Booms and Busts as Exchange Options: Valuing the Decision to Enter and Exit from an Emerging Market

Stephen Matteo Miller*

Department of Economics, Monash University, Melbourne, Australia

Abstract

Selling (buying) a country's equity index in exchange for equity investments elsewhere is analogous to exercising an option to exchange an underperforming country (global benchmark) index for a global benchmark (country) index. Okunev and Tippett's (1993) single factor option pricing framework is summarized, extended and used to determine the exchange option value of entering into and exiting from an emerging market. The key inputs are daily, rolling, country betas, corrected for non-synchronous trading bias, which rise during the Asian Crisis and fall thereafter. Option values to exit are found to rise during the Asian Crisis and fall afterward.

JEL classification: F30; F36; G2; G15

Keywords: Country Systematic Risk and Risk-Adjusted Performance; Benchmark Premium and Insurance; International Transmission; Net Capital Flow Monitoring; Non-synchronous Trading Bias

* Department of Economics, Monash University, Victoria 3800, Australia. Tel.: +(03) 9905-2320; fax: +(03) 9905-5476. *E-mail address*: stephen.miller@buseco.monash.edu.au.

1. Introduction

There is an analogy between booms and busts and exercising exchange options, which may one day open up the possibility of replicating and hedging against such events. In what follows Okunev and Tippet's (1993) single factor option pricing framework is summarized, extended and used to get a dollar value of the urgency of overnight exit from a country in crisis and overnight entry into a country during a boom.

The exchange option contract that characterizes a boom, called the global benchmark premium, pays when a country's global systematic risk adjusted performance exceeds that for a broad global stock market index, and equals zero otherwise. This is the call option in Okunev and Tippett's (1993) version of the performance management fee. They do not consider the put option, but by applying Put-Call Parity, it is possible to characterize a bust. This exchange option contract is called global benchmark insurance. It pays the difference between global systematic risk-adjusted performance on a broad global stock market index and a country's stock index if this difference is positive, and zero otherwise.[1] So the benchmark premium gives the dollar value of exercising an option to enter a country, while benchmark insurance gives the dollar value of exercising an option to exit a country.

These potentially marketable products relate to Merton's (1990) suggestion that global capital flow volatility might be hedged with financial instruments.[2] He discusses hypothetical swaps, in which global and local investors enter into contracts written on the total rate of return differential between a small emerging market and some proxy for the

---

[1] While they do not define it formally, the choice of the term "benchmark insurance" is due to Jaeger and Zimmerman's (1995) description of such a product in their discussion of surplus insurance as application of Margrabe's (1978) exchange option pricing formula.

[2] The idea has also been revisited by Bodie and Merton (2002) and Draghi, *et al*. (2003), and Gray, *et al.* (2003).

world portfolio. At year's end, small market (foreign) investors are compensated if the rate of return on the i^{th} small country index falls short of (exceeds) the rate of return on the world index. It will be shown that the underlying in that contract is similar to the underlying in the benchmark premium and insurance contracts discussed here, when the country is as risky as the global benchmark, which in fact is rarely the case.

In a related effort, Miller (2005) estimates a rolling variant of Jensen's (1968) "alpha" for thirteen emerging markets, suggesting that it could be used as the underlying index in a swap contract. The country alpha is the difference between the average return on a country's index and the product of the country's contribution to global systematic risk, or "beta", with the average return on the world index. The alphas and betas are adjusted for non-synchronous trading bias using a simplified version of Scholes and Williams's (1977) method, since markets have different hours of operation, such that closing index values do not arrive at the same time. Country alphas become increasingly negative until the end of the Asian Crisis, and generally rise thereafter, eventually becoming positive. So country alpha swaps with a strike set to zero are proposed. This way hedging demanders (suppliers) are compensated when a country's alpha is negative (positive) if they take short (long) positions in country alpha swaps.

Miller (2005) offers no swap pricing methodology, but the patterns exhibited by the combined benchmark premium-benchmark insurance payouts resemble the country alphas, since the key input in both the exchange option and the country alpha swap is a daily, rolling, country beta. This suggests that a short (long) position on a country alpha swap is analogous to benchmark insurance (the benchmark premium).

It may be tempting to think that these exchange options can be replicated by actual exchange traded options on the underlying stock market indices, opening the way to an analysis of implied risk measures. However, Siegel (1995) shows that if an option is created to exchange a security for a broad market portfolio, or vice versa, and then if it trades in the marketplace, the implied risk measure is no longer simply the volatility as in Latane and Rendleman (1976). It also includes an implied systematic risk measure, or beta. So, as the exchange options discussed here are not yet traded, then it is not possible to explore this issue through implied risk measures. Instead, the beta risk input will be estimated, using a rolling variant of the method proposed by Scholes and Williams (1977), to correct for possible non-synchronous trading bias that arises as markets operate in different time zones, and used to get the theoretical option prices.

Even if the product is never marketed, the formula to price such options can be useful for monitoring net capital flows, which as reported by Bordo, et al. (2004), is a task viewed as increasingly important by officials at the International Monetary Fund (IMF). More precisely, the formulas provide a high-frequency measure of the willingness to pay to get into or out of a country. Accordingly, Okunev and Tippett's (1993) single factor option pricing model is summarized and used to define the global benchmark premium and then used to derive benchmark insurance. This is followed by a description of the methodology used to estimate the rolling country alphas and betas. After describing the data, and revisiting the key events of the Asian Crisis, the value of exiting and entering an emerging market, together with the country alphas, betas and their standard errors will be presented, before concluding.

2. Valuing Capital Flight with Exchange Options

2.1 The Single Factor Option Pricing Model in A Global Equity Market World[3]

Okunev and Tippett (1993) derive a single-factor option pricing formula as a special case of their multi-factor option pricing model, and use it to modify the performance management fee that Margrabe (1978) discusses in the context of exchange options. Okunev and Tippett (1993) work within a domestic asset pricing context, so the relationship they define is between the stock price for a particular company and the domestic stock market index. Therefore, the beta in their model is akin to the beta in Black and Scholes's (1973) "alternative derivation," or in Merton's (1973) intertemporal capital asset pricing model, when the investment opportunity set is constant.

Okunev and Tippett's (1993) model can be applied in the context of a reduced form of Solnik's (1974a) international asset pricing model, if either fixed, or perfectly hedged exchange rates are assumed, so that the returns are denominated in a single currency. As in Clark (2002) and Taylor and Tonks (1989) this assumption is made here.

Assume first that the global index, denominated in US dollars, follows Geometric Brownian Motion (GBM), while a country index, also denominated in US dollars, follows a continuous-time, single factor model. Using subscript *w* to indicate the world index and subscript *k* to indicate the country index, the instantaneous changes in the value of the indices are denoted, respectively, as

$$\frac{dV_w}{V_w} = \mu_w dt + \sigma_w dz_w \qquad (1)$$

$$\frac{dV_k}{V_k} = \alpha_{kw} dt + \beta_{kw} \frac{dV_w}{V_w} + \sigma_k dz_k \qquad (2)$$

[3] I am grateful to Mark Tippett for a helpful discussion concerning the option pricing framework.

where V_k and V_w are the country and global equity price indices, respectively, dt is an increment of time, μ_w is the expected return on the global index, dz_k and dz_w are unit normal Wiener processes, σ_k and σ_w are the volatility scaling parameters, the former capturing country-specific idiosyncratic risk and the latter representing global systematic risk, β_{kw} measures a country's contribution to global systematic risk, and α_{kw} can be thought of as a measure of risk-adjusted profit. Substituting Eq. (1) into (2) yields

$$\frac{dV_k}{V_k} = \alpha_{kw}dt + \beta_{kw}\left(\mu_w dt + \sigma_w dz_w\right) + \sigma_k dz_k \tag{3}$$

The solutions to the stochastic differential equations in Eq.'s (1) and (3) are, respectively

$$V_{wT} = V_{wt}\exp\left[\left(\mu_w - \tfrac{1}{2}\sigma_w^2\right)(T-t) + \sigma_w\left(z_{wT} - z_{wt}\right)\right] \tag{4}$$

and

$$V_{kT} = V_{kt}\left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} \exp\left[\left(\alpha_{kw} + \tfrac{1}{2}\left(\beta_{kw}\left(1-\beta_{kw}\right)\sigma_w^2 - \sigma_k^2\right)\right)(T-t) + \sigma_k\left(z_{kT} - z_{kt}\right)\right] \tag{5}$$

Taking expectations of Eq.'s (1) and (3), respectively, yields

$$E\left[\frac{dV_w}{V_w}\right] = \mu_w dt \tag{6}$$

and

$$E\left[\frac{dV_k}{V_k}\right] = \mu_k dt = \alpha_{kw}dt + \beta_{kw}\mu_w dt \tag{7}$$

By the rules of stochastic calculus, the relevant expressions for the variance are

$$E\left[\left(\frac{dV_w}{V_w}\right)^2\right] = \sigma_w^2 dt \tag{8}$$

and

$$E\left[\left(\frac{dV_k}{V_k}\right)^2\right] = \left(\beta_{kw}^2\sigma_w^2 + \sigma_k^2\right)dt \tag{9}$$

By rearranging Eq. (7) and dividing through by *dt*, this leads to a simplified expression for alpha as the systematic risk-adjusted, excess expected return, or

$$\alpha_{kw} = \mu_k - \beta_{kw}\mu_w \tag{10}$$

If this is not zero, then it will signify that there are arbitrage opportunities.

In this bi-variate framework, the boundary conditions for the single-factor call option-pricing formula for a particular country index would be

$$C(V_k, S, 0) = \begin{array}{ll} V_k - S, & if\ V_k > S \\ 0, & if\ V_k \le S \end{array} \tag{11}$$

where *C* is the call option price, V_k is the value of the country index, *S* is the strike price. This states that the option pays out if the country's index value exceeds the strike, otherwise it equals zero. By applying Ito's lemma to the call option price, Okunev and Tippett (1993) show that it is homogenous of degree one in terms of the stock and the market portfolio. As a result, the partial differential equation they derive has only second order terms, as the first order terms, excluding the time derivative, cancel, yielding

$$\tfrac{1}{2}\frac{\partial^2 C}{\partial V_k^2}V_k^2\left(\beta_{kw}^2\sigma_w^2 + \sigma_k^2\right) + \tfrac{1}{2}\frac{\partial^2 C}{\partial V_w^2}V_w^2\sigma_w^2 + \frac{\partial^2 C}{\partial V_k \partial V_w}V_k V_w \beta_{kw}\sigma_w^2 + \frac{\partial C}{\partial t} = 0 \tag{12}$$

The solution differs slightly from the formula proposed by Black and Scholes (1973) in both the volatility input, and the absence of a risk-free rate of return and reduces to

$$C(V_k, S, T-t) = V_k N(d_1) - SN(d_2) \tag{13}$$

where d_1 and d_2 are now defined, respectively, as

$$d_1 = \frac{\ln\left(\frac{V_k}{S}\right) + \frac{1}{2}\left[\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right](T-t)}{\sqrt{\left(\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right)(T-t)}}$$

and

$$d_2 = \frac{\ln\left(\frac{V_k}{S}\right) - \frac{1}{2}\left[\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right](T-t)}{\sqrt{\left(\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right)(T-t)}}$$

Two reasons are given as to why the market portfolio does not seem to appear. First, the market portfolio is redundant, if investors have access to the option and the underlying company shares. In addition, even after including a risk-free asset, the stock and option are still shown to be sufficient to span all possible states of nature. A second reason why the market portfolio does not appear is that it is present in the definition of the underlying stock's expected return, as the terms σ_w^2 and β_{kw} are included in the volatility term. Assuming no transaction costs, Put-Call Parity in this framework simplifies to

$$C + S = V_k + P \tag{14}$$

where P is the put option price, and all other variables are defined as before. From this, Okunev and Tippett (1993) derive the put option pricing formula

$$P(V_k, S, T-t) = SN(-d_2) - V_k N(-d_1) \tag{15}$$

with d_1 and d_2 defined as above.

2.2 An International Performance Management Fee: The Benchmark Premium

Using this option pricing formula, Okunev and Tippett (1993) then reconsider Margrabe's (1978) performance management fee, noting that his formula for the fee omits systematic risk. This means that, as defined, a fund manager would have incentives to take on more risk without regard for expected return. Margrabe's (1978) formula for the performance management fee, or benchmark premium, is based on the portfolio's excess rate of return

$$Fee = \$W \cdot \left(\ln\left(\frac{V_{kT}}{V_{kt}}\right) - \ln\left(\frac{V_{wT}}{V_{wt}}\right) \right) \tag{16}$$

where *$W* is wealth, and Okunev and Tippett (1993) adjust for systematic risk and base it on the portfolio's excess total return

$$Fee = \$W \cdot \left(\frac{V_{kT}}{V_{kt}} - \left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} \right) \tag{17}$$

Given this problem and the following terminal values

$$C(V_k, V_w, 0) = \begin{matrix} V_{kT} - V_{kt}\left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}}, & if\ V_{kT} \geq V_{kt}\left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} \\ 0, & if\ V_{kT} < V_{kt}\left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} \end{matrix} \tag{18}$$

the benchmark premium is the price of a call option, where the underlying is the price of terminal relative to initial values of the country index, while the strike is the price of terminal relative to initial values on the global benchmark, multiplied beta times, or

$$C(V_k, V_w, T-t) = \frac{V_{kT}}{V_{kt}} N(d_1) - \left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} N(d_2) \tag{19}$$

with d_1 and d_2 now defined as

$$d_1 = \frac{\ln\left(\frac{V_{kT}}{V_{kt}}\left(\frac{V_{wT}}{V_{wt}}\right)^{-\beta_{kw}}\right) + \frac{1}{2}\left[\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right](T-t)}{\sqrt{\left(\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right)(T-t)}}$$

and

$$d_2 = \frac{\ln\left(\frac{V_{kT}}{V_{kt}}\left(\frac{V_{wT}}{V_{wt}}\right)^{-\beta_{kw}}\right) - \frac{1}{2}\left[\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right](T-t)}{\sqrt{\left(\sigma_w^2(1-\beta_{kw})^2 + \sigma_k^2\right)(T-t)}}$$

As discussed at the outset, this has a useful interpretation in this study because it gives the value of investing in a country that is outperforming the global benchmark index, hence the name benchmark premium. Having established this, it is now possible to derive the value of exiting a country that is underperforming a global benchmark index, which, as will be shown, rises during financial crises.

2.3 Benchmark Insurance is to Puts as the Benchmark Premium is to Calls

An investor seeking protection from underperformance, rather than compensation for outperformance, would want a contract specified as

$$Insurance = \$W \cdot \left(\left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} - \frac{V_{kT}}{V_{kt}}\right) \tag{20}$$

After setting β_{kw} = 1, if the total returns are replaced by rates of return this resembles the underlying in the swap contract discussed by Merton (1990)

$$Insurance = \$W \cdot \left(\ln\left(\frac{V_{wT}}{V_{wt}}\right) - \ln\left(\frac{V_{kT}}{V_{kt}}\right)\right) \tag{21}$$

So the underlying considered here allows for variation in country systematic risk. Given Eq. (20) and the following terminal values

$$P(V_k, V_w, 0) = \begin{cases} 0, & if\ V_{kT} \geq V_{kt}\left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} \\ \left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} V_{kt} - V_{kT}, & if\ V_{kT} < V_{kt}\left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} \end{cases} \tag{22}$$

benchmark insurance can be defined as the put option price, which is obtained by Put-Call Parity.

First, assume zero transaction costs, then Eq. (14) can be re-expressed in this context as the price of a call plus the difference between the relative price of the global index to the beta power and the relative price of the country index, or

$$P = C + \left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} - \frac{V_{kT}}{V_{kt}} \tag{23}$$

Substituting the call option value from Eq. (19) into this Put-Call parity condition yields

$$P(V_k, V_w, T - t) = \left(\frac{V_{wT}}{V_{wt}}\right)^{\beta_{kw}} N(-d_2) - \frac{V_{kT}}{V_{kt}} N(-d_1) \tag{24}$$

where d_1 and d_2 are computed as for the benchmark premium. As defined, if a country's index under-performs the global benchmark, the option pays that difference; otherwise, it has no value. This is the price of disinvesting from that country. With these contract prices defined, the focus can turn to the estimated inputs, and the application.

3. Estimated Inputs for the Single-Factor Option Pricing Formula

The Black-Scholes formula requires only a single volatility estimate, but the single-factor option pricing model has three required risk inputs: the country's idiosyncratic risk, the country's contribution to global systematic risk, or beta, risk, and global systematic risk. In what follows, rolling regression and volatility estimates will be used, along with the daily country and global index closing values, as inputs to track the price of entering and leaving a country over time. The rolling estimator requires choosing a sub-set of the first ω data points in a time series of T observations, and applying the estimator to each of $T–\omega+1$ sub-samples by rolling the "window" forward in time. Here, ω is fixed at 250 observations, roughly one year of trading days, which is a frequently used time horizon in calculating asset return volatility.

Since daily data are used, it is necessary to correct for an additional problem that occurs when working with close-to-close return data from markets in different time zones. For instance, markets in East Asia open and close before those in Europe, the Middle East and Africa, which in turn open and close before those in North and South America. Therefore, as discussed in Harvey (1995), the Scholes and Williams (1977) OLS regression adjustment procedure for non-synchronous data is applied to a moving windows variant of the empirical analog of Eq. (2) proposed by Solnik (1974b). Also, in studies that make use of monthly return data a risk-free asset is typically essential. Scholes and Williams (1977) work with daily data, and the risk-free rate of return during such intervals is typically close to zero, so this assumption is adopted here. Another reason not to include the risk free rate is that, as discussed earlier, it is a redundant security in Okunev and Tippett's (1993) framework.

It is straightforward to apply Scholes and Williams's (1977) methodology. Each day the betas are constructed as follows

$$\beta_{kwt}^{S} = \frac{\beta_{kwt}^{+} + \beta_{kwt} + \beta_{kwt}^{-}}{1 + 2 \cdot \rho_{wt}} \tag{25}$$

which in words is the sum of one-day leading, contemporaneous, and one-day lagging betas, divided by one plus twice the estimated rolling, world market autocorrelation coefficient. As this method is well known, a more concrete expression of these regressions, and also the standard errors is left in the appendix. The time subscript t reflects the fact that each component is applied to sub-samples of 250 observations, so that it can vary over time. The alpha will be graphed, and while not directly used as an option pricing input, it is used to compute the residual variance, which will be an input, and is calculated as

$$\alpha_{kwt}^{S} = \bar{r}_{k,t,t-247} - \beta_{kwt}^{S}\bar{r}_{w,t,t-247} \tag{26}$$

where $\bar{r}_{k,t,t-247}$ and $\bar{r}_{w,t,t-247}$ are respectively, the average dollar-denominated returns for country k and the world index w, estimated between day t and t-247, the superscript S refers to the estimate being corrected for non-synchronous trading bias. Standard errors for the alpha and beta are calculated according to the formulas discussed in the appendix.

Idiosyncratic risk, σ_k^2, is estimated with $\sigma_{e_{kt}^S}^2$, by calculating the variance of the residuals constructed from the rolling alphas, betas and a window of past returns

$$\begin{pmatrix} e_{k,t}^{S} \\ e_{k,t-1}^{S} \\ \vdots \\ e_{k,t-247}^{S} \end{pmatrix} = \begin{pmatrix} r_{k,t} \\ r_{k,t-1} \\ \vdots \\ r_{k,t-247} \end{pmatrix} - \alpha_{kwt}^{S} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} + \beta_{kwt}^{S} \begin{pmatrix} r_{w,t} \\ r_{w,t-1} \\ \vdots \\ r_{w,t-247} \end{pmatrix} \tag{27}$$

Finally, estimates of the variance of global index returns are required to numerically illustrate how global benchmark insurance works. Scholes and Williams (1977) define the relationship between the estimated autocorrelation coefficient and variance of benchmark portfolio returns and the true variance in their equation (18) as

$$\rho_w = \frac{1}{2}\left[\frac{\sigma_{True,w}^2}{\sigma_w^2} - 1\right] \tag{28}$$

The autocorrelation will be positive if the observed variance is less than the true variance. A rolling version of the true variance implied by Eq. (28) is therefore obtained by solving for the true variance

$$\sigma_{True,wt}^2 = \left(1 + 2 \cdot \rho_{wt}\right)\sigma_{wt}^2 \tag{29}$$

The term r_{wt}, and all other auto-correlation coefficients used here are estimated with a rolling regression because there are times when the rolling, Maximum Likelihood AR(1) estimator reports null values, but otherwise the two estimated time-paths track one another closely. The events of the Asian Crisis will be summarized before discussing the data used to estimate the rolling alphas, betas and standard errors, and the exchange option prices.

4. The Asian Crisis and Investable Emerging Equity Market Data

4.1 The Asian Crisis Revisited, Again

The series of events of concern here is the Asian Crisis, which has been summarized in a number of places.[4] The country in which the crisis begins to unfold is Thailand, already in 1996, where an insolvent financial services firm is forced to close by the Thai Central Bank. For the next year the Thai baht is subjected to speculative attacks until July 2, 1997, when the Thai Central Bank introduces a managed float, replacing the existing pegged exchange rate regime. The result is a devaluation of between 15-20%. By July 11, the Philippine Central Bank is forced to abandon its peg, while the Indonesian Central Bank widens the range of the exchange rate band. This is followed three days later by the collapse of the Malaysian ringitt peg. One month later, the Indonesian rupiah band can no longer be defended resulting in the currency's depreciation. On October 17, 1997, the Taiwanese new dollar is allowed to float, and for the next week, global investors anticipate the end of the Hong Kong Monetary Authority's quasi-currency board-like arrangement. On October 27, 1997, the Dow Jones falls over 500 points, similar in magnitude, but much smaller in percentage terms, than

[4] See for instance, IMF (1998, 1999, 2003), and Kaminski and Schmukler (1999).

the October 1987 crash. A few weeks later on November 17, 1997 the South Korean central bank floats the won. January 15th and 16th mark the signing of the International Monetary Fund (IMF) agreement with Indonesia, and the rolling over of debts to South Korea.[5] A new phase begins eight months later in relation to the Russian government's debt default. On September 1, 1998, President Mahatir in Malaysia imposes capital controls, which results in the country's securities being delisted from the ACWI on September 30th, 1999.[6] The last phase of the Asian Crisis occurs in mid-January 1999 when the Brazilian central bank widens the real band.

Following the Asian Crisis, Turkey and Argentina experienced financial crises. The Turkish crisis unraveled when evidence of a banking corruption scandal became public on November 17, 2000. After an initial currency devaluation the Turkish lira floats and a currency crash follows on February 22, 2001, but the crisis is contained with the signing of the Turkish government's standby agreement with the IMF.

Turmoil in Argentina, ultimately leading to a banking crisis, begins in March 2001 with two successive finance ministers announcing their resignations within three weeks. By May, Standard and Poor's (S&P) downgrades the sovereign bond rating for Argentina from B+ to B. A restructuring of federal debts occurs on November 30, 2001, and the next day government officials announce that they will impose restrictions on bank withdrawals and foreign exchange dealings, triggering a run on banks, and social turmoil. Other than the Malaysian capital controls, which occurred shortly after the Russian debt default, the events listed in Table 1 are depicted in Figures 1b through 16b.

---

[5] See IMF (1998), ibid.

[6] See http://www.msci.com/methodology/meth_docs/MSCI_May06_IndexCalcMethodology.pdf. The securities were later relisted on May 31st, 2000. It is tempting to think that the delisting from the ACWI benchmark index might affect the estimated coefficients for Malaysia. However, the patterns in Figures 3a. through 3c. resemble those for other countries in the region.

[Insert Table 1 about here]

4.2 Data

Standard & Poor's (S&P) Emerging Markets Database (EMDB), described by Edison and Warnock (2003), is the source of the country data. It includes daily index closing values for "investable" and "global" equities, the former (latter) representing those available to all investors (a country's residents).[7] S&P analysts determine if a reasonably liquid market exists for a given security that can be freely purchased by global investors, in which case it is listed as investable. The number of securities used to construct each investable index varies considerably across countries and to a lesser extent over time.[8] Daily, U.S. dollar-denominated investable index closing values are obtained from 6/30/1995 to 1/11/2006 for: Argentina, Brazil, Chile, China, Czech Republic, India, Indonesia, Malaysia, Mexico, Philippines, Poland, South Africa, South Korea, Taiwan, Thailand, Turkey. U.S. dollar denominated closing values from 6/30/1995 to 1/11/2006 for the Morgan Stanley Capital International All Country World Index (ACWI), are used to proxy for returns on the global market portfolio. This broad, market capitalization-weighted index is comprised of over 2600 companies from more than 50 countries.[9] Observations for New Years Day, Good Friday, and Christmas, which tend to be null are removed for each series. From 2721 daily closing values, daily rates of return are computed as the natural log of the closing price relative to the previous day's closing price. From the 2720 daily returns, 2471 rolling alphas and betas are estimated and used

---

[7] The EMDB is available from Bloomberg terminals with an additional subscription. To see how useful this distinction can be, Edison and Warnock (2003) propose a continuous, zero-to-one measure of a country's capital controls computed from an adjusted ratio of the market value of "investable" to "global" indices.

[8] For instance, some markets (i.e., Czech Republic) have fewer than ten investable securities, while others (i.e., Brazil) have more than two hundred.

[9] See http://www.msci.com/methodology/meth_docs/MSCI_May06_IndexCalcMethodology.pdf for a full description of how the index is created.

in the option pricing model.[10]

5. Dollar Values of Entry and Exit, Country Alphas and Country Betas

5.1 Generating Overnight Option Prices

As these options do not exist, the information content of the pricing formula can be seen using the following thought experiment. Assume that at the close of business for each day it is possible to purchase 250 trading day options that expire in two days, meaning that they could be exercised the next day. The benchmark premium would indicate the value of entering a country the next morning, since it implies exchanging the global benchmark for the country. The price of benchmark insurance reflects the value of exiting a country overnight, since it implies exchanging the country for the global index. These values change over time. The volatility inputs for Eq.'s (19) and (24) are the country betas from Eq. (25), the variance of the residuals reported in Eq. (27), and the global index volatility defined in Eq. (29). Index values for each country and the MSCI ACWI are rescaled to equal 100 on June 30, 1995, the first day for which the EMDB has recorded daily data. The realized country and global index ratios covering a 248-day period are computed as $V_{kt}/V_{k,t-247}$ and $V_{wt}/V_{w,t-247}$. The 248-day ratios are computed beginning on June 18, 1996 relative to July 4, 1995, and iterated forward until the last observation in the sample, calculated using values for January 10, 2006 relative to January 25, 2005. These inputs are used in the pricing formulas in Eq.'s (19) and (24) to get the implied price of either exiting or entering an emerging market.

5.2 Visualizing the Output

[10] The formula to determine the number of estimates is $s = T - w + 1 = 2720 - 250 + 1$. Estimates for January 11, 2006 is lost because of the non-synchronous data bias adjustment since the first and last observations are lost when estimating the lagged and leading regressions.

In Figures 1 through 16, Panel a. depicts the option values, Panel b. depicts the annualized county alpha relative to the global benchmark and the 95% confidence intervals, and Panel c. depicts the country beta and the 95% confidence intervals. The countries appear roughly in the order of the time zone in which they are situated, with countries in the same time zone sorted alphabetically. The vertical axes are not aligned along a common scale to emphasize similarities across countries during the Asian Crisis.

By assumption $\$W = \$1$ in Eq. (17) and (21), so Figures 1a through 16a show how many dollars one might expect to pay to buy the right to invest one dollar in (if positive) or disinvest one dollar from (if negative) an emerging equity market. Negative benchmark insurance values are used to illustrate that the combined benchmark premium-benchmark insurance payouts closely resemble the country alphas depicted in Figures 1b through 16b. Thus, when the benchmark premium (benchmark insurance) equals \$1.50 (−\$1.50), this is analogous to a country alpha being equal to 50% (−50%) since alphas are annualized after multiplying by 250 and then 100%. During the Asian Crisis and other downturns, it is as if the benchmark insurance values are being bid up, just as the country alphas become increasingly negative. During stock market booms, it is as if the benchmark premia are being bid up just as the country alphas rise. The novelty of this finding is that it is found using two completely different methods, but it makes sense because when a country outperforms a global benchmark, the value of investing in that market is positive, and zero otherwise. Also, the rise in the country betas during the Asian Crisis seems to move along with the option values and country alphas.

In terms of the country-specific stories, there are broadly speaking four types. The first type is comprised of countries in Asia with a high exposure to the crisis (China, Indonesia, Malaysia, the Philippines, South Korea, Thailand). The second includes countries less exposed to the crisis (Taiwan, India). The third includes countries in Central Europe, the Middle East, and Africa, which also have less exposure (the Czech Republic, Poland, South Africa, and Turkey). The final group includes countries in Latin America (Argentina, Brazil, Chile, and Mexico).

Interestingly, both the value of exiting Thailand and the country alpha become increasingly negative already in July 1996, well before the official start of the crisis, which corroborates the anecdotal evidence reported in Kaminsky and Schmukler (1999), among other places. Judging by the alpha standard errors, losses in Thailand are economically and statistically significantly different from zero. In contrast, Chile, the Czech Republic, India, Poland, and Taiwan appear to have the least exposure among the sixteen countries, so the option values, and the country alphas and betas are smaller in magnitude. For Turkey and Argentina, two countries that experienced isolated financial crises after the Asian Crisis, the exit option values and alphas also become increasingly negative. The subsequent Argentine stock market boom in 2003, attributed by Yeyati, et al. (2004) to the inconvertibility of bank deposits, is seen in the rise of the option value of entering Argentina as well as in the country alpha. This rise is also apparent in Brazil, Chile, and to a lesser extent Mexico.

A scan of Figures 1b. through 16b. reveals that the profits can be large, sometimes exceeding +/−100%. Even so, zero lies almost always within each country alpha's two-sided, 95% confidence interval. Drawing from Black's (1986) conjecture, the fact that zero almost always lies within the alpha two-standard error bands can be loosely interpreted to suggest that markets have been 95 percent efficient most of the time.[11]

Lastly, country betas rise in all countries during the Asian Crisis and fall afterward. This is a key factor driving country alpha movements and the entry and exit option values. After the crisis, the betas approach zero for a number of countries, which as pointed out by Bekaert (1995) may reflect the fact that these markets became less interesting to global investors, and hence less integrated with the global index.

6. Conclusion

The option prices of entry and exit may provide a relatively high-frequency indicator of the direction and intensity of net capital flows. These hypothetical prices may be of interest to global investors, as well as IMF officials charged with monitoring capital flows. It has also been shown that, because the option values are tied to country-specific performance, they resemble the country alphas, and therefore can be useful in terms of checking for consistency. A hedging strategy to neutralize the effects of a crisis may one day be possible. Because the two effects seem to cancel over the longer run, a hedging supplier might take the long position, called the benchmark premium, and a short position in the benchmark insurance. However, the merits of this idea are beyond the scope of this paper.

There are shortcomings. Among them, is the fact that if applied as is, the exit-entry values will be delayed because the Scholes-Williams alpha and beta estimates are not available until one day later, while the standard errors are not available until two days later, due to the leading regressions. One solution may be to omit those regressions to

[11] Black (1986), p. 533, writes "I think almost all markets are efficient almost all of the time. 'Almost all' means at least 90 percent."

simplify the estimator. Also, it may be worth down-weighting earlier observations when estimating the rolling regressions to reduce the influence of older observed returns.

Acknowledgements

I am grateful to an anonymous referee as well as to my dissertation committee, including my advisor, Joe Reid, David M. Levy, Jot Yau, and Jim Gentle. Peter Carr, Daniel Carrigan and Steven Malinsky at the Philadelphia Stock Exchange, Michel Dacorogna, Mark Tippett and Michalis Zervos provided valuable suggestions about pricing. I would also like to thank Kevin Davis, Emanuel Derman, Edgardo Favaro, Campbell Harvey, Steve Jewson, Robert Merton, Kurt Schuler, Ajay Shah, William Speth at the Chicago Board Options Exchange, Peter Tran, Susan Woodward, and seminar participants at the World Bank, the US Treasury Department, Monash University, Sydney University, the 2006 INFINITI conference at Trinity College, Dublin, and the 2007 FINSIA/Melbourne Centre Conference. Remaining errors should be attributed to me.

Appendix: Calculating Alpha and Beta Standard Errors[12]

To construct the rolling variant of the Scholes-Williams beta reported in Eq. (25), each day's "one-day leading", "contemporaneous" and "one-day lagging" regressions are

$$\begin{pmatrix} r_{k,t} \\ r_{k,t-1} \\ \vdots \\ r_{k,t-247} \end{pmatrix} = \alpha^{+}_{kwt} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} + \beta^{+}_{kwt} \begin{pmatrix} r_{w,t+1} \\ r_{w,t} \\ \vdots \\ r_{w,t-246} \end{pmatrix} + \begin{pmatrix} e^{+}_{k,t} \\ e^{+}_{k,t-1} \\ \vdots \\ e^{+}_{k,t-247} \end{pmatrix} \tag{A1}$$

$$\begin{pmatrix} r_{k,t} \\ r_{k,t-1} \\ \vdots \\ r_{k,t-247} \end{pmatrix} = \alpha_{kwt} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} + \beta_{kwt} \begin{pmatrix} r_{w,t} \\ r_{w,t-1} \\ \vdots \\ r_{w,t-247} \end{pmatrix} + \begin{pmatrix} e_{k,t} \\ e_{k,t-1} \\ \vdots \\ e_{k,t-247} \end{pmatrix} \tag{A2}$$

and

$$\begin{pmatrix} r_{k,t} \\ r_{k,t-1} \\ \vdots \\ r_{k,t-247} \end{pmatrix} = \alpha^{-}_{kwt} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} + \beta^{-}_{kwt} \begin{pmatrix} r_{w,t-1} \\ r_{w,t-2} \\ \vdots \\ r_{w,t-248} \end{pmatrix} + \begin{pmatrix} e^{-}_{k,t} \\ e^{-}_{k,t-1} \\ \vdots \\ e^{-}_{k,t-247} \end{pmatrix} \tag{A3}$$

where $r_{k,t}$ ($r_{w,t}$) is the day t rate of return on the country (global) index, and $e_{k,t}$ is the day *t* residual for that window of observations. Also required is the auto-correlation coefficient for the global benchmark for day *t* is characterized as

$$\begin{pmatrix} r_{w,t} \\ r_{w,t-1} \\ \vdots \\ r_{w,t-247} \end{pmatrix} = \rho_{wt} \begin{pmatrix} r_{w,t-1} \\ r_{w,t-2} \\ \vdots \\ r_{w,t-248} \end{pmatrix} + \begin{pmatrix} e_{w,t} \\ e_{w,t-1} \\ \vdots \\ e_{w,t-247} \end{pmatrix} \tag{A4}$$

As the AR(1) estimator reports some null values, a least squares regression is used.

With the rolling country betas, and alphas, as well as the residual variances, the standard errors can be obtained as follows. First, for each window, a rolling measure of

[12] I am grateful to Edgardo Favaro for suggesting that I explore standard errors.

the correlation coefficient $\rho_{e_{kt}^S} = \dfrac{\sigma_{e_{k,t}^S, e_{k,t-1}^S}}{\sigma_{e_{k,t}^S}\sigma_{e_{k,t-1}^S}}$ is estimated for the residuals constructed according to Eq (26). Another variable that Scholes and Williams (1977) prove is necessary to compute standard errors is the sum of lagged, current and leading realized rates of return on the world benchmark portfolio, $r_{3wt} = r_{w,t-1} + r_{w,t} + r_{w,t+1}$. In using this variable, two additional observations, the full-sample endpoints, are lost from the final sample. A rolling autocorrelation coefficient for three-day returns, $\rho_{3wt} = \dfrac{\sigma_{r_{3w,t+1}, r_{3w,t}}}{\sigma_{r_{3w,t+1}}\sigma_{r_{3wt}}}$, is required with $\sigma_{r_{3w,t+1}}$ and $\sigma_{r_{3w,t}}$ being the standard deviation of the new variable over the window being consider, and $\sigma_{r_{3w,t+1}, r_{3w,t}}$ being the covariance estimate between subsequent observations in that window. A third data point is lost from the sample in the process of estimating this parameter because it requires calculating the correlation between $r_{3w,t+1} = r_{w,t} + r_{w,t+1} + r_{w,t+2}$ and $r_{3w,t} = r_{w,t-1} + r_{w,t} + r_{w,t+1}$, and $r_{w,t+2}$ at the endpoint is out of sample. A rolling regression is estimated between $r_{w,t}$, $r_{3w,t}$, denoted $\beta_{wt,3wt} = \dfrac{\sigma_{wt,3wt}}{\sigma_{3wt}^2}$.

These inputs are used to construct the Scholes-Williams beta standard error

$$\sigma_{\beta_{kwt}^S} = \sqrt{\frac{\sigma_{e_{kt}^S}^2}{\omega - 2}\frac{1 + 2\rho_{e_{kt}^S}\rho_{3wt}}{\beta_{wt,3wt}^2 \sigma_{r_{3w,t}}^2}} \tag{A5}$$

where ω is the window size. This standard error is also a component of the alpha's standard error, which is computed as follows

$$\sigma_{\alpha_{kwt}^S} = \sqrt{\left(\frac{\sigma_{e_{kt}^S}^2}{\omega - 2}\frac{1 + 2\rho_{e_{kt}^S}\rho_{3wt}}{\beta_{wt,3wt}^2 \sigma_{r_{3wt}}^2}\right)\bar{r}_{w,t-1,t-248}^2 + \frac{\sigma_{e_{kt}^S}^2}{\omega - 2}\left(1 + 2\rho_{e_{kt}^S}\right)} \tag{A6}$$

References

Bekaert, G., 1995. Market integration and investment barriers in emerging equity markets. The World Bank Economic Review 9, 75-107.

Black, Fischer, 1986. Noise. Journal of Finance 41, 529-543.

Black, Fischer and Myron Scholes. 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81, 637-653.

Bodie, Zvi, and Merton, Robert C., 2002. International pension swaps. Journal of Pension Economics and Finance 1, 77-83.

Bordo, Michael, Ashoka Mody, and Nienke Oomes. 2004. Keeping capital flowing: the Role of the IMF. International Finance 7, 421-450.

Clark, E. 2002. International Finance. Thomson Learning, London.

Draghi, Mario, Francesco Giavazzi, and Robert C. Merton. Transparency, Risk Management and International Financial Fragility, Vol. 4. Geneva Reports on the World Economy. Geneva: International Center for Monetary and Banking Studies, 2003.

Edison, H., Warnock, F., 2003. A simple measure of the intensity of capital controls. Journal of Empirical Finance 10, 81-103.

Gray, Dale F., Merton, Robert C., and Zvi Bodie. 2007. Contingent claims approach to measuring and managing sovereign credit risk. Journal of Investment Management 5: 5-28.

Harvey, C. R., 1995. The risk exposure of emerging equity markets. World Bank Economic Review, 19-50.

IMF. 1998. The Asian Crisis: Capital Markets Dynamics and Spillover. The International Capital Markets, Chapter II.

IMF. 1999. Financial Sector Crisis and Restructuring: Lessons from Asia.

IMF. 2003. Lessons from the Crisis in Argentina.

Jaeger, Stefan, and Zimmermann, Heinz. 1995. Economic cost of surplus insurance: An application of the Margrabe model. Finanzmarkt und Portfolio Management 9, 393-397.

Jensen, Michael C., 1968. The performance of mutual funds in the period 1945 -1964. Journal of Finance 23, 389-416.

Kaminsky, G., Schmukler, S., 1999. What triggers market jitters? A chronicle of the

Asian crisis. Journal of International Money and Finance 18, 537-560.
Latane, H. and Rendleman, R., 1976. Standard deviations of stock price ratios implied in option prices. Journal of Finance 31, 369-381.

Margrabe, William, 1978. The value of an option to exchange one asset for another. The Journal of Finance 33, 177-186.

Merton, Robert C., 1973. An intertemporal capital asset pricing model. Econometrica 41, 867-887.

______, ______ _., 1990. The financial system and economic performance. Journal of Financial Services Research 4, 263-300.

Miller, S. 2005. Betting on country alphas to hedge against Asian crisis risk. Journal of Risk Finance 6, 17-30.

Okunev, John and Tippett, Mark, 1993. A multifactor option pricing model. Advances in Futures and Options Research 6, 67-80.

Scholes, M., Williams, J., 1977. Estimating betas from non-synchronous data. Journal of Financial Economics 5, 309-327.

Siegel, Andrew, 1995. Measuring systematic risk using implicit beta. Management Science 41, 124-128.

Solnik, B., 1974a. An equilibrium model of the international capital market. Journal of Economic Theory 8, 500-524.

______, _., 1974b. The international pricing of risk: an empirical investigation of the world capital market structure. The Journal of Finance 29, 365-378.

Taylor, Mark and Tonks, Ian, 1989. The internationalisation of stock markets and the abolition of U.K. exchange controls. The Review of Economics and Statistics 71, 332-336.

Yeyati, Eduardo Levy, Sergio L. Schumkler, and Neeltje Van Horen. 2004. The price of inconvertible deposits: The stock market boom during the Argentine crisis. Economics Letters 83, 7-13.

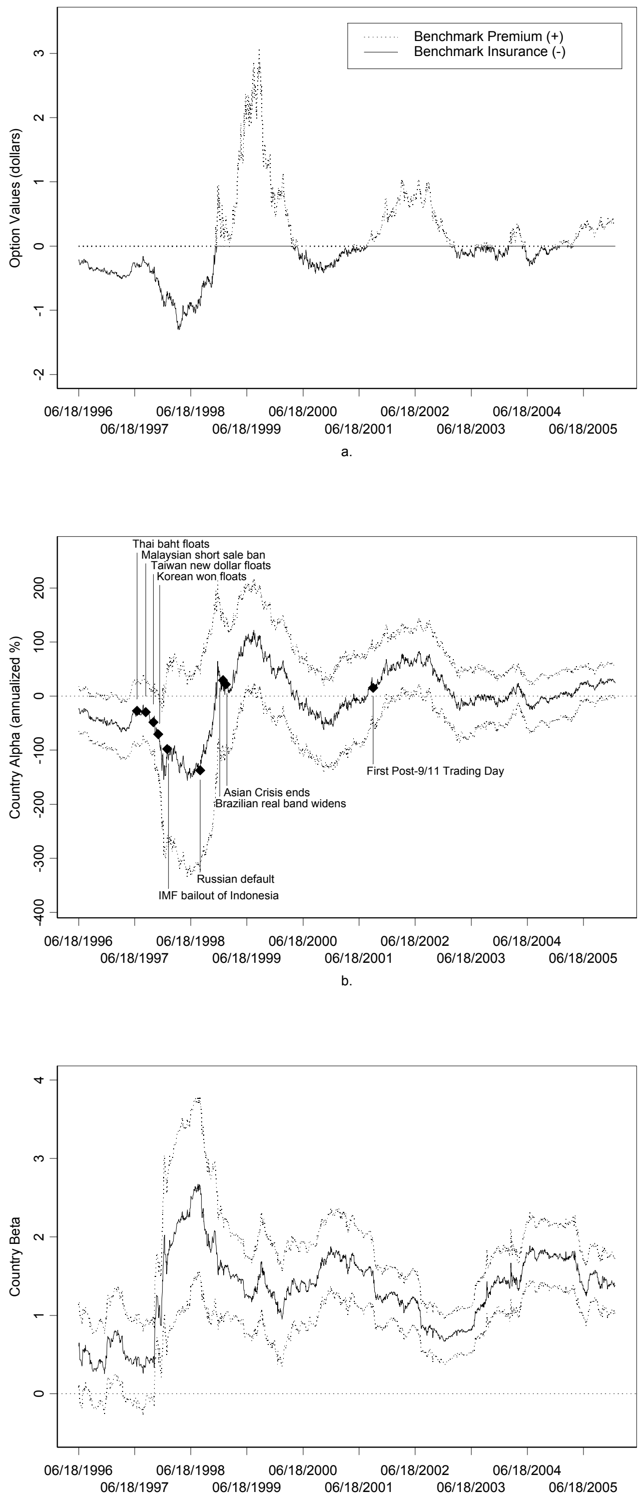


Figure 1. Korea: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

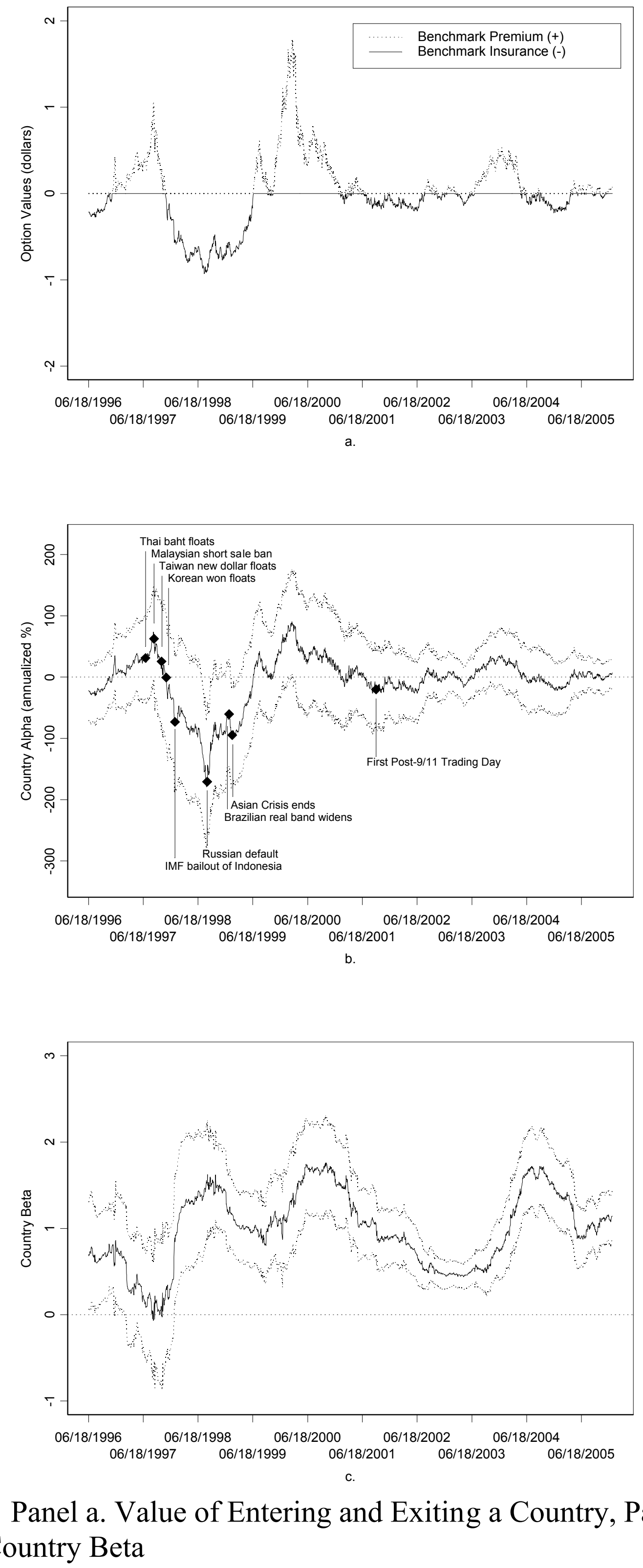


Figure 2. China: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

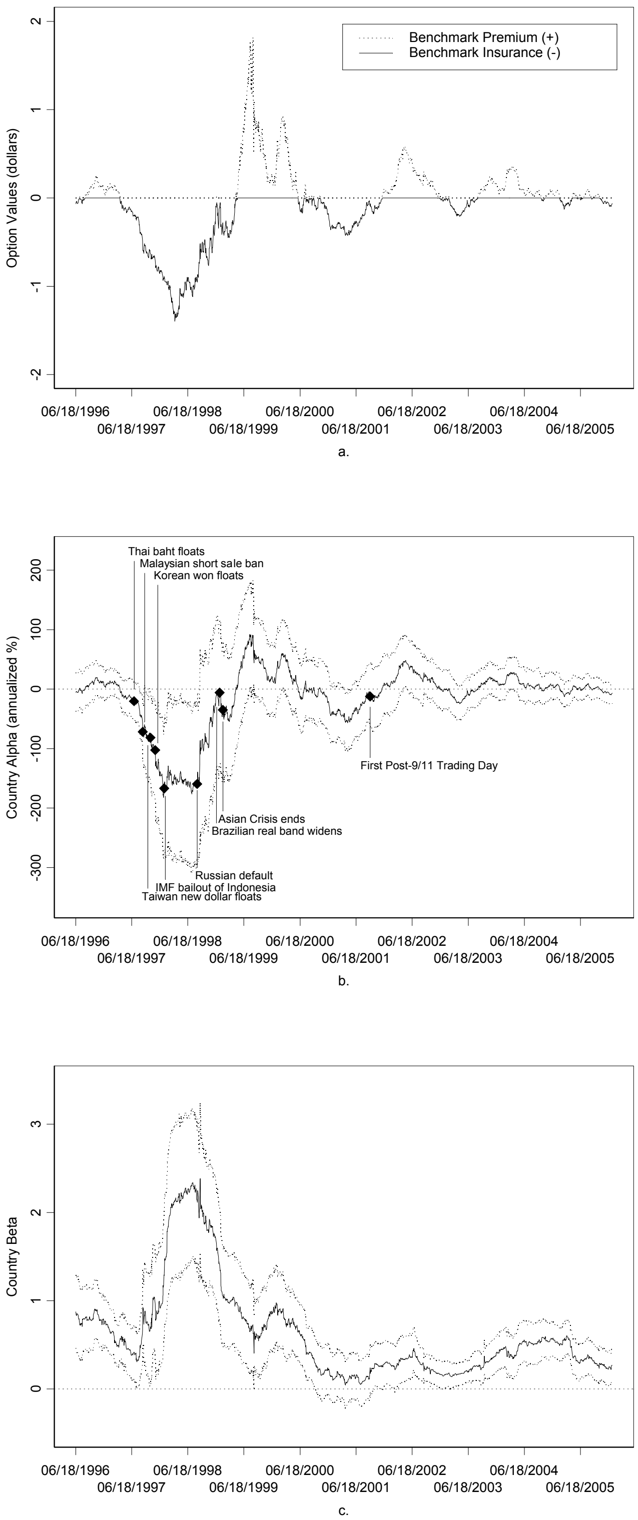


Figure 3. Malaysia: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

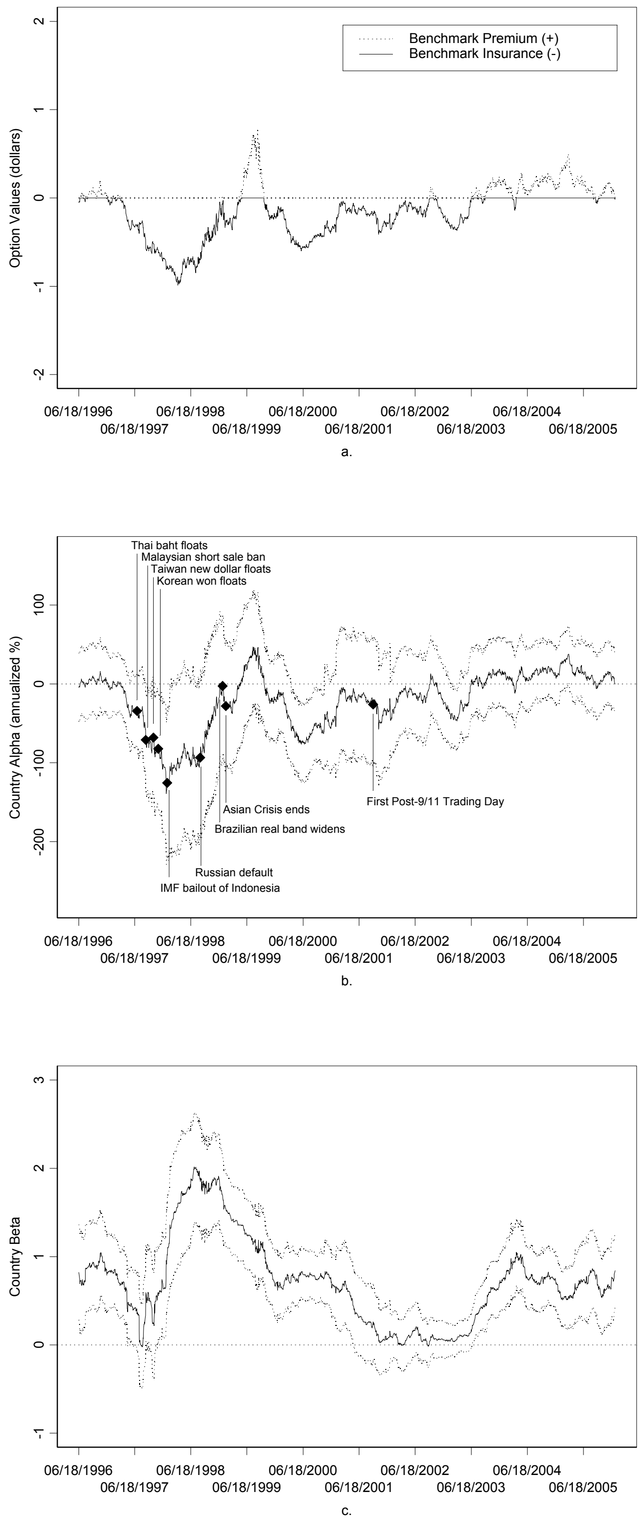


Figure 4. Philippines: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

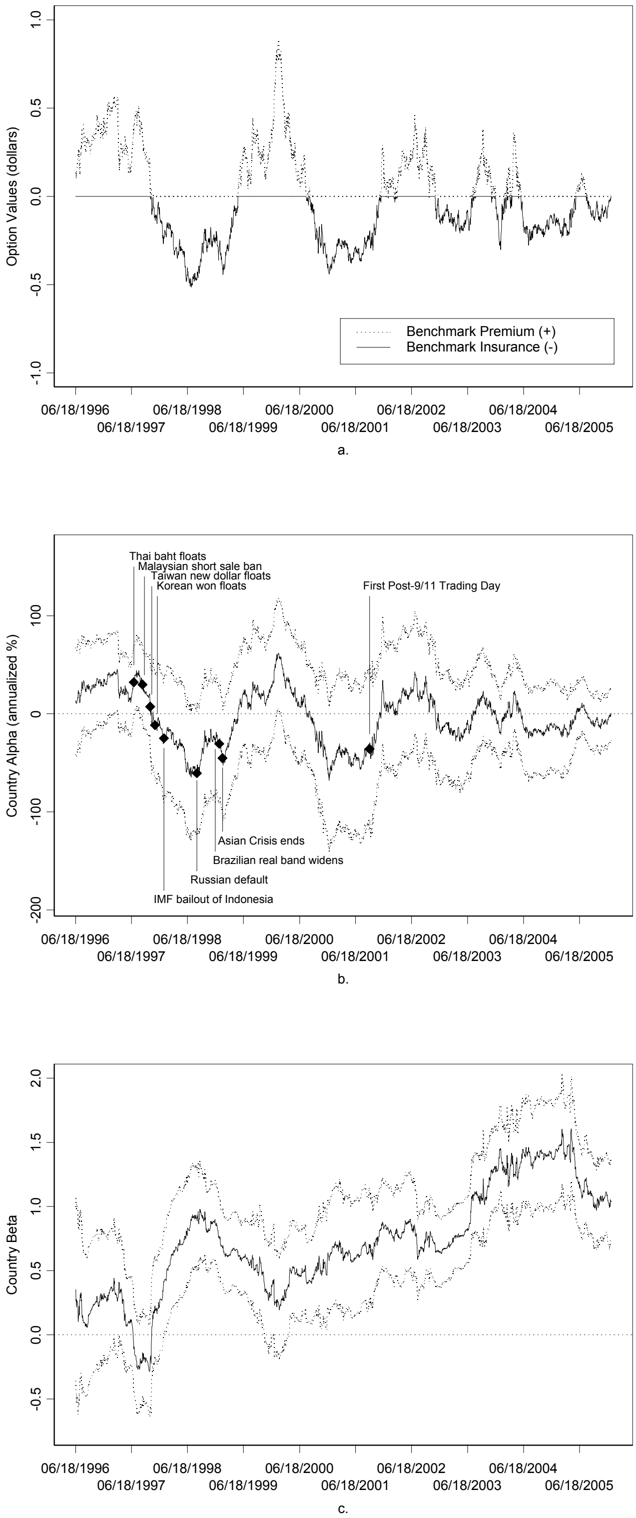


Figure 5. Taiwan: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

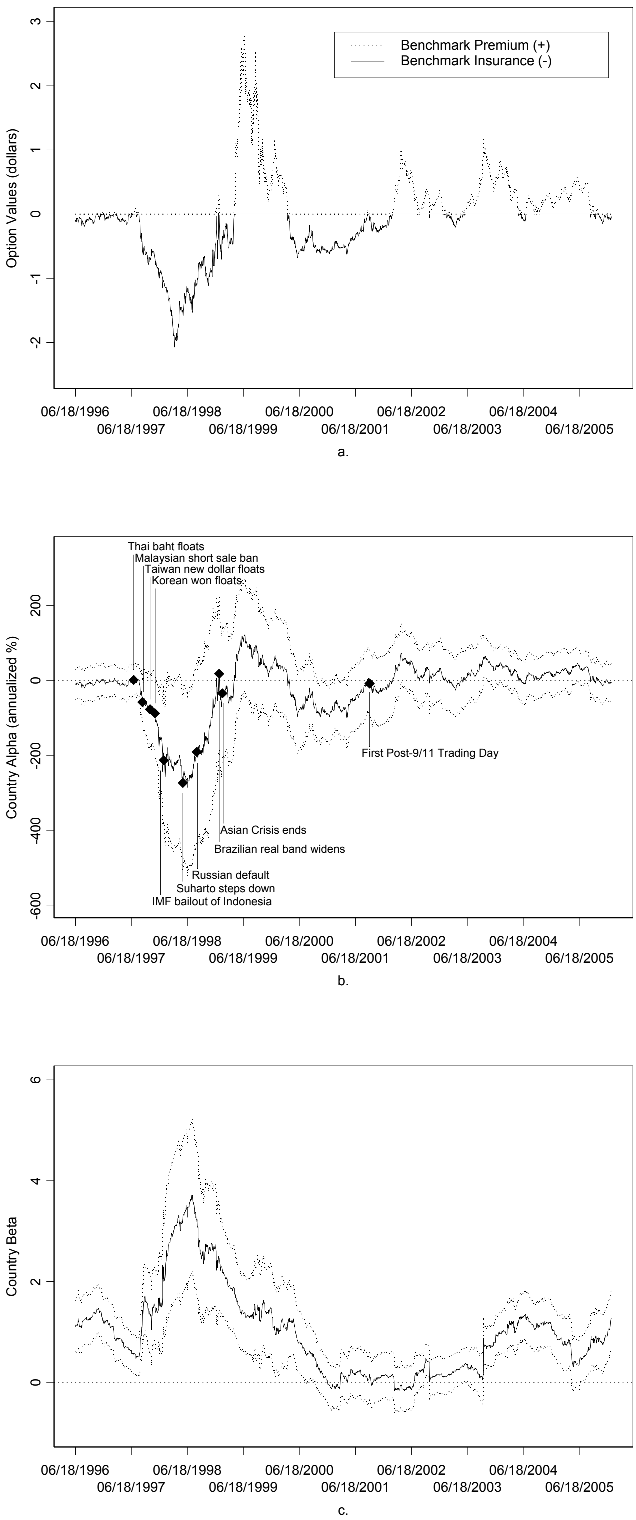


Figure 6. Indonesia: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

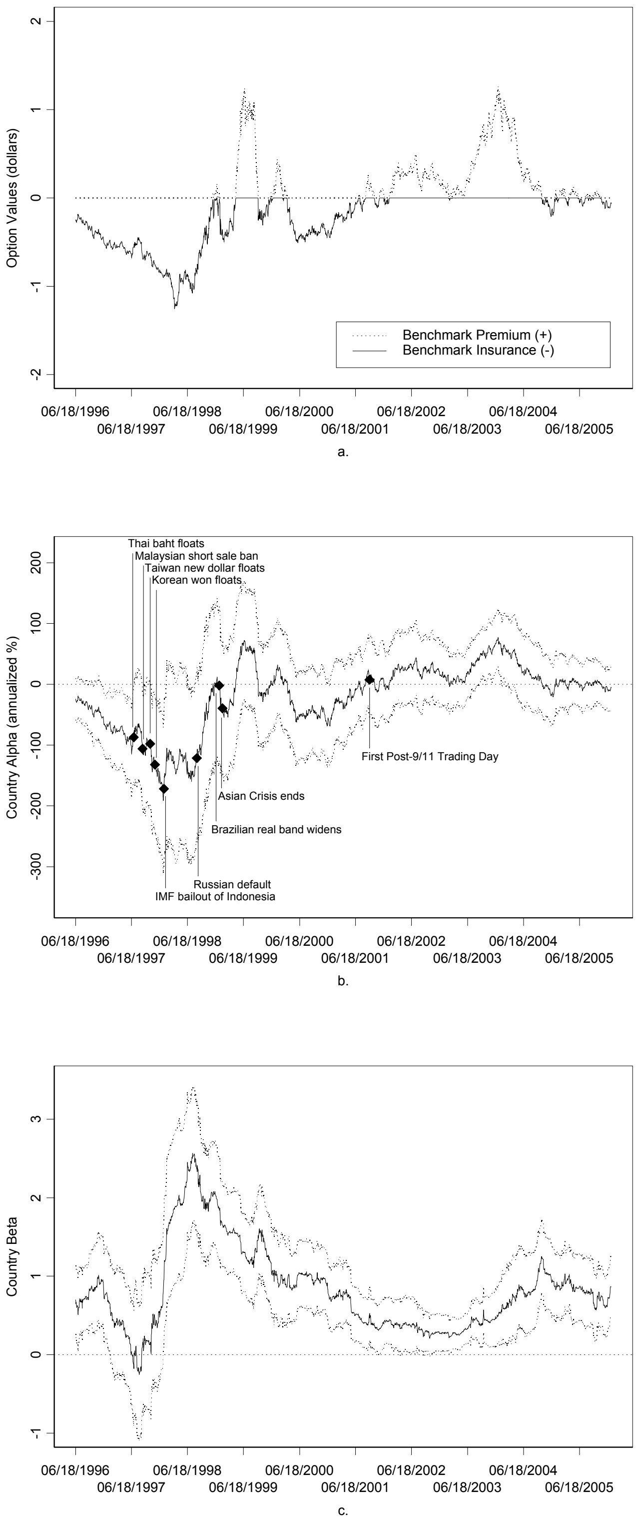


Figure 7. Thailand: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

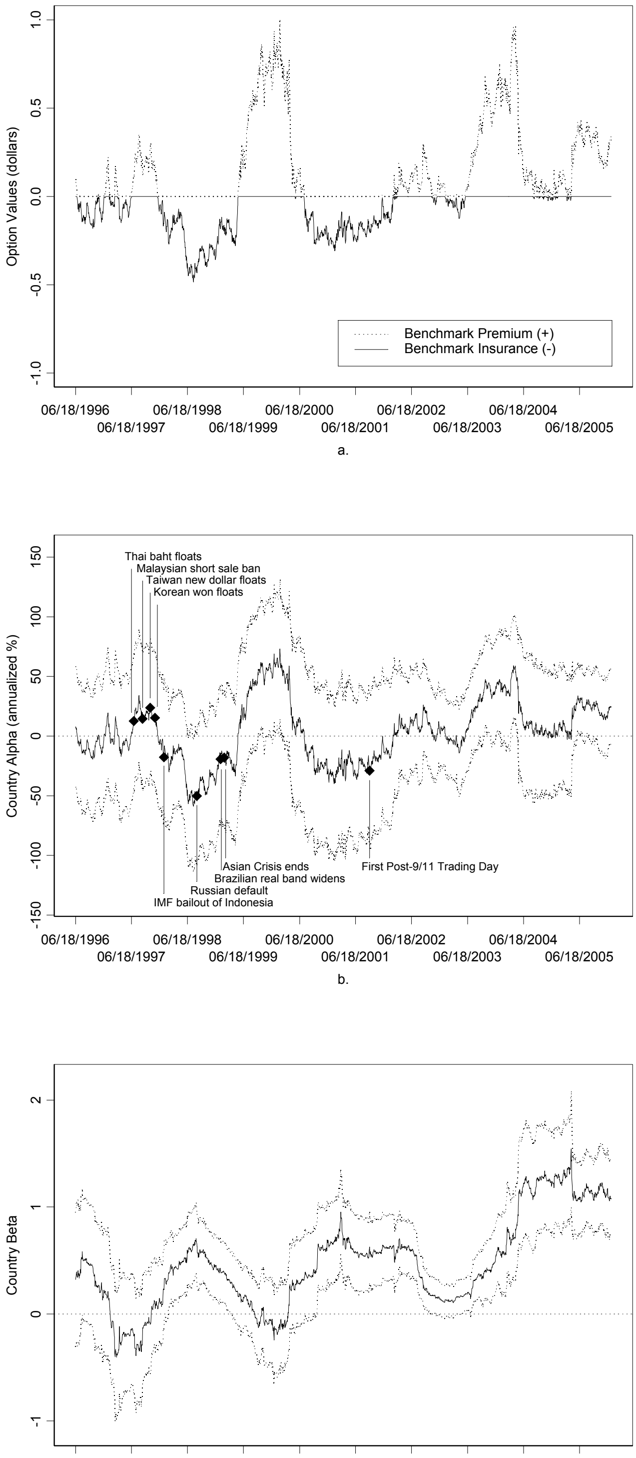
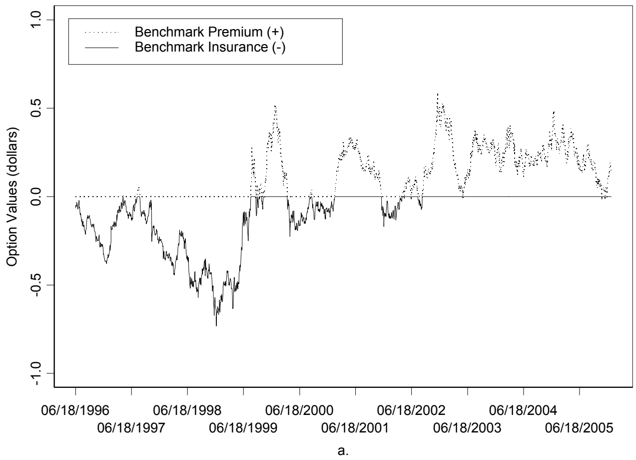
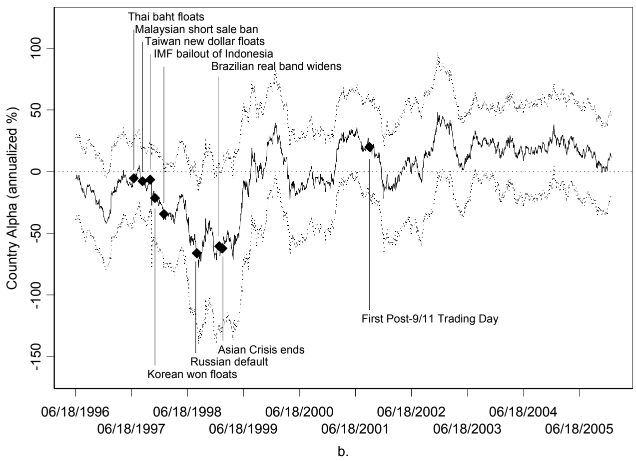


Figure 8. India: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta





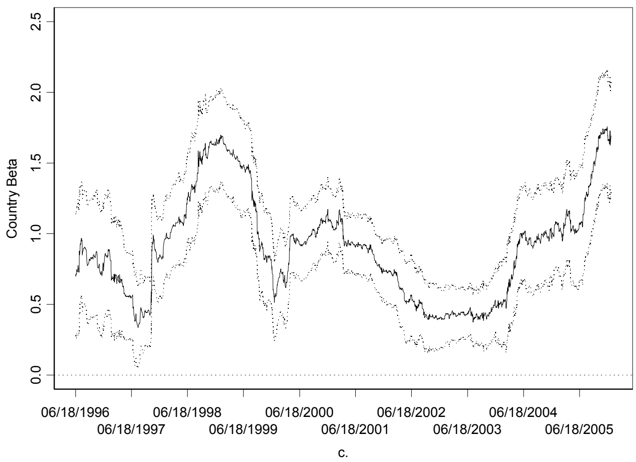


Figure 9. South Africa: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

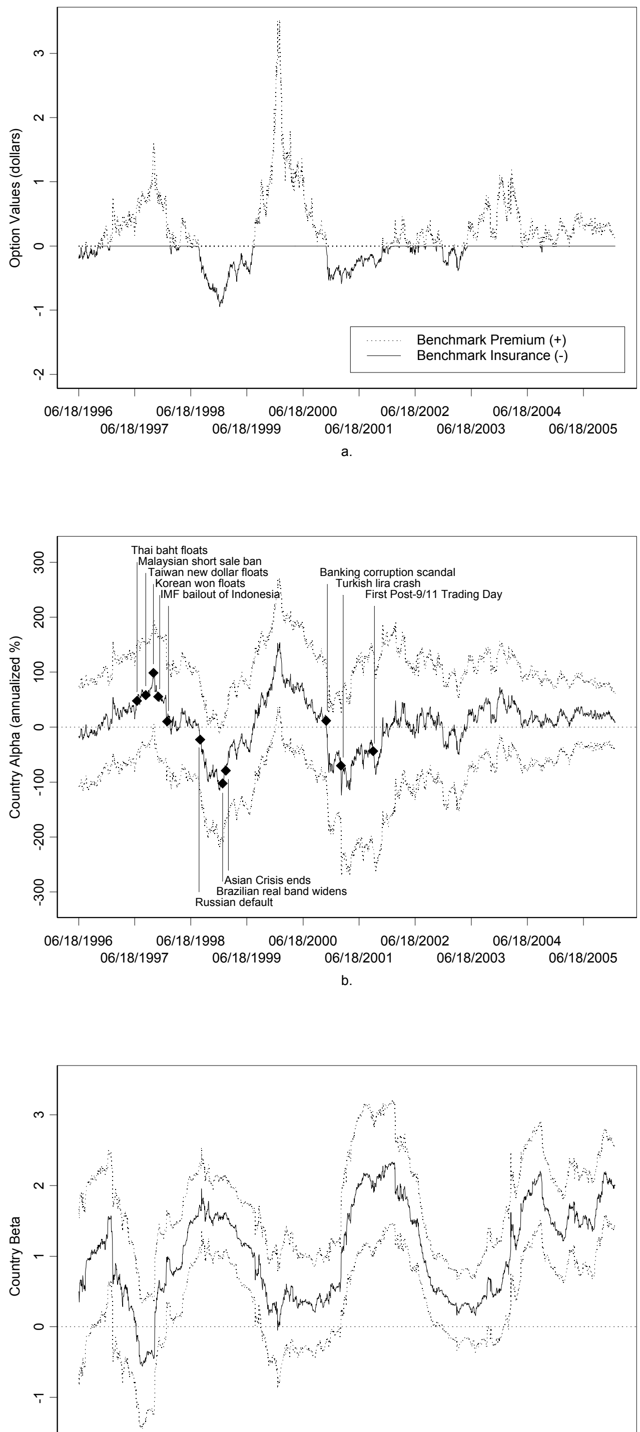
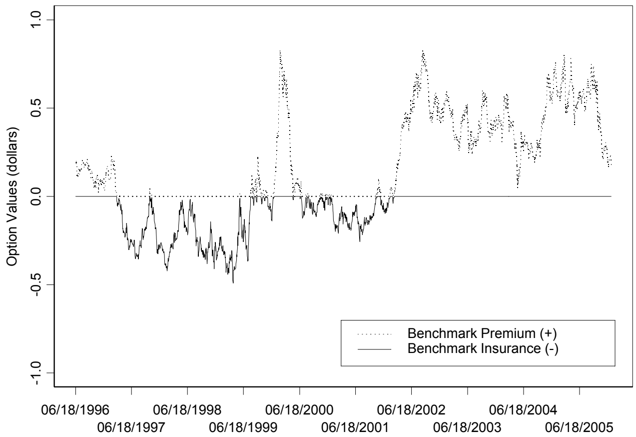
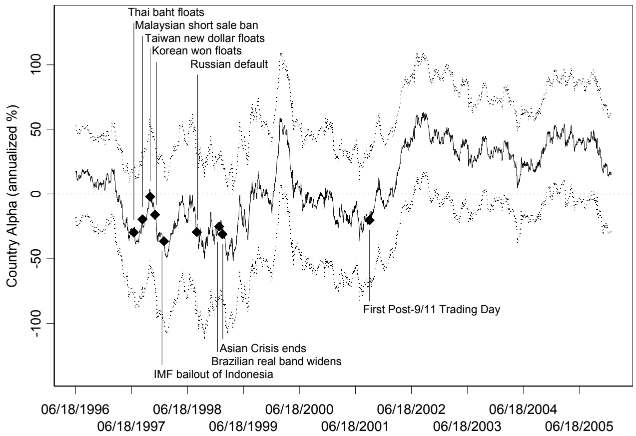


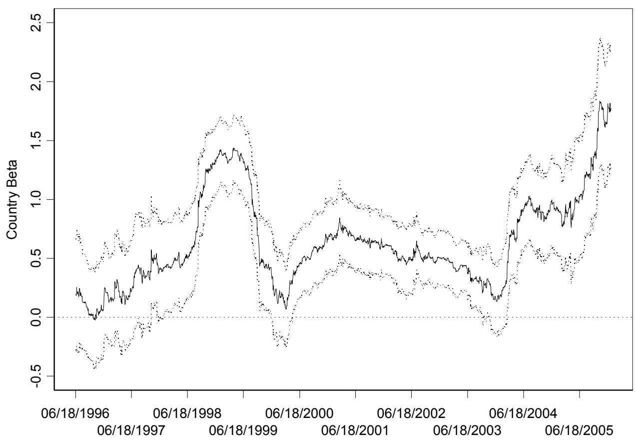
Figure 10. Turkey: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta



a.



b.



c.

Figure 11. Czech Republic: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

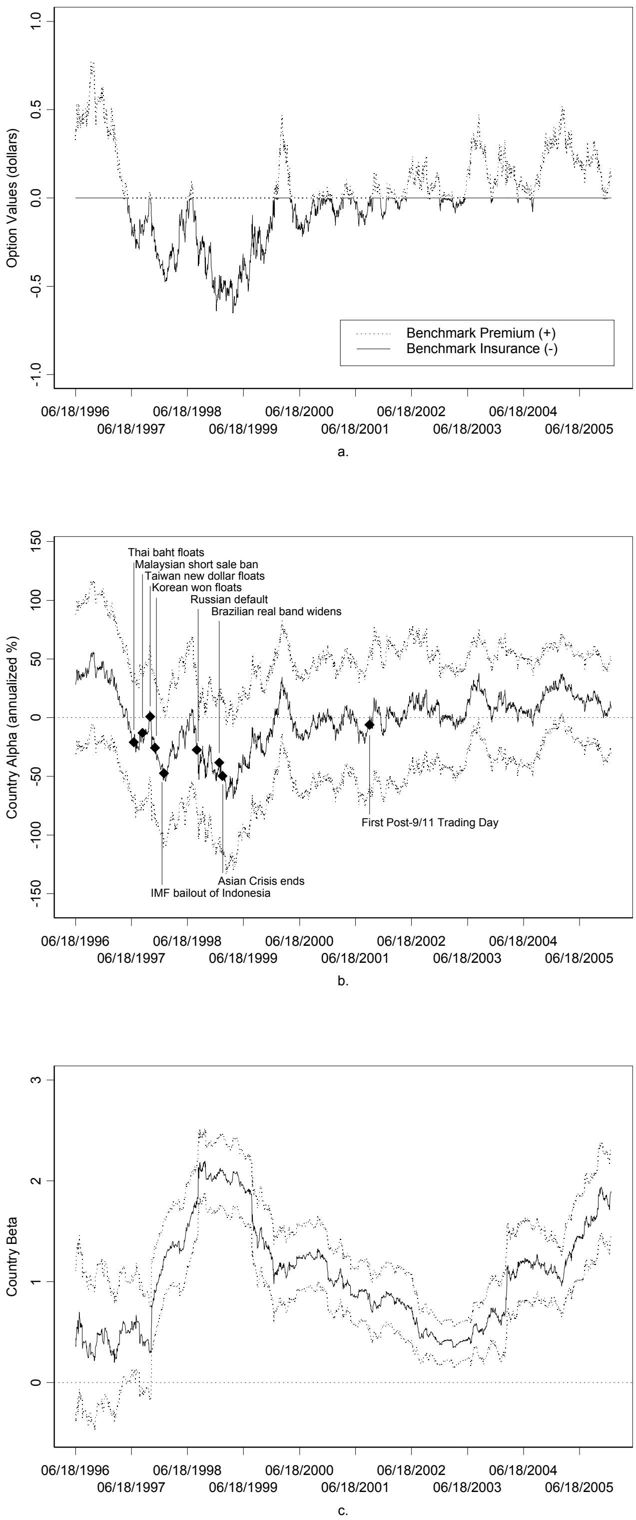


Figure 12. Poland: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

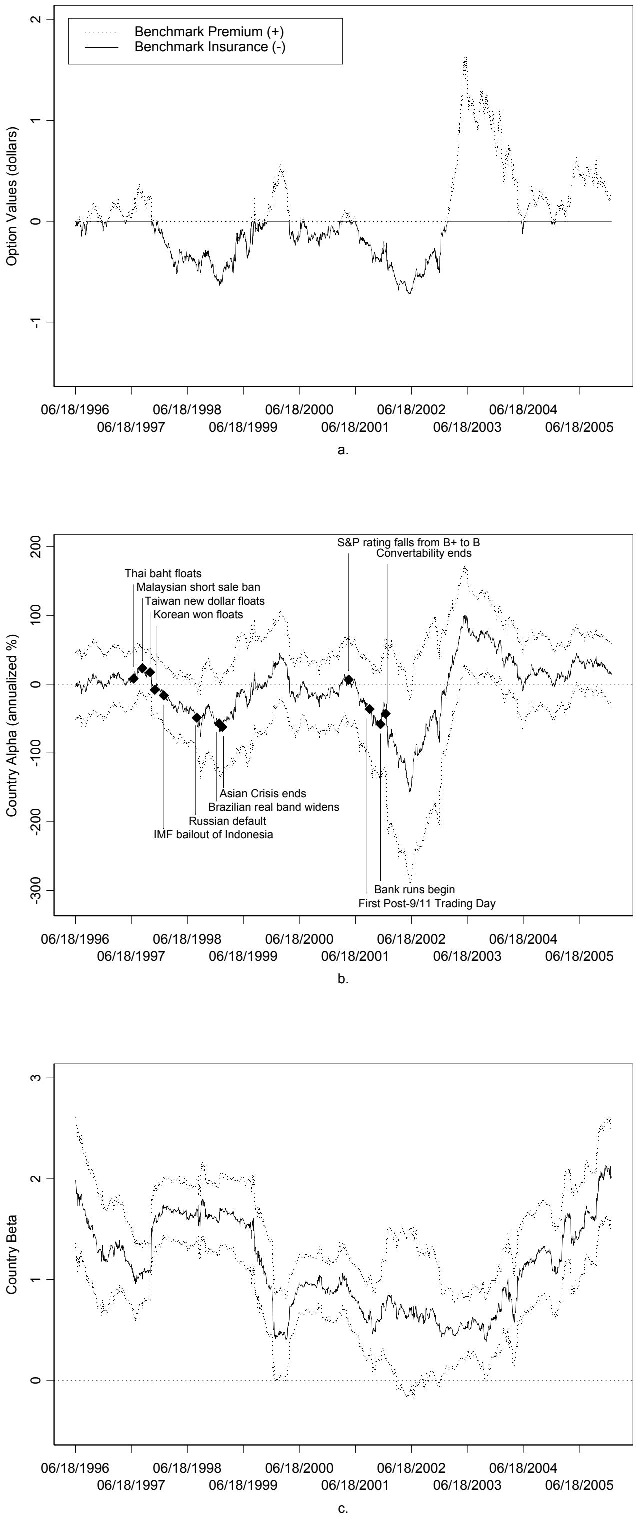


Figure 13. Argentina: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

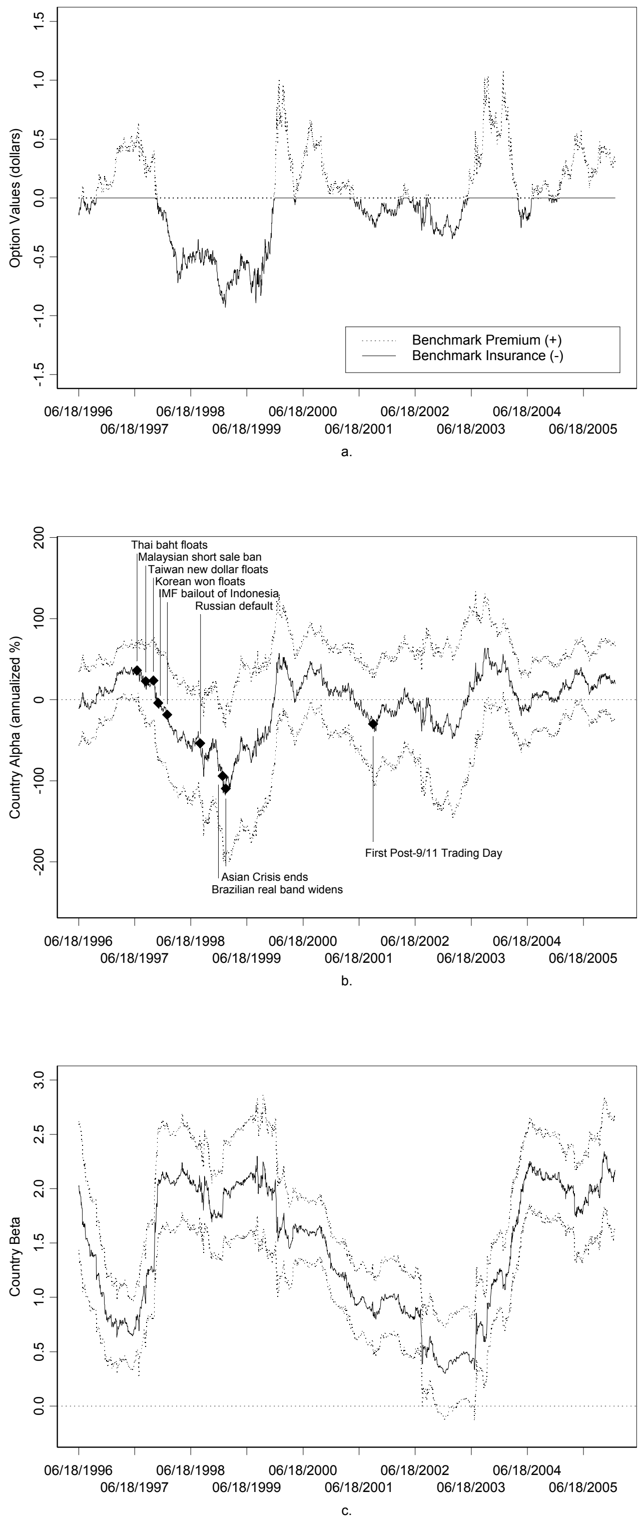
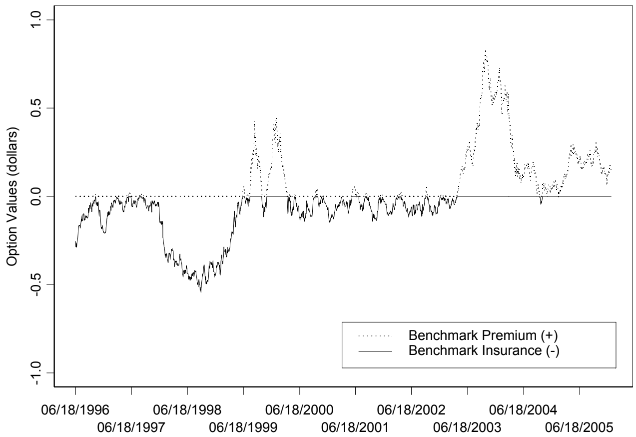
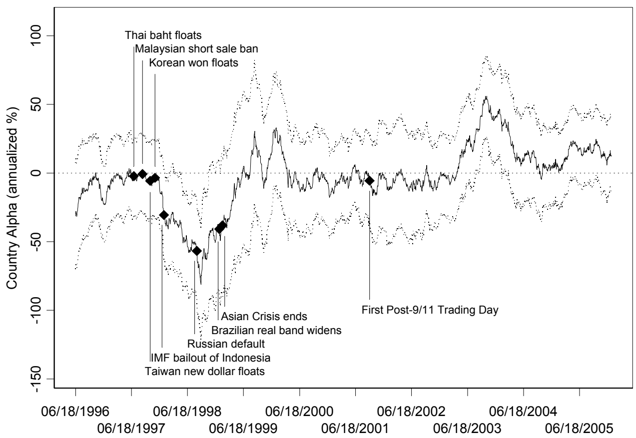


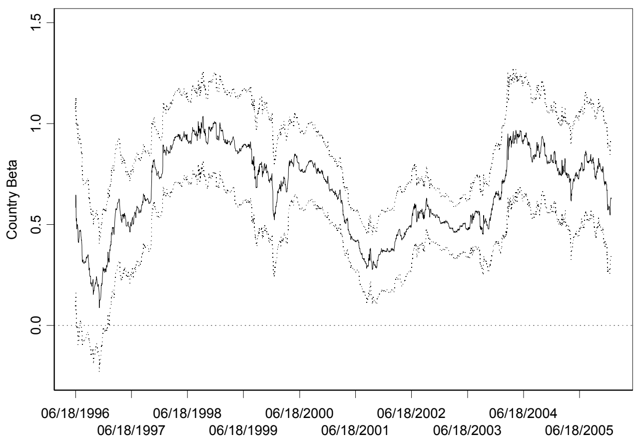
Figure 14. Brazil: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta



a.



b.



c.

Figure 15. Chile: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

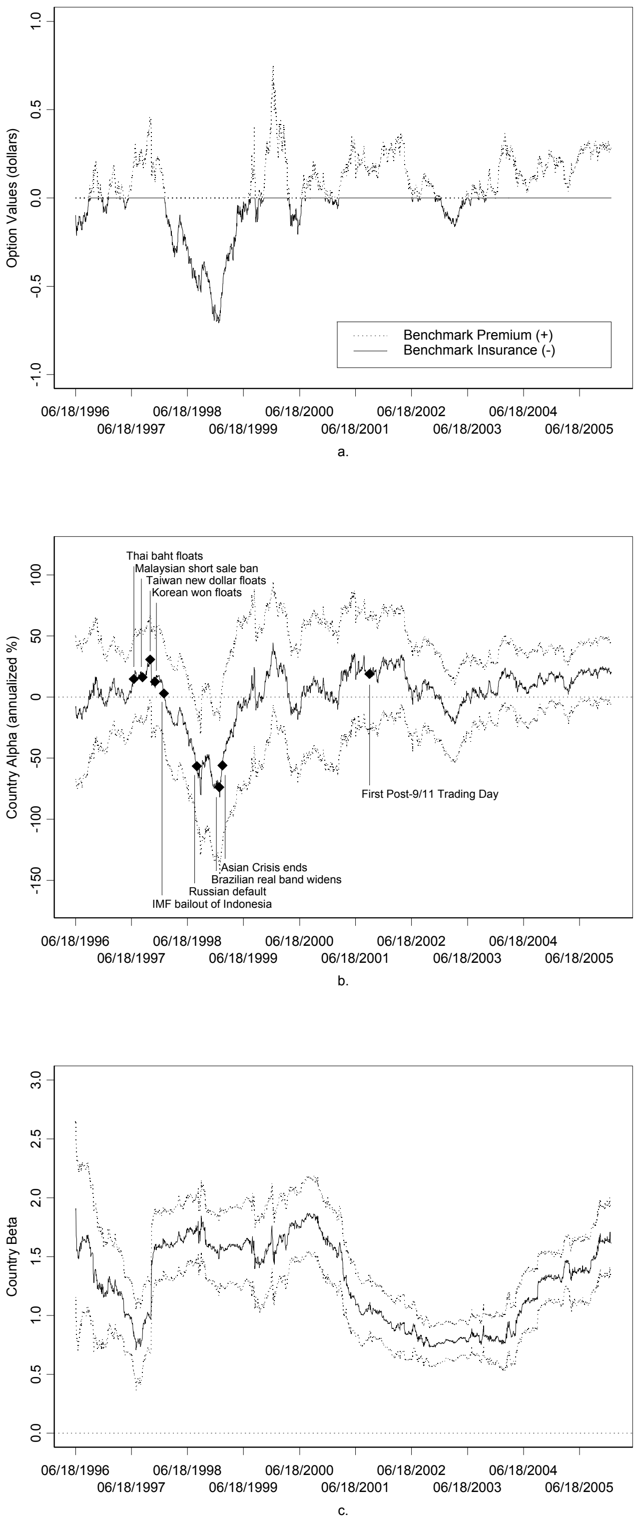


Figure 16. Mexico: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

Figure 1. Korea: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 2. China: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 3. Malaysia: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 4. Philippines: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 5. Taiwan: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 6. Indonesia: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 7. Thailand: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 8. India: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 9. South Africa: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 10. Turkey: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 11. Czech Republic: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 12. Poland: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 13. Argentina: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 14. Brazil: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 15. Chile: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta
Figure 16. Mexico: Panel a. Value of Entering and Exiting a Country, Panel b. Country Alpha, Panel c. Country Beta

Table 1. Newsworthy Events During Recent Financial Crises

Dates	Event
Asian Crisis	
July 2, 1997	Thai baht floats, Philippine peso and Malaysian ringitt peg collapse shortly thereafter, and the Indonesia rupiah band is widened
August 28, 1997	Short-selling restrictions imposed in Malaysia
October 17, 1997	The Taiwanese new dollar floats
November 17, 1997	The South Korean won floats
January 15, 1998	The IMF standby agreement with Indonesia is implemented; major banks roll-over Korean government debts the next day
May 21, 1998	Indonesian President Suharto resigns after riots and civil unrest
August 17, 1998	The Russian Ministry of Finance effectively defaults on its debt
September 1, 1998	Capital controls implemented in Malaysia
January 13, 1999	Brazilian central banker resigns in response to pressure to abandon the real peg
February 1, 1999	Asian Crisis ends
Turkish Crisis	
November 17, 2000	Banking corruption scandal in Turkey uncovered; Turkish financial crisis breaks out over the next month and the currency is floated in February resulting in a significant depreciation
February 21, 2001	Turkish lira crashes
Argentinean Crisis	
March 23, 2001	Second Finance Minister resigns in just over two weeks
November 30, 2001	Government restructures debt, and bank runs begin the next day