\tilde{r}_{\quad}$, making the numerator of the second term negative. Rubinstein (1973) shows that if the person's income and the return on the stock are jointly normally distributed, then the preference term can be removed from within the covariance operator and (1) rewritten as

$$\begin{aligned} E\ \tilde{r}_{\quad} &= \frac{E\left[u''(\tilde{\ })\right]}{E\left[\quad\right]}\,\mathrm{cov}\left[\quad\right] \\ &= \quad + \quad\left[\quad\right] \\ &= \quad + \quad\cdot\quad\left[\quad\right] \\ &= \quad + \quad\cdot\quad\cdot \end{aligned}$$

where ARA is the Pratt-Arrow coefficient of absolute risk aversion. This transformation separates tastes for risk from the quantity of risk. The utility-maximizing dollar investment in the risky stock becomes

$$S = \frac{1}{ARA}\,\frac{E\ \tilde{r}_{\quad}}{\sigma_{\quad}}$$

or, dividing both sides by current wealth, the optimal fraction of wealth

$$w_S = \frac{S}{W_0} = \frac{1}{W_0 \cdot} \frac{E\tilde{r}}{\sigma} = \frac{\tilde{r}}{\sigma} \qquad (2)$$

where $\lambda = \frac{1}{W_0 \cdot}$ is the coefficient of *relative* risk tolerance. Equation (2) tells us that the optimal investment is increasing in relative risk tolerance, increasing in the expected risk premium, and decreasing in the asset's riskiness. The result can be generalized directly to the case of many risky assets, *n*, as

$$w = \cdot \Sigma \cdot \qquad (3)$$

where w is now interpreted as an *n*-vector of investment weights, Σ as the inverse of the *n* x *n* covariance matrix of risky asset returns, and μ as the *n*-vector of expected risk premiums ($\tilde{r}_1 \quad \tilde{r} \quad \tilde{r}$). It should be noted that the elements of w do not sum to one because the elements of μ are differences from the risk-free rate. One minus the sum of these weights, that is, the residual, is the investment in the risk-free asset.

4.2 Unconditional Hedged Portfolios

Following Solnik (1974), Glen and Jorion (1993), and Jorion and Khoury (1996), I estimate vector w for portfolios comprised of the stock indices and government bond indices of 20 countries or region. The portfolio is referred to as *hedged*, as in Glen and Jorion, because forward contracts on the various currencies are included. It is also referred to as *unconditional* because the position in all assets and forwards, if any, is de-

termined jointly. The performance of the hedged portfolios can be compared to those which do not include forward positions.

The practical estimation of w requires that a number of assumptions be made. It is assumed that utility-maximizers invest in perfect international financial markets where short sales are not restricted, and where there are no transaction costs or barriers to trade. The perfect markets assumption also subsumes informational efficiency and implies that covered interest rate parity holds, so that the payoffs on currency forwards, that is, the forward premium, can replace interest differentials between domestic and foreign bills in the portfolios. This is a convenience as data on government bonds is not available for all of the countries being studied. The inflation rate in each country is assumed to be non-stochastic so that nominal returns can be used. Finally, because (3) is not a closed-form solution — λ depends on the distribution of returns — I assume that the investor has a log utility function, implying a relative risk tolerance coefficient equal to one.

Bringing these assumptions together, the unconditional, optimal vector of weights I estimate is

$$w = \Sigma \quad \cdot \qquad (4)$$

where $\mu =$ is the vector of mean differences and $\Sigma =$ the covariance matrix, both decomposed into their spot components (returns on stock and bond indices) and forward payoffs.

4.3 Conditional Hedged Portfolios

It is also useful to consider the optimal hedging strategy for an investor whose spot position is already given. In commerce, this is most relevant for any producer who has dealings with foreigners, for example, accounts payable of EUR50 million per month denominated and accounts receivable of Pesos65 million per month.

Let the investor be a mean-variance utility-of-return maximizer represented as

$$u(\tilde{\imath}_{-P}, \quad \tilde{} \quad \tilde{}$$

or, expanding,

$$u(\tilde{\imath}_{-P}, \quad \tilde{} \quad - \quad +$$

where γ is a risk aversion parameter, and recall, f is the payoff on a forward contract. Maximizing utility with respect to the hedge ratio, h, yields the optimal hedge ratio

$$h^* = \frac{\sigma}{\sigma_{\cdot}} - \frac{\tilde{}}{\gamma\sigma_{\cdot}} \qquad (5)$$

The first term is the risk-minimizing hedge ratio and is equivalent, in estimating, to the slope coefficient of a regression of spot asset returns on forward payoffs. The second is the speculative demand for forward contracts, which is increasing in the expected payoff of forward contracts and decreasing in risk aversion and the riskiness of forward positions.

It is commonly assumed in the hedging literature that financial markets are efficient, which in turn implies that the expected payoff of forward contracts is zero. The optimal conditional hedge ratio therefore collapses to the first term as in (6).

$$h^* = \frac{\sigma}{\sigma_{\cdot}} \qquad (6)$$

It is (6) that will be estimated for the purposes of investigating conditionally hedged portfolios.

5. Data and Methods

5.1 Sample

The study covers seven developed and 15 emerging markets, all of which have actively traded currencies. The developed countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, and the emerging countries or region are Argentina, Brazil, Chile, China, Colombia, Hungary, India, Mexico, Philippines, Poland, South Africa, South Korea, Taiwan, Thailand, and Turkey. For each I obtained the monthly total return on stock and bond indices, spot and forward currency prices, and the nominal monthly U.S. T-bill rate to represent the return on a risk-free asset for an American investor. The sample period starts September, 2003, which is the earliest date that the data is available for all variables, and ends April, 2010.

The total return stock indices are measured in local currency and were obtained from MSCI Barra, which measures international market performance and is a market-capitalization weighted index. The indices include gross dividends and consider the maximum possible reinvestment. The total return bond indices are also in local currency and were obtained from the J.P. Morgan Government Bond Index and J.P. Morgan Emerging Local Markets Index Plus. These include all bonds with a maturity of more than three years for developed countries and two and one-half for emerging markets. The returns are computed with interest payments and capital gains. I combined the indices of the three countries of the European Union into an equally-weighted index called Euroland, so the effective number of countries in the sample is 20, five developed and 15 emerging.

Spot and one-month forward U.S. dollar currency prices were calculated as the arithmetic mean of bids and offers obtained from WM/Reuters, which reports closing prices at 4 p.m. U.K. time. The U.S. nominal monthly risk-free rate is taken from Morningstar Ibbotson and is the return computed using portfolios constructed of the shortest treasury bills with a maturity of less than one month.

5.2 Test Statistics

I consider an unconditionally hedged portfolio to have outperformed an unhedged portfolio if its Sharpe ratio is bigger. To test for this, I follow Glen and Jorion and employ the test statistic developed by Gibbons, Ross, and Shanken (1989), hereafter GRS, in which the payoffs of each forward contract are regressed against the returns of all of the spot assets contained in the portfolio

$$\tilde{} \qquad \sum_{j=} \quad \tilde{} \qquad \tilde{} \qquad \cdots \qquad \cdots \qquad (7)$$

where the null hypothesis is that the series of regressions has (jointly) zero intercepts. The GRS test statistic is

$$\frac{T - \quad -}{N} \left(\qquad \right) \qquad (8)$$

T is the number of dated observations in each regression; L is the number of spot assets; N the number of currency forwards; α is the vector of estimated intercepts; and Σ is the estimated covariance matrix defined previously. The GRS statistic is distributed as F(T-N-L, N). Additional details about its derivation and properties can be found in Diether (2001).

5.3 Descriptive Statistics

Table 4 reports summary statistics for unhedged and fully- or naively-hedged one-asset portfolios, exchange rates, and currency forward payoffs over the entire sample period. The first column of Panel A shows the average percentage change of the various spot currency prices, illustrating that they vary widely, with the pound, Mexican peso, and Argentine peso depreciating, and the others appreciating from as little as 1 percent (Turkey) to 75 percent (Brazil). There is similar diversity in the volatility of the spot exchange rates as shown in the corresponding column of Panel B, which reports standard deviations as low as 0.4 percent for the Chinese yuan (largely pegged) and as high as 5.1 percent for the South Africa Rand. What is notable is that half of the emerging markets currencies are more volatile than the most volatile developed market currency, foreshadowing possible benefits for hedging when developed market portfolios are expanded to include emerging markets securities. As expected, the volatility of forward prices matches closely that of the corresponding spot prices.

The right-hand side of panels A and B report the mean monthly excess return and standard deviation of excess return for each bond and stock index over the sample period. It is clear that hedging affects returns. Mean excess return falls, sometimes dramatically, with an average decline of 43 percent for both bonds and stocks. But so does standard deviation, which declines 151.1 percent on average for stocks and 252.7 percent for bonds. Consistent with Glen and Jorion's findings, fully-hedged assets exhibit substantially lower risk but also lower return, with bonds experiencing the bigger risk reduction.

Table 4. Summary Statistics

A. Means

	Change in Exchange Rate	*Forward Payoffs*	*Bonds*	*Fully Hedged Bonds*	*Stocks*	*Fully Hedged Stocks*
Canada	0.41	0.40	0.68	0.28	1.28	0.87
Euroland	0.21	0.18	0.45	0.27	0.64	0.47
Japan	0.26	0.03	0.25	0.22	0.27	0.24
United Kingdom	-0.07	0.03	0.17	0.14	0.51	0.48
United States	0.00	0.00	0.24	0.24	0.30	0.30
Argentina	-0.35	0.55	0.69	0.14	1.93	1.38
Brazil	0.75	1.58	1.69	0.11	2.94	1.36
Chile	0.38	0.43	0.50	0.06	1.65	1.22
China	0.25	0.01	0.04	0.04	2.20	2.19
Colombia	0.58	0.93	1.08	0.16	3.51	2.59
Hungary	0.20	0.64	0.71	0.06	1.85	1.20
India	0.06	0.26	0.41	0.15	2.16	1.89
Mexico	-0.10	0.30	0.36	0.05	1.76	1.46
Philippines	0.28	0.55	0.69	0.14	1.66	1.11
Poland	0.46	0.62	0.68	0.06	1.63	1.01
South Africa	0.06	0.57	0.62	0.05	1.68	1.11
South Korea	0.13	0.12	0.20	0.08	1.54	1.42
Taiwan	0.11	-0.15	-0.04	0.11	0.63	0.78
Thailand	0.28	0.37	0.52	0.16	1.38	1.01
Turkey	0.01	1.15	1.25	0.11	2.47	1.32

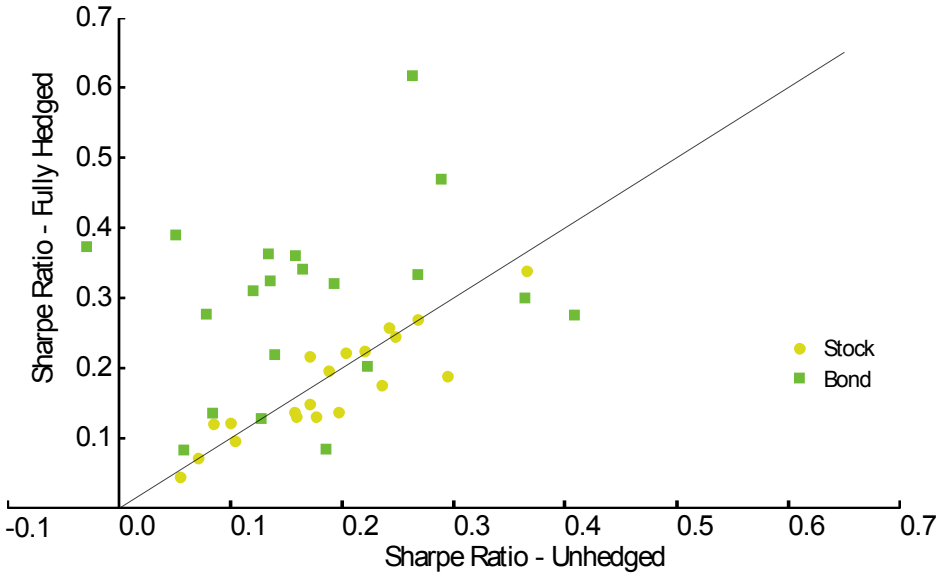
B. Standard Deviations

	Change in Exchange Rate	*Forward Payoffs*	*Bonds*	*Fully Hedged Bonds*	*Stocks*	*Fully Hedged Stocks*
Canada	3.07	3.08	3.08	1.41	6.77	4.45
Euroland	2.93	2.94	3.20	1.26	6.17	4.87
Japan	2.87	2.86	3.15	0.78	4.91	5.48
United Kingdom	2.73	2.73	2.84	1.72	5.03	3.97
United States	-	-	1.91	1.91	4.26	4.26
Argentina	1.48	2.52	3.72	1.63	10.90	10.55
Brazil	4.05	4.04	4.13	0.36	9.98	7.21
Chile	3.68	3.68	3.71	0.12	6.18	4.53
China	0.42	0.42	0.51	0.21	8.86	8.93
Colombia	4.03	4.04	4.12	0.22	9.62	7.66
Hungary	4.25	4.30	4.30	0.12	10.77	8.10
India	2.04	2.07	2.14	0.47	9.77	8.46
Mexico	2.62	2.61	2.62	0.07	7.27	5.68
Philippines	1.70	1.70	1.87	0.47	7.05	6.34
Poland	4.27	4.27	4.26	0.07	10.30	7.39
South Africa	5.13	5.15	5.18	0.08	8.25	5.00
South Korea	3.99	3.99	3.91	0.16	8.97	6.53
Taiwan	1.47	1.46	1.58	0.27	7.34	6.52
Thailand	1.75	1.79	1.93	0.42	8.66	7.77
Turkey	4.21	4.26	4.33	0.19	12.52	9.68

Percentages for monthly data, September, 2003 to April, 2010. Euroland consists of three countries: France, Germany, and Italy. For stocks and bonds the returns are in excess of the U.S. one-month T-Bill rate.

Figure 3 compares fully-hedged with unhedged assets and indicates that hedging improves the Sharpe ratios of most of the bonds and more than half of the stocks. For Mexican and Polish bonds the improvement is fivefold.

Figure 3. Relative Sharpe Ratios for Fully-Hedged and Unhedged Assets



Monthly data, September, 2003 to April, 2010. A point on the dashed line (45 degrees) represents a security for which the Sharpe ratio is unaffected by hedging.

5.4 Correlations and Efficient Frontiers

Table 5 reports the cross-country correlations for bond and stock returns. Panel A shows that bond returns in developed markets are positively correlated, ranging from 0.08 to 0.60 and average 0.41, with two exceptions: Japanese bonds are the least correlated with the other four developed markets and Euroland bonds are the most highly correlated with the U.K. (0.73). The correlations between emerging markets bond are likewise positive but less so than developed markets, with an average of 0.35, a bigger spread (0.02 to 0.60), and instances of negative correlations, particularly with China. What is most rele-

vant to this study, however, is that the correlations between developed and emerging bond markets are lower still, averaging 0.26, boding well for international diversification.

Like the results of Solnik, Boucrelle, and Le Fur (1996), stocks markets tend to be more highly correlated than bond markets, as is evident in panel B. In developed markets, this is a reflection of their integration, as among the U.S., U.K. and Euroland. Notable too is that the correlations between the bonds of developed and emerging markets (0.26) are lower than those within developed markets (0.41) or within emerging markets (0.35).

Table 5. Return Correlations

A. Bonds

	Canada	Euro-land	Japan	U.K.	U.S.	Argentina	Bra-zil	Chile	China	Co-lombia	Hun-gary	In-dia	Mex-ico	Philip-pines	Po-land	South Africa	South Korea	Tai-wan	Thai-land	Tur-key
Canada	1.00																			
Euroland	0.60	1.00																		
Japan	0.08	0.41	1.00																	
U.K.	0.47	0.73	0.19	1.00																
U.S.	0.24	0.54	0.54	0.27	1.00															
Argentina	0.34	0.30	-0.03	0.18	0.29	1.00														
Brazil	0.40	0.19	-0.21	0.25	-0.20	0.19	1.00													
Chile	0.45	0.51	0.02	0.44	0.12	0.39	0.38	1.00												
China	-0.09	0.25	0.26	0.02	0.23	0.02	-0.01	0.11	1.00											
Colombia	0.46	0.41	-0.03	0.28	0.05	0.25	0.51	0.38	0.08	1.00										
Hungary	0.55	0.76	0.11	0.66	0.16	0.21	0.28	0.33	0.11	0.52	1.00									
India	0.48	0.44	0.14	0.32	0.07	0.25	0.49	0.42	0.13	0.53	0.38	1.00								
Mexico	0.47	0.32	-0.26	0.47	-0.04	0.28	0.62	0.50	-0.10	0.51	0.47	0.45	1.00							
Philip-pines	0.32	0.30	-0.03	0.17	0.11	0.25	0.36	0.31	0.22	0.53	0.19	0.61	0.35	1.00						
Poland	0.61	0.69	0.11	0.64	0.09	0.05	0.38	0.36	0.03	0.49	0.83	0.35	0.55	0.22	1.00					
South Africa	0.50	0.47	-0.09	0.46	-0.01	0.18	0.33	0.35	-0.06	0.44	0.62	0.44	0.40	0.31	0.58	1.00				
South Korea	0.48	0.54	0.14	0.38	0.07	-0.08	0.46	0.23	0.07	0.46	0.52	0.61	0.46	0.53	0.57	0.52	1.00			
Taiwan	0.33	0.52	0.30	0.38	0.09	0.05	0.31	0.17	0.15	0.40	0.52	0.45	0.33	0.36	0.55	0.37	0.67	1.00		
Thailand	0.29	0.48	0.27	0.46	0.12	0.05	0.25	0.31	0.17	0.30	0.30	0.45	0.22	0.40	0.40	0.28	0.47	0.55	1.00	
Turkey	0.47	0.33	-0.22	0.37	0.08	0.31	0.56	0.33	-0.04	0.59	0.49	0.46	0.58	0.44	0.51	0.57	0.44	0.32	0.30	1.00

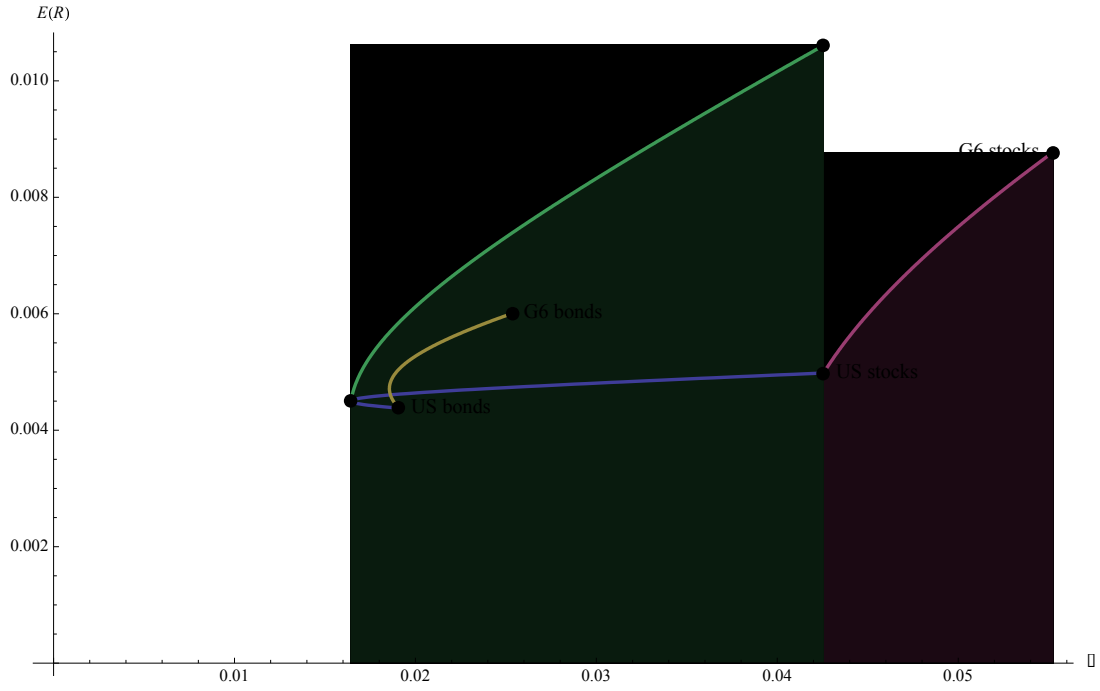
B. Stocks

	Canada	Euro-land	Japan	U.K.	U.S.	Argentina	Brazil	Chile	China	Colombia	Hungary	India	Mexico	Philippines	Poland	South Africa	South Korea	Taiwan	Thailand	Turkey
Canada	1.00																			
Euroland	0.81	1.00																		
Japan	0.66	0.69	1.00																	
U.K.	0.86	0.91	0.69	1.00																
U.S.	0.81	0.90	0.67	0.86	1.00															
Argentina	0.62	0.57	0.55	0.64	0.55	1.00														
Brazil	0.85	0.72	0.63	0.79	0.69	0.72	1.00													
Chile	0.65	0.57	0.41	0.65	0.59	0.49	0.65	1.00												
China	0.72	0.70	0.54	0.75	0.66	0.54	0.77	0.61	1.00											
Colombia	0.56	0.62	0.61	0.62	0.59	0.43	0.57	0.50	0.52	1.00										
Hungary	0.73	0.81	0.68	0.82	0.76	0.63	0.68	0.58	0.64	0.68	1.00									
India	0.77	0.76	0.64	0.77	0.75	0.44	0.75	0.67	0.72	0.66	0.66	1.00								
Mexico	0.79	0.80	0.70	0.78	0.84	0.66	0.73	0.61	0.60	0.64	0.79	0.68	1.00							
Philippines	0.52	0.53	0.34	0.56	0.60	0.29	0.45	0.50	0.50	0.50	0.54	0.62	0.59	1.00						
Poland	0.66	0.77	0.63	0.76	0.75	0.63	0.65	0.55	0.61	0.56	0.85	0.60	0.79	0.55	1.00					
South Africa	0.77	0.80	0.72	0.79	0.73	0.60	0.76	0.59	0.78	0.65	0.75	0.72	0.76	0.40	0.71	1.00				
South Korea	0.69	0.75	0.67	0.68	0.76	0.52	0.67	0.53	0.66	0.60	0.69	0.69	0.72	0.46	0.70	0.72	1.00			
Taiwan	0.72	0.72	0.55	0.72	0.70	0.46	0.67	0.60	0.70	0.52	0.65	0.67	0.67	0.45	0.60	0.66	0.78	1.00		
Thailand	0.69	0.70	0.61	0.72	0.63	0.61	0.71	0.57	0.65	0.55	0.62	0.68	0.60	0.47	0.57	0.64	0.64	0.64	1.00	
Turkey	0.61	0.62	0.63	0.65	0.64	0.49	0.68	0.55	0.64	0.61	0.70	0.73	0.60	0.54	0.70	0.66	0.67	0.55	0.62	1.00

Monthly returns, September, 2003 to April, 2010.

Figure 4 depicts efficient frontiers constructed from a position in the U.S. bond or stock index combined with an equally-weighted index of the indices of the other developed markets (labelled G6) or a similar index of all the emerging markets bond or stock indices (labelled EM).

Figure 4. Mean-Variance Efficient Frontier for Developed and Emerging Markets



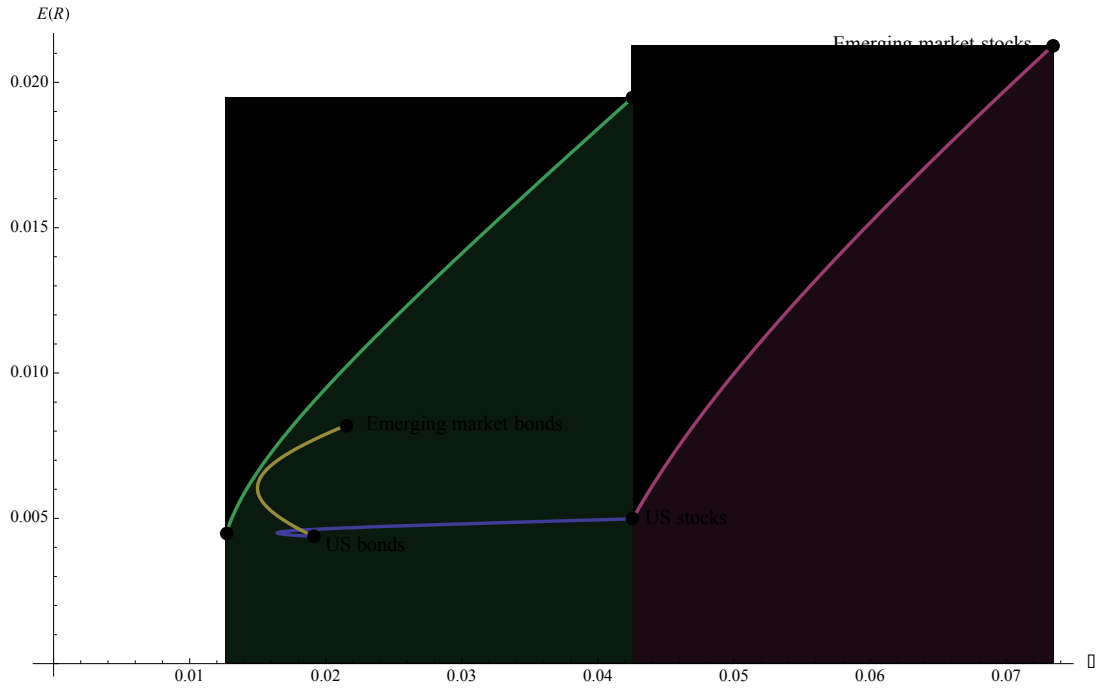


Figure A. Portfolio frontiers that combine equally-weighted indices of U.S. stocks or bonds with that of similarly-formed G6 country stocks or bonds. Figure B. U.S. portfolios combined with similarly-formed emerging markets securities.

Consistent with the description of the distributions in the previous tables, the frontiers show that international portfolios (G6 or EM) dominate US-only positions and an expansion into foreign bonds dominates an expansion in foreign stocks. It goes without saying that the frontiers are extreme, reflecting the rapid rise of emerging markets during the sample period and the turbulence, particularly in developed markets, of the financial crisis, so extrapolation into the future would be inappropriate.

6. Results and Discussion

6.1 Unconditionally Hedged Portfolios

Six optimal unconditional hedged portfolios, each with the investment weights, *w*, were estimated as in equation (4), and where it should be recalled that the position in the risk-free asset is the residual or 100 - *w*. The six portfolios are bonds; bonds and forwards; stocks; stocks and forwards; bonds and stocks; bonds, stocks, and forwards. Those with forwards are what I have referred to as hedged. Portfolio in-sample performance is reported in Table 6.

Table 6. Returns on Optimal Unconditional Portfolios

	Bonds Only	*Bonds and Forwards*	*Stocks Only*	*Stocks and Forwards*	*Bonds and Stocks*	*Bonds, Stocks, and Forwards*
A. Developed and Emerging Markets						
T-Bill weight	87.595	-90.669	106.276	100.802	125.245	-234.955
Mean	0.639	2.335	0.385	1.238	1.106	4.049
Std. Dev.	0.801	1.514	0.625	1.120	1.066	2.007
Sharpe ratio	0.798	1.543	0.616	1.105	1.037	2.017
B. Developed Markets						
T-Bill weight	90.111	41.773	100.831	98.276	91.337	35.727
Mean	0.061	0.202	0.045	0.083	0.163	0.267
Std. Dev.	0.249	0.460	0.171	0.290	0.317	0.527
Sharpe ratio	0.244	0.440	0.266	0.287	0.516	0.506
C. Emerging Markets						
T-Bill weight	91.559	-68.587	95.139	91.130	98.409	42.740
Mean	0.497	1.607	0.273	0.870	0.873	3.148
Std. Dev.	0.706	1.268	0.525	0.936	0.525	1.773
Sharpe ratio	0.704	1.267	0.519	0.929	1.663	1.775

Monthly percentage returns in excess of the U.S. one-month T-Bill rate, September, 2003 to April, 2010. T-Bill weight denotes the percentage investment weight in treasury bills.

The table is divided into three panels. The first shows portfolios that include the securities of both the developed and emerging markets. The second and third show the results for the two market types separately. The positions in the individual indices, $w_s =$ and $w_f =$ appear in Appendix 1.

Despite the fact that the inclusion of forwards has made the portfolios riskier, hedging has improved performance in every case as indicated by the higher Sharpe ratios. Bond portfolios either outperform stock portfolios or improve more when hedged, but this may simply be a result of the sample period used. And the portfolios that combine developed and emerging market securities outperform portfolios that restrict themselves to either market. The investment weights, as reported in Appendix 1, are extreme in many instances, particularly the short positions which could not be maintained for any appreciable length of time.

Table 7 reports the results of the GRS tests from equation (8). It can be seen that adding forward contracts to bond portfolios, either of developed or emerging markets is improved, as the joint hypothesis of zero intercepts in the multivariate regressions of equation (7) is rejected. For stock portfolios, the *p*-values are higher than 5 percent, so the null cannot be rejected. I conclude that unconditional hedging improves the performance of bond portfolios but not of stock portfolios.

Table 7. GRS Tests of Portfolio Performance Improvement

	Bond and Forwards	*Stock and Forwards*	*Bonds, Stocks, and Forwards*
A. Developed and emerging Markets			
F	4.1804	1.0010	2.3388
p-value	0.0001	0.4803	0.0332
B. Developed Markets			
F	5.8087	0.5202	5.6561
p-value	0.0004	0.7211	0.0002
C. Emerging Markets			
F	6.3742	1.2462	4.0486
p-value	0.0000	0.2720	0.0004

The GRS test statistics (F) from equation (7) of the joint hypothesis of zero intercepts in the multivariate regressions described in equation (8).

6.2 Optimal Conditional Hedging

I now consider an investor with a fixed spot position in various equally-weighted combinations of the bonds and stocks that make up the sample of this study, and compute from (6) the conditional risk-minimizing hedges on the assumption that the expected payoff on forwards is zero. These, as noted, are optimal for mean-variance utility maximizers. Following the convention in the futures literature pertaining to hedging, I report the percentage reduction in risk of both a naively-hedged portfolio, that is, employing a hedge ratio of one, and the risk-minimizing portfolio, both relative to the standard deviation of the unhedged portfolio. Table 8 compares the performance of the portfolios. The estimated hedge ratios are reported in Appendix 2.

Table 8. In-Sample Performance of Conditional Hedged Portfolios

	Bonds				*Stocks*				*Bonds and Stocks*			
	Mean	*S.D.*	Δ	*Sharpe*	*Mean*	*S.D.*	Δ	*Sharpe*	*Mean*	*S.D.*	Δ	*Sharpe*
A. Developed and Emerging Markets												
Unhedged	0.75	1.98	-	0.28	1.79	6.71	-	0.24	1.27	4.20	-	0.26
Naïve	0.30	0.35	-82.06	0.31	1.34	5.12	-23.70	0.22	0.82	2.51	-40.10	0.25
Optimal	0.27	0.24	-87.85	0.35	0.34	2.55	-62.00	0.06	0.31	1.25	-70.19	0.09
B. Developed Markets												
Unhedged	0.55	2.08	-	0.17	0.79	4.98	-	0.12	0.67	3.05	-	0.16
Naïve	0.39	1.28	-38.32	0.15	0.64	4.04	-18.85	0.11	0.51	1.93	-36.74	0.17
Optimal	0.42	0.99	-52.49	0.23	0.34	3.02	-39.42	0.05	0.38	1.54	-49.40	0.12
C. Emerging Markets												
Unhedged	0.82	2.17	-	0.29	2.13	7.39	-	0.26	1.47	4.66	-	0.27
Naïve	0.29	0.19	-91.08	0.66	1.60	5.65	-23.51	0.25	0.94	2.85	-38.97	0.26
Optimal	0.24	0.15	-93.22	0.42	0.37	3.18	-56.93	0.06	0.38	1.59	-65.95	0.07

Percentage mean returns, standard deviations (S.D.) and percentage change in standard deviation (Δ) relative to unhedged equally-weighted spot portfolios, September, 2003 to April, 2010. Optimal *denotes the risk-minimizing hedge.*

As with the unconditional portfolios, the conditional emerging markets portfolios are riskier than their developed market counterparts. However, hedging reduces more risk in emerging markets portfolios, and when emerging markets and developed markets securities are combined, the resulting optimally-hedged portfolios are less risky than developed market hedged portfolios.

Risk is reduced most by employing the risk-minimizing or optimal hedge, where for example, 93 percent of the standard deviation of the equally-weight emerging market bond portfolio can be washed away. This, of course, will always be true in-sample because it is the result of a minimization problem applied to the data from which the characteristics of the distributions have been estimated. In most of the hedging literature it is reported that a naïve hedge accounts for the bulk of the reduction in risk, and the incre-

mental improvement due to optimal hedging is small but often significant. This observation has been used to advocate naïve hedging as a simple approach that largely does the job and perhaps avoids the need to consider problems posed by time-variation in the distribution of returns. Here, however, I find that the incremental reduction in risk of the risk-minimizing hedge over the naïve hedge is quite large, and in some instance the risk-minimizing hedge has contributed more to risk-reduction than the naïve hedge.

Is it worth it? With the exception of bond portfolios in either developed or emerging markets, the Sharpe ratios are lower for naively hedged and optimally hedged portfolios than they are for unhedged portfolios. Although this may be sample specific, it raises concern that the assumption of zero expected payoffs on forward positions may be inappropriate. It cannot be concluded that conditional hedging is a free lunch in this regard.

6.3 Out-of-Sample Performance of Conditional Hedged Portfolios

Table 9 provides the same performance comparison as Table 8, but this time 43 one-month-ahead forecasts of the risk-minimizing investment weights, each one estimated from a fixed window of 36 preceding months. [2]

[2] The results for a 24-month estimation window are qualitatively similar, so only the results for the 36-month window are reported here.

Table 9. Out-of-Sample Performance of Conditional Hedged Portfolios

	Bonds				*Stocks*				*Bonds and Stocks*			
	Mean	*S.D.*	Δ	*Sharpe*	*Mean*	*S.D.*	Δ	*Sharpe*	*Mean*	*S.D.*	Δ	*Sharpe*
A. Developed and Emerging Markets												
Unhedged	0.77	0.15	-	0.31	1.51	1.12	-	0.28	1.14	0.63	-	0.30
Naïve	0.37	0.04	-71.93	0.27	1.11	0.97	-0.15	0.27	0.74	0.48	-23.97	0.28
Optimal	0.33	0.08	-44.58	0.33	1.02	0.53	-0.59	0.48	0.67	0.26	-58.40	0.52
B. Developed Markets												
Unhedged	0.55	0.08	-	0.14	0.57	0.93	-	0.266	0.56	0.46	-	0.23
Naïve	0.42	0.08	-2.76	0.12	0.44	0.89	-4.58	0.272	0.43	0.42	-9.49	0.26
Optimal	0.46	0.13	+67.71	0.20	0.24	0.78	-16.88	0.272	0.35	0.44	-5.32	0.31
C. Emerging Markets												
Unhedged	0.84	0.19	-	0.33	1.82	1.18	-	0.29	1.33	0.68	-	0.30
Naïve	0.37	0.05	-74.61	0.83	1.35	1.01	-14.96	0.27	0.86	0.50	-26.17	0.28
Optimal	0.33	0.04	-77.45	0.50	1.52	0.64	-45.45	0.56	0.93	0.33	-51.70	0.59

Percentage monthly mean returns, standard deviations (S.D.) and percentage change in standard deviation (Δ) relative to unhedged equally-weighted portfolios, September, 2003 to April, 2010. Optimal denotes the risk-minimizing hedge. The out-of-sample period is October, 2006 to April, 2010, where for each month investment weights are estimated using the previous 36 months' data.

Out-of-sample, the application of a risk-minimizing hedge to portfolios combining emerging market and developed market securities results in lower risk than a risk-minimizing hedge applied to a portfolio of developed market securities. Furthermore, Sharpe ratios are increased.

Both the naïve and optimal hedges reduce risk but not as much as they do in-sample. This is to be expected, or at least one expects greater variation in risk reduction. In fact, the risk-minimizing portfolio need not necessarily yield the smallest risk, and may not even outperform an unhedged portfolio. One portfolio, the developed markets bond portfolio, sees its standard deviation increased by 67 percent relative to the unhedged portfolio; this, in turn, results in the naïve hedge outperforming the optimal hedge in the combined developed-emerging markets bond portfolio. And while the optimal

hedge tends to outperform the naïve hedge in most cases, the gap between them is narrower. Sharpe ratios, on the other hand, are higher than they are in-sample, and this is true more so in the emerging markets than the developed markets portfolios.

7. Conclusion

Reports in the media have paid much attention to the rapid growth of emerging real economies and have observed correspondingly impressive financial returns. Emerging financial markets are also more volatile than many developed markets, and this has begged the question as to whether it is advisable for investors who make developed markets their home to expand their portfolios into emerging markets. This study provides a qualified yes to that question by demonstrating that both unconditional and conditional optimal portfolios of securities from both markets outperform corresponding portfolios from developed markets alone. The qualifications are that the time series is shorter than is desirable owing to the newness of the emerging financial markets, and that explicit transactions have not been incorporated because they are not easily obtained. These two aspects are left to future work.

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Appendix

Appendix 1. Investment Positions for Optimal Unconditional Portfolios

	Bonds Only	*Bonds and Forwards*	*Stocks Only*	*Stocks and Forwards*	*Bonds and Stocks*	*Bonds, Stocks, and Forwards*
A. Developed and Emerging Markets						
Bonds						
Canada	2.32	66.34	1.82		13.31	153.61
Euroland	-8.62	32.98	2.50		-12.77	-26.94
Japan	9.90	82.13	-5.72		12.93	55.27
United Kingdom	-12.55	-96.59	-8.10		7.14	-35.50
United States	13.70	3.05	-11.17		-3.98	-22.64
Argentina	-2.73	-21.61	-0.82		-2.01	48.33
Brazil	18.60	99.12	3.55		32.17	387.27
Chile	-2.09	-5.50	2.18		-18.40	-1055.21
China	-21.27	-299.35	3.51		-44.18	-831.13
Colombia	-4.64	605.44	4.75		-10.02	880.49
Hungary	19.39	-89.92	-0.73		16.44	660.44
India	-10.41	130.50	-0.48		-1.74	125.72
Mexico	-2.47	799.93	6.21		-16.55	955.12
Philippines	32.77	-128.29	0.83		56.68	-106.01
Poland	-1.38	778.72	0.40		1.10	3217.84
South Africa	0.70	-2573.74	-1.60		-5.16	-5212.17
South Korea	-11.99	599.90	1.77		-18.20	30.17
Taiwan	-28.74	69.35	-4.85		-53.97	588.50

	Thailand	23.30	133.30	0.00		23.64	226.67
	Turkey	-1.36	4.93	-0.34		-0.86	278.73
Stocks							
	Canada				11.95	-2.32	-32.01
	Euroland				12.11	7.39	-28.86
	Japan				-13.39	-7.92	-20.85
	United Kingdom				-40.08	-32.32	-21.03
	United States				7.12	13.28	59.34
	Argentina				-4.71	0.24	-4.36
	Brazil				0.12	-4.73	1.10
	Chile				6.54	7.89	-15.04
	China				2.94	3.77	-13.04
	Colombia				8.37	7.76	12.17
	Hungary				1.44	-0.31	-0.92
	India				-4.41	-5.76	-3.34
	Mexico				7.57	5.19	22.82
	Philippines				-8.14	-4.73	-3.88
	Poland				2.09	5.68	4.51
	South Africa				5.50	4.57	36.40
	South Korea				1.42	-2.56	-6.01
	Taiwan				4.00	6.13	43.24
	Thailand				2.56	1.29	1.61
	Turkey				-3.79	-3.33	-15.46
Forwards							
	Canada		-72.31		-18.36		-130.34
	Euroland		-21.78		-32.04		30.37
	Japan		-94.70		6.48		-59.35

	United Kingdom		87.44		15.19	124.47
	Argentina		46.16		24.23	-8.59
	Brazil		-83.16		25.04	-341.95
	Chile		-8.56		-11.16	1011.20
	China		225.48		-53.29	915.81
	Colombia		-613.75		-15.23	-884.35
	Hungary		114.46		18.48	-668.24
	India		-148.71		1.20	-127.07
	Mexico		-798.12		-25.57	-1012.40
	Philippines		170.85		46.11	160.99
	Poland		-779.77		19.34	-3199.84
	South Africa		2607.99		-10.48	5252.27
	South Korea		-591.46		2.27	-4.22
	Taiwan		-152.30		-95.37	-847.59
	Thailand		-120.41		28.74	-261.82
	Turkey		-21.81		-1.95	-312.55
B. Developed Markets						
Bonds						
	Canada	7.82	25.39		0.66	19.08
	Euroland	-0.01	27.80		1.17	32.24
	Japan	1.13	40.67		1.67	43.34
	United Kingdom	-2.84	-21.90		-5.23	-18.80
	United States	3.79	-13.73		9.77	-14.09
Stocks						
	Canada			3.98	9.92	6.13	10.43
	Euroland			3.80	2.49	0.15	2.71
	Japan			-0.04	-2.12	-2.43	0.26

	United Kingdom			-7.04	-0.45	2.88	-1.69
	United States			-1.52	-8.12	-6.12	-9.21
Forwards							
	Canada		-17.72		-6.29		-24.12
	Euroland		-27.30		-0.46		-33.15
	Japan		-42.13		2.06		-44.13
	United Kingdom		21.28		-4.49		17.35
C. Emerging Markets							
Bonds							
	Argentina	0.24	-13.79			0.18	-12.83
	Brazil	15.20	90.59			23.62	275.41
	Chile	-4.09	-153.91			-9.25	-743.74
	China	-7.41	-258.33			-13.68	-430.49
	Colombia	-1.84	404.54			-10.04	684.79
	Hungary	10.81	-233.54			13.30	25.09
	India	-5.64	109.24			-5.09	238.38
	Mexico	-9.22	436.25			-20.55	967.10
	Philippines	27.78	-93.38			40.42	-152.08
	Poland	0.58	1100.16			4.89	2018.62
	South Africa	-1.48	-1882.88			-4.89	-3935.05
	South Korea	-9.34	333.17			-13.70	397.18
	Taiwan	-24.17	165.99			-34.86	373.33
	Thailand	17.67	98.70			23.73	158.99
	Turkey	-0.67	65.78			0.64	180.61
Stocks							
	Argentina			-0.90	-3.72	-2.49	2.36
	Brazil			3.87	-2.54	-3.20	-7.79

	Chile		3.00	8.98	7.10	6.45
	China		3.23	2.90	3.56	-3.12
	Colombia		4.94	7.04	6.42	9.01
	Hungary		-2.05	-1.17	-1.33	-4.81
	India		-2.38	-3.84	-4.49	-6.62
	Mexico		2.31	7.11	7.26	6.86
	Philippines		1.06	-4.48	-4.22	-4.64
	Poland		-0.11	0.30	1.78	-3.15
	South Africa		-2.55	-1.02	-1.08	6.36
	South Korea		1.22	4.18	2.21	4.72
	Taiwan		-5.16	-0.34	-0.23	29.41
	Thailand		-1.01	-1.73	-2.87	-10.85
	Turkey		-0.60	-2.79	-1.54	-12.25
Forwards						
	Argentina	35.56		13.77		49.63
	Brazil	-74.11		21.06		-251.11
	Chile	150.65		-11.54		723.97
	China	215.04		0.92		342.81
	Colombia	-412.60		-12.08		-706.20
	Hungary	253.78		7.53		1.91
	India	-121.05		-10.73		-240.86
	Mexico	-440.80		-17.99		-979.75
	Philippines	124.94		35.33		227.93
	Poland	-1101.31		12.60		-1988.01
	South Africa	1899.94		-4.77		3967.63
	South Korea	-323.64		-6.13		-389.29
	Taiwan	-233.24		-56.24		-580.18

Thailand	-101.84	22.88	-152.46
Turkey	-75.41	2.88	-185.88

Monthly data, September, 2003 to April, 2010.

Appendix 2. Conditional Hedge Ratios

	Bonds Portfolios	Stocks Portfolio	Bond and Stock-Portfolios
A. Developed and Emerging Markets			
Canada	0.0231	0.4670	0.2451
Euroland	0.1110	-0.3517	-0.1204
Japan	0.0830	-0.3231	-0.1200
United Kingdom	0.0006	-0.1153	-0.0573
Argentina	0.0885	0.1841	0.1363
Brazil	0.0303	0.2901	0.1602
Chile	0.0678	0.2894	0.1786
China	-0.0685	-1.6303	-0.8494
Colombia	0.0456	0.0673	0.0565
Hungary	0.0482	0.3113	0.1798
India	0.0423	0.2490	0.1456
Mexico	0.0585	0.0448	0.0517
Philippines	0.0926	-0.2462	-0.0768
Poland	0.0566	0.1067	0.0816
South Africa	0.0363	0.1487	0.0925
South Korea	0.0599	0.2200	0.1399
Taiwan	0.0001	0.3932	0.1967
Thailand	0.0580	0.5510	0.3045
Turkey	0.0751	0.1261	0.1006
B. Developed Markets			
Canada	0.1211	0.9123	0.5167
Euroland	0.4198	0.5114	0.4656
Japan	0.2931	-0.2685	0.0123
United Kingdom	-0.0033	0.1117	0.0542
C. Emerging Markets			
Argentina	0.0855	0.1731	0.1293
Brazil	0.0678	0.4190	0.2434
Chile	0.0752	0.2655	0.1704
China	0.1065	-2.3709	-1.1322
Colombia	0.0615	0.0940	0.0778
Hungary	0.0713	0.1308	0.1010
India	0.0771	0.2099	0.1435
Mexico	0.0570	0.2314	0.1442
Philippines	0.1093	-0.0858	0.0118
Poland	0.0711	0.1106	0.0909
South Africa	0.0556	0.2688	0.1622
South Korea	0.0639	0.1489	0.1064
Taiwan	0.0553	0.1780	0.1167

Thailand	0.0854	0.3997	0.2425
Turkey	0.0753	0.2535	0.1644
Philippines	0.1093	-0.0858	0.0118
Poland	0.0711	0.1106	0.0909
South Africa	0.0556	0.2688	0.1622
South Korea	0.0639	0.1489	0.1064
Taiwan	0.0553	0.1780	0.1167
Thailand	0.0854	0.3997	0.2425
Turkey	0.0753	0.2535	0.1644

The hedge ratio is minimum-variance hedge ratio.