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Investors' Risk Appetite and Global Financial Market Conditions

Brenda González-Hermosillo

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Prepared by Brenda González-Hermosillo[1]

Authorized for distribution by Laura Kodres

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Abstract

A structural vector autoregression model is developed to analyze the dynamics of bond spreads among a sample of mature and developing countries during periods of financial stress in the last decade. The model identifies and quantifies the contribution on bond spreads from global market conditions (including funding liquidity, market liquidity, as well as credit and volatility risks), contagion effects, and idiosyncratic factors. While idiosyncratic factors explain a large amount of the changes in bond spreads over the sample, global market risk factors are fundamental driving forces during periods of stress. The relative importance of the different risk factors changes substantially depending on the crisis episode. Contagion from emerging markets becomes small or non-existent when global financial market risks explicitly are taken into account.

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Author's E-Mail Address: bgonzalez@imf.org

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> "When U.S. stocks are volatile, EMBI spreads widen. They narrow again when U.S. stocks calm down. That suggests that emerging market debt is not being driven by judgments of governments' creditworthiness."
>
> *Financial Times*, 10/26/07 (p. 15).

I. Introduction

The typical assumption is that spreads on sovereign bonds reflect the default risk of that country, which in turn are determined by its economic fundamentals. However, fundamentals do not change from one day to the other, unless new information is revealed periodically affecting the expectations about the underlying drivers of that particular economy. Yet spreads on sovereign bonds vary constantly, sometimes substantially over very short intervals of time. As quoted above by a leading international financial newspaper, observers have noticed that bond spreads generally tend to move with changes in global financial conditions, such as volatility in equity markets.

One observed regularity is that bond spreads tend to widen in a country facing financial stress, as investors price higher a risk in that country. But during periods of financial stress, spreads sometimes widen not only in the source crisis country but also across other countries that appear to be unrelated. Indeed, shocks can transmit rapidly across global financial markets. One possible channel is that conditions in global financial markets affect international investors' risk appetite, and changes in the latter may actually spread the original shock across global financial markets. Through this mechanism, seemingly unrelated asset markets across national boundaries may actually be affected by an otherwise unrelated shock.

As evidenced by the U.S. subprime mortgage and liquidity crisis that began in mid-2007, financial crises are not simply events from the past—although it has been several years since global financial markets experienced such a pervasive shock—and are not confined to emerging markets. This recent crisis was characterized by a drying up of liquidity across financial markets which was sparked by difficulties in the U.S. subprime mortgage market (see International Monetary Fund (2007)). Empirical analyses of this recent episode of global financial crisis are still scant, particularly in the context of other historical crises. A recent analysis on the U.S. subprime and liquidity crisis in mid-2007 is Dungey, Fry, González-Hermosillo, Martin and Tang (2007b), which found that the most acute episodes of global contagion across markets and countries in the past decade have been the Russia/LTCM crisis in 1998 and the U.S. subprime and liquidity squeeze in mid-2007. In both of these cases, the channel of contagion is primarily from credit markets to equity markets. They also find that there was contagion from U.S. credit markets to Russian and Argentinean credit markets, both of which had their central banks inject emergency liquidity during the U.S. subprime and liquidity crisis.[2]

[2] *Financial Times* (9/26/07) and *Fitch Ratings* (10/18/07).

There is a rich literature on financial contagion, which has tried to identify the channels through which shocks in one country transmit to financial markets in other countries (see Dornbusch, Park and Claessens (2000); Pericoli and Sbracia (2003) and Dungey, Fry, González-Hermosillo and Martin (2005), for surveys of this literature). The theoretical determinants of contagion are discussed in Kodres and Pritzker (2002). While most of the empirical literature on contagion has focused on emerging markets, a few exceptions have analyzed emerging markets and mature economies jointly for clues as to how shocks transmit globally during periods of financial stress, usually across the same asset market class (Kaminsky and Reinhart (2003); and Dungey, Fry, González-Hermosillo and Martin (2006) and (2007a)). Analyses of spillover and contagion effects across emerging markets and mature economies, as well as across different asset market classes are even less common (one exception is Dungey, Fry, González-Hermosillo, Martin and Tang (2007b)).

There may be several mechanisms for contagion whereby channels are established only during periods of stress that are over and above the market fundamental mechanisms, that link countries and asset markets during noncrisis periods. One such mechanism may be the presence of common international investors who react to a given shock by rebalancing their portfolios globally in assets and markets that would be otherwise seemingly unrelated. As investors become less willing to assume risk, they require a higher compensation for bearing such risk. This re-pricing of risk can effect the prices of other risky assets (Kumar and Persaud (2002)).

Observers often refer to this mechanism as investors' increased risk aversion or reduced risk appetite. However, these two concepts are conceptually different.[3] Risk aversion measures the subjective attitude of investors with regard to uncertainty. Since the degree of investors' risk aversion reflects entrenched preferences, it is usually assumed to be constant in asset pricing models. In contrast, the notion of investors' risk appetite is more broad as it is also influenced by the amount of uncertainty about the fundamental factors that drive asset prices. Thus, the risk premia embedded in asset prices are influenced by both risk aversion and the riskiness of the asset in question. One potential channel for shifts in investors' risk appetite is changes in global financial market conditions, a venue which is investigated empirically in this paper. Gauging the degree of investors' risk appetite is relevant from a global financial stability perspective as past episodes of brisk changes in risk premia, variations in market liquidity, and sharp movements in asset prices have been often associated with changes in investors' risk appetite.

Work analyzing the role of risk appetite as a transmission channel of financial crises include Kumar and Persaud (2002), Gai and Vause (2005), Coudert and Gex (2007), and Dungey, Fry, González-Hermosillo and Martin (2003). The first two papers analyze the relative importance of contagion due to shifts in risk appetite; the third paper analyzes the predictive power of several risk appetite indices; and the last one identifies the global market channels

[3] In practice, it is clearly difficult to disentangle risk appetite from risk aversion. An increase in either one causes asset prices to decline and risk premia to increase. This issue is examined in Bliss and Panigirtzoglou (2004).

of financial crises.[4] There is also a wide literature on the determinants of emerging market spreads. For example, Kashiwase and Kodres (2005) estimate a panel data model in which emerging market spreads are a function of liquidity risk and fundamental factors.

This paper quantifies the relative importance of potential determinants of spreads for emerging markets' sovereign bonds and mature markets' corporate bonds from 1998 through 2007, encompassing several episodes of financial market distress. A vector autoregression model is constructed to capture the dynamics of global bond spreads as a function of global market conditions, idiosyncratic factors, and contagion effects. The identification of the factors is made through long-run restrictions, which permit quantifying the contribution of the various factors to the bond spreads during various periods of financial stress.

In particular, four different global market risk factors are assumed to reflect the degree of risk appetite of international investors. The first risk factor is the *funding liquidity* premium, proxied by monetary conditions. The second risk factor is *default risk*. The third factor is *market liquidity risk*, as investors prefer liquid instruments which can be transformed into other assets without a significant loss of value during times of stress. Market liquidity may be an especially important systemic factor during financial crises if a liquidity squeeze forces a generalized sale of assets, depressing their prices and resulting in additional default risks which may feed back into even more illiquidity. The final aggregate risk factor considered reflects *volatility*, as measured in equity markets and in future interest rate contracts. The four aggregate global market risk factors are used to explain daily movements in the sovereign bond spreads for thirteen emerging markets and the spreads in BBB investment grade corporate bonds for four mature markets from January 2, 1998 through August 9, 2007 (one day before the European Central Bank began a round of liquidity injections into the financial system, which was followed a few days later by the easing of monetary policy in other central banks, including the U.S. Federal Reserve). In addition, idiosyncratic and contagion effects from emerging markets are also estimated in the model.

The results suggest that, while idiosyncratic factors explain a significant amount of the changes in bond spreads over time, global financial market conditions are fundamental driving forces at times of crisis. The relative importance of the various global risk factors depends on the crisis episode. An important result of this paper is that, once global financial market factors are explicitly considered, contagion from emerging markets becomes very small or essentially not existent, suggesting that investors' risk appetite may be the key

[4] The approach in this paper is similar to Dungey, Fry, González-Hermosillo, and Martin (2003), with several important differences. First, the proxies for global market conditions in this paper are different and chosen to reflect, where possible, some of the newer instruments in financial markets. Second, the choice of countries is different and expanded, as they only examine emerging markets, while mature markets are also introduced here as part of a more global framework. As highlighted during the 2007 subprime mortgage meltdown and liquidity squeeze, global financial crises can also originate in mature markets. Third, this paper covers a longer period, January 1998 to August 2007, with a larger number of episodes of financial stress including the recent turbulence sparked by the U.S. subprime mortgage crisis. In contrast, in Dungey, Fry, González-Hermosillo, and Martin (2003), only nine emerging markets' sovereign spreads are examined during three crises episodes (the Russian default (1998), the LTCM bail-out (1998), and the Brazilian devaluation (1999)).

channel of transmission of shocks across national boundaries and market classes, especially in increasingly integrated global financial markets.

The paper proceeds as follows: Section II discusses the conceptual basis of risk appetite. Section III surveys the variables which have been used in the empirical literature and by practitioners to proxy investors' risk appetite, and discusses the actual variables used in this paper. Section IV discusses the identification and estimation strategy. Section V examines the unconditional variance decomposition. Section VI discusses the spread decomposition and the empirical results. Section VII concludes and offers suggestions for future research. Appendix I details the crises dates. Appendix II contains an explanation of the Data Sources, as well as the Tables and Figures.

II. The Concept of Risk Appetite

The investors' degree of risk aversion reflects underlying preferences and, as such, it is expected to change infrequently over time. In contrast, risk appetite is likely to change more often as investors respond to changing levels of uncertainty in the macroeconomic environment. Thus, risk appetite depends on the subjective degree to which investors are willing to bear uncertainty *and* on the overall level of uncertainty about the fundamental factors which drive asset prices.

The standard treatment of asset pricing theory (e.g., Cochrane (2001) and also discussed in Gai and Vause (2005)) states that in an efficient market, with fully rational and informed investors, the current price of an asset, p_t, should equal the expected discounted value of its possible future payoffs, x_{t+1}. These payoffs comprise income (such as dividend payments) received over the long-run horizon, plus the ongoing value of the asset as implied by its future price. More formally,

$$p_t = E_t\left(m_{t+1} \cdot x_{t+1}\right) \tag{1}$$

where x_{t+1} denotes the payoff in period t+1, and m_{t+1} denotes the discount factor—the marginal rate at which the investor is willing to substitute consumption at time $t + 1$ for consumption at time t. Both x_{t+1} and m_{t+1} vary across states of the world. Indeed, m_{t+1} is usually referred to as the *stochastic* discount factor.

The basic asset pricing equation can also be expressed in terms of gross returns, R_{t+1}, by dividing equation (1) by current prices. Thus,

$$1 = E_t\left(m_{t+1} \cdot R_{t+1}\right) \tag{2}$$

Although, in general, different assets have different expected returns, all assets have the same expected *discounted* return in equilibrium (of unity). Since both the gross return and the stochastic discount factor are random variables, equation (2) can be written as

$$1 = \underbrace{E_t\left(m_{t+1}\right)\cdot E_t\left(R_{t+1}\right)}_{\text{risk-neutral component}} + \underbrace{cov_t\left(m_{t+1}, R_{t+1}\right)}_{\text{risk adjustment}} \tag{3}$$

The first term on the right-hand side of equation (3) reflects the mean return required by investors to hold the asset *if* they were indifferent to risk, the risk-neutral component. The second term is a risk adjustment required by risk-averse investors. Given that the gross risk-free rate can be denoted as $R_{t+1}^f = 1/E_t m_{t+1}$, we can rearrange (3) to obtain the familiar expression

$$\underbrace{E_t\left(R_{t+1}\right) - R_{t+1}^f}_{\text{risk premium}} = -R_{t+1}^f cov_t\left(m_{t+1}, R_{t+1}\right) \tag{4}$$

Equation (4) states that the expected return of a risky asset in excess of that available on a risk-free asset is proportional to *minus* the covariance of its state-contingent rate of return and the stochastic discount factor.

The risk premium can, in turn, be decomposed into the quantity of risk, β_i, inherent in each asset and the unit price of risk that is common across assets, λ_t. In particular,

$$E_t\left(R_{t+1}\right) - R_{t+1}^f = \underbrace{\frac{-cov_t\left(m_{t+1}, R_{t+1}\right)}{var\left(m_{t+1}\right)}}_{\beta_i}\cdot\underbrace{var\left(m_{t+1}\right)\cdot R_{t+1}^f}_{\lambda_t} \tag{5}$$

The price of risk, λ_t, is the expected excess return that, in equilibrium, investors require to hold each unit of risk. *Risk appetite*—the willingness of investors to bear risk—can therefore be defined as the inverse of the price of risk. So when an investor's risk appetite falls, they require larger expected excess returns to hold risky assets.

It is apparent from equation (5) that risk appetite reflects variation in the stochastic discount factor, $var(m_{t+1})$. Since the stochastic discount factor specifies the marginal rate at which the investor is willing to substitute uncertain future consumption for present consumption, risk appetite depends on the *degree* to which investors dislike uncertainty about their future consumption and on factors that determine the overall *level* of uncertainty surrounding consumption prospects. The degree to which investors dislike uncertainty corresponds to *risk aversion*. Accordingly, risk aversion reflects innate preferences over uncertain future consumption prospects—the curvature of individuals' utility functions—that are unlikely to vary significantly over time.

The factors underpinning risk appetite can also be examined by imposing some structure on the stochastic discount factor. For example, if consumption growth is log-normally distributed with variance, $\sigma_t^2\left(c_{t+1}\right)$, and investors have power utility functions, then the price of risk is

$$\lambda_t = \gamma\sigma_t^2\left(c_{t+1}\right) \tag{6}$$

where γ is the coefficient of absolute risk aversion.[5] So a rise in γ would mean a fall in risk appetite. But risk appetite will also fall if the uncertainty about future consumption growth (the expected volatility of future consumption) is amplified. The expected volatility of future consumption may depend on factors such as unemployment prospects, the stance of macroeconomic policy, global prospects and, more generally, global financial market conditions. In general, one would expect that the periodic shifts in market sentiment witnessed over time are more likely to be driven by the macroeconomic environment rather than by changes in the risk aversion of investors.

III. Variables in the Empirical Model

Investors' risk appetite is, nevertheless, not directly observable. Yet, risk appetite is frequently cited as a factor explaining asset price movements and several indicators are typically used by market participants to measure it. These measures are often amalgamations of an array of different market-based indicators which are aggregated to produce a single index of "risk appetite." Box 1 details some of the key market-based indicators typically used to gauge investors' risk appetite.[6]

This plethora of market-based indicators are used routinely by market participants.[7] However, they are less than ideal for analytical purposes as they essentially add up all the potential risk factors into a mix that creates an index of risk appetite. In addition, they do not generally examine potential linkages among the different risk components.

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[5] This is a standard result in asset pricing. See Cochrane (2001) for a detailed exposition.

[6] The group of indicators summarized in Box 1 include: CBOE's Volatility Index (VIX); JP Morgan's Risk Tolerance indices −one global (JPM G-10 RTI) and another one for emerging markets (JPM EM RTI); UBS FX Risk Index (UBS FX); Westpac's Risk Appetite Index (WP); Bank of America's Risk Appetite Monitor (RAM); Merrill Lynch's Risk Aversion Indicator (ML RAI); Dresdner Kleinwort's Aggregate Risk Perception Index (ARPI); and Lehman Brothers' Market Risk Sentiment Index (MARS).

[7] In addition to market-based indicators, another strand of the literature has examined financial CAPM−type models in a single financial market. These include the Goldman Sachs Risk Aversion Index and the Credit Suisse Global Risk Appetite Index. They are not considered here because they tend to rely on macroeconomic data only available in monthly or quarterly data frequencies, whereas the approach in this paper is to focus on financial market high frequency data. For a survey of these indicators, see European Central Bank (2007).

Box 1. Survey of Market-Based Indicators of Risk Appetite

Index	Components	Method
VIX	• Implied volatility of S&P500 Index	Based on a weighted average of the implied volatility from eight calls and puts on the index.
JPM G-10 RTI	• US swap spread (liquidity risk) • VIX (equity market risk) • EMBI+ (credit risk in emerging markets) • Trade-weighted Swiss franc (risk appetite in currency markets)	Constructed as an equally weighted average after having standardized the four components.
JPM EM RTI	• VIX • EMBI+	A weighted average after standardizing the two components (weights: 30% VIX, 70% EMBI+).
UBS FX	• US Treasury relative to the U.S. stocks • Three-month foreign exchange option implied volatility (USD/JPY and EUR/USD) • Gold in EUR and USD • VIX • EMBI+ • US Treasury spread • Differences in stock returns between the S&P financials and utilities • High-yield corporate spreads relative to the US Treasury	An arithmetic average of the normalized values of market variables.
WP	• An average of the three-month implied volatility for six major currencies • VIX index • US ten-year bond-swap spread • JP Morgan emerging markets bond spread • US BB1 industrial bond spread	A 60-day z-score[1)] of a base index calculated in three steps: the first step calculates the daily percentage change of each variable, then the figures obtained are averaged, and finally the index values are indexed to 100 on 1 January 1998.
RAM	• EMBI spread • Carry AUD/JPY • Corporate bond spread BB • Carry EUR/CHF • Spread MSCI EM Lccy	The correlation (over a rolling six-week period) among a large sample of emerging economies for each of the three asset classes, multiplying them by a market direction measure (in order to distinguish between bullish or bearish periods). Finally, the correlation coefficients are aggregated with an equally weighted average.
ML RAI	• US high-yield spreads (US higher yield spread over Treasuries, expressed as % yield) • VIX implied volatility • TED spreads (three-month euro-dollar deposits minus three-month T-bills) • US ten-year swap spreads, emerging market bond spreads (ML USD Emerging Markets Sovereign 'Plus' Index yield) • The trade-weighted Swiss franc, and emerging market equities (USD) • US small cap stock	For each item, this takes the standard deviations from 52-week moving averages. Then it sums the standard deviations of US high-yield spreads, VIX implied volatility, TED spreads, US ten-year swap spreads, emerging market bond spreads and the trade-weighted Swiss franc, while it subtracts those of EM equities and US small cap stock.
ARPI	Based on high-frequency data (mainly spreads and implied volatilities) from five asset classes: • Fixed income basket (global and political risk) • Equity basket (equity investment risk) • Liquidity basket (liquidity risk) • Commodity basket (energy risk) • Credit basket (credit risk)	Based on a two-step principal component analysis (PCA), firstly within the baskets, and secondly between the principal components of these baskets.
MARS	• Market volatility (one-year FX implied volatility and equity implied volatility) • EM event risk (EM CDS spreads and EM equities) • Market liquidity (G3 swap spread) • Risk appetite ratios (equity to bond returns, gold price to gold equity returns, and US equity P/E ratio).	Built on a four-step process: input transformation a rank transformation of each risk input relative to its past 20 day values), data aggregation (a simple equally weighted average), transformation of the average rank into a score between 0 and 1, and finally a computation of the two-day moving average of the aggregate index.

1) The X-day z-score is defined as the value of a base index, net of its X-day mean, and divided by its X-day standard deviation.

Source: European Central Bank (2007)

Thus, for example, it is not clear how to examine analytically measures of risk appetite which throw into the mix sovereign bond spreads for emerging markets, movements in commodity prices, in equity prices, in fixed income markets, and in exchange rate markets, in addition to measures of volatility and liquidity and other market data. The approach adopted in this paper is more fundamental, based on a few representative variables that are viewed to reflect the key risk factors in global financial markets. In particular, the model includes sovereign bond spreads in representative emerging markets and roughly comparable investment grade BBB corporate bonds in mature economies, several risk premia in global financial markets that are assumed to represent the compensation that international investors demand to accept risk, idiosyncratic factors proxying for "fundamentals," and any additional contagion effects from emerging markets.

Given that the price and the quantity of risk that investors are willing to assume are not distinguishable from each other in the data, the observed risk premium demanded by investors is assumed to reflect their risk appetite. The overall risk premium in global financial markets, itself also not directly observable in one single indicator, is assumed to have several key components: a funding liquidity premium, a credit risk premium, a market liquidity premium and a market volatility premium.[8] In addition to these aggregate global factors, bond spreads can be also influenced by fundamental factors which are idiosyncratic and, potentially, by additional sources of contagion from emerging markets which are not already captured by the global financial market conditions that are assumed to condition investors' risk appetite.

Economic fundamentals are modeled rather simplistically in this paper; essentially, as everything else that is not encompassed by the aggregate market factors or by the additional sources of contagion, discussed in more detail below, emanating from emerging markets. This trade-off is accepted because the objective is to analyze the role of changes in global market conditions based on high frequency data, whereas measures of economic fundamental drivers rely on monthly or quarterly data. Indeed, the objective of this paper is to determine the relative importance of aggregate risk factors during periods of financial stress, rather than to provide a model that best fits bond spreads. Moreover, because bond spread across countries tend to be more strongly correlated during periods of stress (Dungey, Fry, González-Hermosillo, and Martin (2005)) than during tranquil periods, common factors are likely to be particularly important during periods of stress.[9]

[8] There is no theoretical model for the global transmission of shocks to guide the choice of the appropriate "global" variables for this paper. However, the actual selection of variables is based on the analysis of the financial position of a representative banking firm in González-Hermosillo and Li (2008, forthcoming) where market, liquidity, and credit risks are viewed as fundamental. In addition, volatility risk is essential in equity and derivatives markets, while funding liquidity is related to credit conditions and the level of the risk-free interest rate.

[9] Of course, the interpretation that idiosyncratic factors represent what is not explained by common global factors or other sources of contagion requires caution since its appropriateness depends on the quality of the proxies used to measure those risk factors.

Below follows a more detailed discussion of the data and the proxies used for the various components determining the risk premia required by global investors.

A. Bond Spreads

The data for bond spreads in emerging markets are based on JP Morgan's EMBI+ country-specific indices. These indices contain U.S. dollar-denominated Brady bonds, Eurobonds and other traded loans issued by sovereigns, rated Baa1/BBB+ or below, and which satisfy certain maturity and liquidity conditions.[10] The spreads are calculated as the difference between the yield on the instruments and the yield on U.S. Treasury bonds of similar maturity. The sovereign spreads include Brazil, Bulgaria, Colombia, Ecuador, Mexico, Panama, Peru, Philippines, Russia, South Africa, Turkey, Ukraine, and Venezuela. For mature markets, the representative bond spread is constructed as the difference between the yields on 10-year BBB-rated corporate bond indices and government bond indices of similar maturity and currency.[11] The mature markets analyzed are the United States, Canada, Japan, and the Eurozone.

B. Global Financial Market Conditions

The choice of variables that reflect global financial markets is constrained by the need to have a parsimonious set of variables that is still able to reflect "global" market conditions. They are discussed below.

Funding Liquidity Premium

The first aggregate market risk factor considered is the funding liquidity premium or a proxy to measure the amount of credit availability in the global financial system. Finding proxies to measure funding liquidity is particularly troublesome after 2004, as long-term interest rates have stayed relatively constant even as a number of central banks have increased short-term interest rates. In addition to traditional monetary aggregates like M1 and M2, more appropriate proxies for funding liquidity would need to also include measures of credit availability, fund flows, asset prices, and leverage (Warsh (2007)). In addition to the fact that it would be extremely difficult to construct proxies for those broad liquidity conditions, most of them would not exist on the daily frequency needed in this model.[12]

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[10] In particular, the instruments must have a maturity greater than two and a half years, meet certain liquidity conditions and have a minimum issue size of US$500 million.

[11] The corporate bond indices are computed by Bloomberg, whereas the government bond indices are computed by DataStream.

[12] It is difficult to get a satisfactory proxy for global liquidity funding conditions reflected in daily data, especially for recent years as financial innovation has led to extraordinary leverage in financial markets. Estimates based on monthly frequency of the data have included monetary aggregates plus foreign official reserve holdings (Rasmus and Stracca (2006)).

In this paper, the *3-month-ahead federal funds futures rate* is used as a measure of global funding liquidity or monetary conditions.[13] The federal funds rate is the instrument used by the U.S. Federal Reserve to affect monetary conditions. This rate can affect risk spreads through two channels. A decline in the federal funds rate implies a lower cost of borrowing and therefore an rising level of funding liquidity in the economy. In addition, it reduces the return from safer assets. Everything else constant, these two channels would be expected to result in international investors seeking higher returns in risky assets. In contrast, higher expected interest rates make borrowing more expensive and drains funding liquidity from the system, increasing the probability that creditors will face difficulties. In this paper, funding liquidity conditions are proxied by the implied federal funds rate in futures markets, rather than the actual federal funds rate, because the former captures the effects of anticipated changes in monetary policy at the time when they are anticipated, rather than when they actually take place. Another advantage of focusing on the 3-month ahead federal funds futures rate is that it implicitly captures a segment of the yield curve that is longer than the spot overnight federal funds rate, while also exhibiting more daily variation than the actual federal funds policy rate.

Credit risk Premium

Two different measures of aggregate credit or default risk are examined. The most direct one, because it prices in the cost of buying insurance against default, is credit default swaps. In particular, the *10-year Itraxx Europe Crossover index* is examined in this paper and it measures the cost of buying insurance against default by European firms whose ratings are between investment and speculative grade.[14] Because credit default swap indices only exist after 2004, we also need to rely on other proxies of credit risk that cover a longer period.

The proxy used to measure aggregate default risk over the longer sample is the *10-year USD swap spread* which is the difference between the 10-year swap rate and the 10-year U.S. Treasury bond ($s_{10,t} - i_{10,t}$).[15] [16] In a swap contract, one party agrees to pay a fixed interest rate in return for received an adjustable rate from another party. When an investor enters a swap agreement as a fixed receiver in a fixed-for-floating swap, the investor is promised to receive from the counterparty a series of semi-annual fixed payments in exchange for paying the

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[13] Kashiwase and Kodres (2005) also choose this proxy for funding liquidity.

[14] There are many Itraxx indices and derivatives on Itraxx. The Itraxx crossover Europe index was chosen because of its relative liquidity and the fact that the 35 companies on which it is based are closer substitutes to emerging market bonds than other higher-rated indices. A similar index exists for U.S. corporations (CDX), which moves similarly to Itraxx. Because most of the other "global" variables are largely U.S.-based, the choice of the Itraxx crossover Europe was thought to give the analysis a more global balance.

[15] Regarding the notation, the first subscript indicates the maturity of the instrument, while the second indicates the time period. Both the maturity and the period are denominated in years.

[16] A large universe of fixed-income securities, including corporate bonds and mortgage-backed securities, use interest rate swap spreads as a key benchmark for pricing and hedging.

counterparty a series of semi-annual floating payments. While the fixed payments are determined at the outset of the swap agreement, the floating payments are to be determined at later dates, based on the relevant maturity of the LIBOR rates prevailing at the beginning of each payment period.[17] The swap rate is the fixed payment on the notional amount. The swap rate examined here is based on contracts in which the variable rate is the 3-month LIBOR rate ($l_{1/4,t}$), and payments are made semi-annually. Ignoring liquidity premiums, the swap rate must be the expected average of future default-risky LIBOR rates.

$$s_{10,t} = E_t\left[\frac{l_{1/4,t} + l_{1/4,t+1/4} + \ldots + l_{1/4,t+10}}{40}\right] \tag{7}$$

Similarly, the 10-year US Treasury note must be the expected path of default-free 3-month Treasury bills.

$$i_{10,t} = E_t\left[\frac{i_{1/4,t} + i_{1/4,t+1/4} + \ldots + i_{1/4,t+10}}{40}\right] \tag{8}$$

The difference between the yield on a Treasury note and the LIBOR rate is a short-term default-risk premium (DR). Thus the 10-year swap spread is the expected average of future short-term default premiums, reflecting not only current but also expected future default risk.

$$s_{10,t} - i_{10,t} = E_t\left[\frac{DR_{1/4,t} + DR_{1/4,t+1/4} + \ldots + DR_{1/4,t+10}}{40}\right] \tag{9}$$

The empirical literature on swap spreads has found that they also contain a liquidity premium. However, the liquidity premium component of swap spreads appears to be much more persistent than the default premium component (Liu, Longstaff, and Mandell (2006)), so most of the variation in swap spreads is expected to be caused by variations in default risk.[18] A proxy for movements in the market liquidity premium is discussed below.

Market Liquidity Premium

The measure of market liquidity premium examined here is the *difference between the yield on the 20-year U.S. Treasury bond and the yield on the 10-year U.S. Treasury note*. Since

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[17] The LIBOR rate is the rate at which banks lend to each other and it is recorded by the British Banking Association (BBA) each day at 11 a.m. London time. The composite rate is calculated based on quotes provided by a basket of reference banks selected by the BBA.

[18] It is worth noting that another potential candidate to measure credit risk could have been the TED spread, or the difference between the 3-month U.S. dollar LIBOR and the yield on the 3-month U.S. Treasury bill. This spread behaves similarly to the 10-year USD swap spread discussed above, except that it captures only short-term movements and it is particularly difficult to separate the component originating from credit risk vs. that related to market liquidity.

these two bonds are default-free, their yield is simply the expected average of future yields on Treasury bills plus a liquidity premium. Their difference must then be equal to:

$$i_{20,t} - i_{10,t} = E_t\left[\frac{i_{1,t+10} + ... + i_{1,t+20}}{10}\right] + LP_{20,t} - LP_{10,t} \tag{10}$$

It is reasonable to assume that the first term of the RHS is fairly constant because of the long horizon of the interest rates at these maturities, given the current information (i.e., the expected U.S. Treasury bond rates for 10-year and 20-year maturities are approximately the same in practice). Thus, movements in this spread will be largely driven by movements in liquidity premiums (LP). In particular, 10-year U.S. Treasury notes are usually used as a benchmark in the pricing of other financial assets and therefore are more liquid than 20-year bonds. In fact, yields on 20-year U.S. Treasury bonds have been some times been above those on 30-year U.S. Treasury bonds (which is also fairly liquid), which could be hardly explained if not by the relative illiquidity of 20-year bonds over other more liquid benchmark maturities.[19] [20]

Market Volatility Premium

The measure of market volatility used in this analysis is the *Chicago Board of Options Exchange (CBOE) Volatility Index*, known as VIX. It measures the implied volatility from option prices on the S&P 500 equity index.[21]

Another measure examined that also captures volatility risk is the uncertainty about the future path of interest rates. This is proxied by the *implied interest-rate volatility from swaptions* with maturities between one and six months.[22]

[19] For example, during the LTCM crisis in the fall of 1998, spreads between the 30- year U.S. Treasury bond and the 29-year U.S. Treasury bond were unusually large, signaling market liquidity pressures (Committee on the Global Financial System (1999)). Yields on the 30-year U.S. Treasury bond are not used here because this maturity was discontinued for several years during the period examined.

[20] Another commonly used measure of liquidity is the difference between the yields of “on-the-run” and “off-the-run” U.S. Treasury bonds. However, this measure has the disadvantage that it exhibits important variations caused directly by the timing of the auctions, and therefore it is not examined.

[21] This volatility index is largely U.S.-based, but it is widely used to measure global market volatility. One disadvantage of using this index is that it is based on an average of a few observations that are out-of-the-money (the so-called “volatility smile”), rather than using all of the possible volatility and out-of-the-money strike price combinations. The problem with the way in which this index is calculated is that it does not take into account changes in the shape of the volatility smile that lead to a different curvature or a shift in the curve. There are other volatility indices, including the VDAX for the German stock market and various volatility indices for foreign exchange contracts. However, VIX was chosen because of its common use as representative of “global” volatility.

[22] A swaption is an option to enter into a swap contract.

C. Contagion Effects

As discussed earlier, the empirical literature has identified contagious effects during some of the recent crises (surveyed in Dornbusch, Park, and Claessens (2000); Pericoli and Sbracia (2003); and Dungey, Fry, González-Hermosillo, and Martin (2005)). This literature identifies the transmission mechanisms that propagate shocks from the source country across national borders and across financial markets, where channels over and above the market fundamental mechanisms that link countries and asset markets during noncrisis periods appear only during a crisis. In particular, an increase in a country's spread can lead to extraordinary increases in the spreads of other countries. This transmission can happen through different channels. For example, a deterioration in the fundamentals of a particular country, or a certain shock (e.g., a terrorist attack, a natural disaster, etc.), can cause a generalized increase in the investors' degree of risk aversion, requiring higher spreads in markets all across the globe. This is an increase in the price of risk, and should be captured by the aggregate risk variables discussed earlier.

But spreads can also increase for other reasons. The discovery of bad news about one country may cause investors to revise their expectations about the fundamentals of other specific countries which share similar features (i.e., not a generalized effect across the globe, as in the case of a decline in risk appetite). This other channel works through an increase in the (perceived) quantity of idiosyncratic risk.

In order to measure the contagion effects from emerging markets to a particular country, it is not practical to include spreads in other countries or an aggregate index of emerging market spreads directly into the model because this would induce multicollinearity. Instead, as a proxy for this country-specific contagion effect, for each country we construct the *difference between the spread in the composite (aggregated) EMBI+ index for all emerging markets and the bond spread of the country in question*. This variable is meant to measure how a particular bond spread is affected by the *relative* performance of bonds spreads in other similar countries.

IV. Identification And Estimation

The variables in the model can be expressed as the following expression:

$$Z_{it} = \left\{ FF_t, DR_t, ML_t, MV_t, IV_t, \log\left(Spread_{EMBI+,t} / Spread_{it} \right), \log\left(Spread_{it,} \right) \right\} \tag{11}$$

where i indicates a particular bond spread, FF stands for the funding liquidity (or monetary conditions) proxy, DR stands for default risk, ML stands for market liquidity, MV stands for market volatility, and IV for interest-rate volatility.

The dynamics of each of the variables is captured by estimating a vector autoregression (VAR) model in which all seven variables are endogenous. This implies that there is immediate feedback among all variables in the short-run. The structural innovations are identified by imposing restrictions on the long-run effects of the variables, as in Blanchard and Quah (1989). In particular, it is assumed that in the long-run: (i) bond spreads have no permanent effect on funding liquidity or on any other aggregate global market risk factor; (ii) feedback effects among default risk, market liquidity risk, and market and interest rate volatility risks are temporary;[23] and (iii) the contagion effects from emerging markets are temporary.

The aggregate global market factors and bond spreads follow the following stationary process

$$\Delta Z_t = \chi + \sum_{j=0}^{\infty} C(j) e_{t-j} \qquad (12)$$
$$e \sim N(0, I)$$

where ΔZ_t is the vector of variables in first differences, e_t is the vector of structural innovations, and I is the identity matrix.

In order to estimate the innovations, the following reduced-form VAR(p) is first estimated:

$$\sum_{j=0}^{p} A(j) \Delta Z_{t-j} = \alpha + v_t \qquad (13)$$
$$A(0) = I$$
$$v \sim N(0, \Omega)$$

We can invert (13) to obtain its moving-average representation

$$\Delta Z = \chi + \sum_{j=0}^{\infty} B(j) v_{t-j} \qquad (14)$$

where $\sum_{j=0}^{\infty} B(j) = \left(\sum_{j=0}^{p} A(j)\right)^{-1}$ and $\chi = \sum_{j=0}^{\infty} B(j)\alpha$. Since $A(0) = I$, $B(0) = I$, it follows that $v_t = C(0)e_t$. Therefore, identification of $C(0)$ allows us to recover the structural shocks from the residuals of the estimated VAR. In order to identify $C(0)$ we first notice that $Var(v) = C(0)Var(e)C(0)'$, which implies

$$\Omega = C(0)C(0)' \qquad (15)$$

Second, since $C(j) = B(j)C(0)$, it follows that

$$\sum_{j=0}^{\infty} C(j) = \left(\sum_{j=0}^{\infty} B(j)\right) C(0) \qquad (16)$$

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[23] The long-term feedback effects of funding liquidity risk are not restricted *a priori* to be zero over the long-term. The intuition is that funding liquidity effects may be more permanent than the other global factors.

Some restrictions are imposed on the matrix of long-run multipliers, the LHS of (16), which is denoted by H. In particular, the identification restrictions discussed earlier imply that H must satisfy the following matrix:

$$H = \begin{bmatrix} h_{11} & h_{12} & h_{13} & h_{14} & h_{15} & 0 & 0 \\ h_{21} & h_{22} & 0 & 0 & 0 & 0 & 0 \\ h_{31} & 0 & h_{33} & 0 & 0 & 0 & 0 \\ h_{41} & 0 & 0 & h_{44} & 0 & 0 & 0 \\ h_{51} & 0 & 0 & 0 & h_{55} & 0 & 0 \\ h_{61} & h_{62} & h_{63} & h_{64} & h_{65} & h_{66} & h_{67} \\ h_{71} & h_{72} & h_{73} & h_{74} & h_{75} & 0 & h_{77} \end{bmatrix} \tag{17}$$

where h_{ik} is the long-run multiplier of an innovation to variable k on variable i. The order of the variables follows that in (11). Once we have $\hat{C}(0)$, we can construct estimates of e_t as $\hat{e}_t = \hat{C}(0)^{-1}\hat{v}_t$.

The reduced-form VAR in equation (13) is estimated by ordinary least squares. We use 5 lags, as suggested by the AIC criteria. Then the estimated coefficients $\hat{A}(j)$ and the residuals $\hat{v}_t$ are used to estimate $C(0)$ and H using the identifying restrictions (15) and (17). Since the model is over-identified, we estimate the parameters in $C(0)$ through maximum likelihood. The log-likelihood function is given by:

$$\ln L = -\sum_{t=1}^{T}\left(\frac{N}{2}\ln\left(2\pi\right) + \frac{1}{2}\ln\left|\Omega\right| + \frac{1}{2}v_t{}'\Omega^{-1}v_t\right) \tag{18}$$

The model is estimated using two different samples. The first sample covers the period between January 2, 1998 and August 9, 2007.[24] The bond spreads analyzed are sovereign spreads from Brazil, Bulgaria, Ecuador, Mexico, Panama, Peru, Russia, and Venezuela, and the corporate spreads are from the United States and Canada. The proxy used for default risk is the 10-year USD swap spread.

The second sample starts in mid-September 2004. Here, we are able to use newer financial instruments that did not exist before (a credit default swap index) to gauge default risk directly. In addition, we are able to analyze a larger number of developing countries and mature markets. The additional sovereign bond spreads correspond to Colombia, the

[24] The sample ends one day before the European Central Bank injected €95 billion into the financial system, marking the first policy intervention aimed at bringing to an end the U.S. subprime mortgage and liquidity crisis.

Philippines, South Africa, Turkey, and Ukraine. The additional corporate bond spreads in mature markets correspond to Japan and the Eurozone.

V. Forecast-Error Variance Decomposition

The analysis proceeds by decomposing the unconditional variance of the bond spreads. The *h*-step ahead forecast error of ΔZ_t is

$$\Delta Z_{t+h} - E_t\left(\Delta Z_{t+h}\right) = \sum_{j=0}^{h-1} C(j) e_{t+h-j} \tag{19}$$

Given the independence of the innovations, the *h*-step ahead forecast error variance of ΔZ_t is

$$\text{var}_t\left(\Delta Z_{t+h}\right) = \sum_0^{h-1} C(j)C(j)' \tag{20}$$

We can obtain the variance due to a particular innovation *k* as

$$\text{var}_{k,t}\left(\Delta Z_{t+h}\right) = \sum_0^{h-1} C(j) I_k C(j)' \tag{21}$$

where I_k is a matrix with 1 in its (k,k) cell and zeros elsewhere. Taking the limit of these expressions we can compute the unconditional variance decomposition. The results are presented in Tables 2 and 14.

The results suggest that, overall, the aggregate global market factors account for a relatively small fraction of the total variance over the 1998–2007 period (Table 2). The extent ranges from only 8 percent in the United States, up to a maximum of 27 percent in Mexico. Contagion from emerging markets is generally very small (accounting for a maximum of 12 percent in the case of Bulgaria).

For the 2004–2007 sample (Table 14), aggregate global market factors explain a more significant fraction of the variance for some of the emerging markets, accounting for around 50 percent for Brazil, Colombia, Mexico, and the Philippines. However, aggregate market factors during this period explain a smaller fraction for some of the other bond spreads, with the smallest contribution being in the case of mature markets (7 percent for Japan, and approximately 15 percent for the United States and the Eurozone). Contagion effects from emerging markets are very small (accounting for less than 4 percent of the variance).

These results suggest that idiosyncratic factors are generally the main drivers of bond spread changes over extended periods of time. We now turn to examining these trends, but for shorter periods known to have been distressful.

VI. Spread Decomposition

For each period of financial stress (Appendix I details each period), the spreads are further decomposed into a benchmark spread, equal to the conditional expectation of the spreads during the period given information available before the start of the period, and the contributions of the structural innovations to the spreads during the period of stress. The purpose of this exercise is to examine how the different aggregate global market factors contribute to the bond spreads, relative to what they would have been if the crisis had not taken place.

Let T denote the first date of a crisis period. The change in the benchmark spread at date $T+h$, given the pre-crisis information is

$$E_{T-1}\left[\Delta Z_{T+h}\right] = \chi + \sum_{i=h+1}^{\infty} C(i) e_{T-2+h-i} \tag{22}$$

We can then decompose the changes in spreads into their pre-crisis conditional expectation and their forecast error, which is given by

$$\Delta Z_{T+h} - E_{T-1}\left[\Delta Z_{T+h}\right] = \sum_{i=0}^{h} C(i) e_{T+h-i} \tag{23}$$

The contribution of error k to the total forecast error is

$$\sum_{i=0}^{h} I_k C(i) e_{T+h-i} \tag{24}$$

Because some crises are preceded by a period which may already show a certain degree of financial stress, in most cases we compute conditional expectations using information up to several days or weeks before the start of the crisis.

A. Empirical Results: Mean Spread Decomposition

The results are presented in the tables containing the mean spread decompositions (Tables 3-13 examine the 1998–2007 period, and Tables 15–18 the 2004–2007 period). The first three columns in these tables show the mean actual spread during the crisis episode, the mean benchmark spread during the same period,[25] and their difference or the mean forecast error. The columns that follow indicate the contribution of each factor innovation to the forecast error.[26] The cases examined comprise the main episodes of financial stress from 1998 to 2007. Some particular episodes were excluded from the empirical analysis if they had a relatively small impact on global financial markets, despite having an important repercussion domestically; some examples are Ecuador's currency collapse (1999–2000), Argentina's debt default (2001) and Iceland's financial crisis (2006). The episodes of

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[25] Recall that benchmark spreads are computed as the conditional expectation, given pre-crisis information.

[26] Note that while actual and benchmark spreads are presented in basis points, the forecast error is $\log\left(Spread_{it}\right) - E_{T-1}\left[\log\left(Spread_{it}\right)\right]$, and thus the contributions to the forecast error are presented in terms of the differences in the logarithms of basis points, or percentage point contribution.

financial stress examined include the Russian default and the subsequent near-collapse of Long-Term Capital Management (1998), the devaluation of the Brazilian currency (1999), the NASDAQ bubble burst (2000), the Turkish crisis (2001), the terrorist attacks on September 11 (2001), the Brazilian elections and the WorldCom accounting scandal (2002), the beginning of the tightening cycle of the Federal Funds rate (2004), the rating downgrades of Ford and General Motors (2005), the Turkish crisis (2006), the Chinese stock market correction (2007), and the U.S. subprime mortgages and liquidity crisis (2007). The specific dates used to define the episodes are described in Appendix I.

Russia's Default and the LTCM Crisis (1998)

In the first episode analyzed, the 1998 Russian default and the LTCM near-collapse are modeled jointly because of the proximity of the two events (Russia defaulted on August 17, and the Fed-orchestrated rescue plan of LTCM was publicly disclosed on September 23). The results in Table 3 suggest that the main aggregate global financial market factors behind the increase in the spreads of all the countries considered in the sample, relative to their conditional expectations or benchmarks, are funding liquidity (proxied by U.S. monetary policy expectations), market volatility and default risk, which together account for almost 40 percent of the forecast error for some of the emerging markets and 23 percent for Canada. Among the three global financial market factors, volatility risk is the most important (accounting for up to 18 percent of the forecast error). The contribution of contagion from emerging markets is negligible for all countries, while the contribution of idiosyncratic factors account for 58–85 percent of the forecast error.

Given that Brazil was the next country to experience a crisis in early January 1999, a few months after the Russian/LTCM crisis, it is interesting to examine the results during the August–October 1998 period but for the particular case of Brazil (Table 3). This is of particular interest because several empirical studies have found evidence of contagion from the Russian/LTCM crises to Brazil (Baig and Godfajn (2001), and Dungey, Fry, González-Hermosillo, and Martin (2006, 2007a)).[27] The results here suggest that global financial market conditions, proxying for investors' risk appetite, accounted for about 42 percent of the difference between the conditional expectation of Brazil's sovereign bond spread and its actual mean value. This difference represents 307 basis points, accounting for almost one-quarter of Brazil's 1,295 basis point actual mean spread against the equivalent U.S. Treasury bond during that period. The idiosyncratic component (the residual in this specification) accounted for another 431 basis points (58.5 percent of the forecast error). These results are consistent with the view that the contagion that was formerly found in previous studies may have been largely accounted for by the role of global investors' risk appetite. At the same time, it appears Brazil's fundamentals may have been reassessed, as captured by the significant size of the idiosyncratic component. Finally, contagion from emerging markets that is not already captured by global financial market conditions was negligible. However, it

[27] In particular, Dungey, Fry, González-Hermosillo, and Martin (2006) provide evidence that the Brazilian bond market was impacted by the Russian crisis, while the results in Dungey, Fry, González-Hermosillo, and Martin (2007a) suggest that Brazil's equity markets were affected by the near-collapse of LTCM.

is somewhat puzzling that the Brazilian results are not that different from other emerging markets, most of which did not have a full-blown crisis in the months that followed the Russian/LTCM crisis.

Brazil's Crisis (1999)

We now turn to examine the next crisis period marked by the devaluation of Brazil's Real on January 12, 1999 (Table 4). During this period, market volatility and funding liquidity are the main factors contributing to the forecast errors in emerging markets. Russia is unusual as the idiosyncratic contribution to the forecast error (the residual) is slightly negative, suggesting that the global market financial factors more than fully accounted for the forecast error. The effect from volatility risk, funding liquidity and default risk combined may have accounted for more than the 350 basis point forecast error in Russia. One interpretation is that the Russian and the Brazilian crises were so close in time that there were actually feedback effects from the latter to the former through a decline in investors' appetite for risk, reflected in the global financial market factors.

Another interesting observation during this period is that mature markets were essentially unaffected by global financial factors, as their benchmark spreads are close to the actual spreads. These results support the view that the Brazilian crisis did not importantly affect other markets, as the forecast errors are generally much smaller during this period, particularly in the case of mature economies. Once again, contagion from emerging markets (not already accounted for by the common global financial market factors) is negligible.

NASDAQ Bubble Burst (2000)

During the NASDAQ bubble burst in 2000, default and funding liquidity risks are the main factors explaining most of the forecast errors considered (Table 5). It is interesting that volatility risk became very small during this period, in contrast to the previous periods of stress considered. The forecast errors are generally small for all the countries considered, except for Ecuador which was still suffering from its own financial crisis.[28] Also noteworthy is the result pointing to a negative forecast error for Russia during this period, less than two years after facing its own crisis. The model suggests that the improvement in Russia's spreads during this period was not so much due to improved fundamentals (recall that in this model, the residual is treated as "fundamentals"), but largely resulting from an improved risk appetite for Russian assets (measured by the negative contributions to the forecast error coming from global market risk factors, despite some increased risk coming from interest volatility).

[28] Ecuador's economy experienced a contraction in real GDP of 7 percent, an inflation rate of 60 percent and a 67 percent depreciation of the Sucre in 1999. Ecuador adopted the U.S. dollar as the legal tender in January 2000. Amid political and economic uncertainty, Ecuador's Finance Minister resigned in May 24, 2000.

Turkey's crisis (2001)

During Turkey's crisis in 2001 (Table 6), all of the forecast errors become smaller as the benchmark conditional expectations are close to the actual spreads for most countries. Volatility is again an important risk factor and, indeed, all global market risk factors take increased importance during this period. In contrast, idiosyncratic factors often have the opposite effect, acting to reduce the spreads. The only exceptions are Bulgaria, Peru, and the United States.

September 11th (2001)

In the period following September 11 in 2001, the U.S. Federal Reserve and other central banks injected substantial amounts of liquidity into the financial system in anticipation of potential disruptions in global markets following the closing on the New York stock exchange after the attacks. This is reflected in a negative contribution to the premia coming from funding liquidity (Table 7). That, plus a reduction in the default risk helped to largely offset the increases in spreads caused by higher premia coming from market liquidity, market volatility and interest-rate volatility risks. All forecast errors are relatively modest. It is noteworthy that market volatility risk, in particular, surged during this period and became the single most important source of risk premia for all emerging markets. However, in the case of mature economies, the largest contributor to the spreads is due to market liquidity risk.

WorldCom Scandal and Brazil's Elections (2002)

The next period of turbulence examined is the WorldCom accounting scandal, which roughly coincided with a period of uncertainty in the run-up to Brazil's elections, during June-October 2002 (Table 8). During this period, Brazil's forecast error is quite large, at around 1,200 basis points (the actual spread is 1,904 basis points and the conditional expectation is 709 basis points). The forecast error is explained mostly by a large contribution of idiosyncratic factors, which is consistent with the fact that investors were nervous about the likely election of a seemingly "populist" Lula government.[29] The forecast errors during this period were also relatively large for other Latin American countries (especially Ecuador and Peru) which may have been influenced by the "Lula-effect." During this period, funding liquidity is the main contributor to the forecast errors, followed by volatility and market liquidity. This may reflect the expectation among market participants that the U.S. Federal Reserve was about to start a new tightening cycle, after an extended period of declines in policy interest rates since early-2000, and uncertainty as to exactly when the new cycle would begin. The results suggest that there were no other contagion effects coming from emerging markets that were not already captured through the international investors' risk appetite conduit.

[29] Lula was in fact elected on October 29, 2002, but his presidency turned out to quite pragmatic and less populist than had been anticipated by financial markets.

U.S. Federal Reserve Begins Tightening Cycle (2004)

Indeed, the U.S. Federal Reserve began to tighten monetary conditions on June 30, 2004 when it increased the federal funds policy rate by 25 basis points. However, the run-up to the tightening of monetary policy in the United States appeared to be a period of uncertainty amid jitters in global financial markets. This episode, marking expectations and uncertainty about the forthcoming tightening in U.S. monetary policy, is assumed to begin following the release of a strong payroll data (for March) on April 2, 2004. Against increasing speculation and uncertainty as to when monetary conditions might be tightened, and in light of a scheduled FOMC meeting, emerging markets experienced a generalized sell-off on May 3, 2004. This spike in spreads was short-lived, however, as spreads resumed their overall downward trend (which had started in the early part of the 2000s) after June 30, 2004 when the U.S. Federal Reserve actually increased its federal funds rate by 25 basis points for the first time in more than four years. This episode of uncertainty about the exact timing of the monetary policy tightening is, therefore, assumed to end on June 30, 2004 when the U.S. Federal Reserve announced the change in its policy stance.

Table 9 decomposes the period during the run-up to the U.S. Federal Reserve switching to a tightening stance. This period is characterized by relatively small forecast errors as the benchmark conditional expectations are close to the actual spreads (less than 200 basis points for all countries). Most of the forecast errors are attributed to funding liquidity risk, though with a much smaller contribution than in the previous episode of stress in 2002 (Table 8). Default risk also plays a role, but market liquidity and volatility risks are generally very small or even negative (acting to offset the increase in spreads). Idiosyncratic factors are fairly large in most cases (the exceptions being Venezuela and Bulgaria). Interest-rate uncertainty does not seem to be a very important factor. This is somewhat surprising, but it may be explained by the funding liquidity risk already capturing some of this uncertainty. Other contagion channels from emerging markets are, again, minuscule.

Ford and General Motors Downgrades (2004)

The Ford and General Motors downgrades in the spring of 2004 coincided with a general moderate (and temporary) increase in bond spreads (Figures 1–3). During this period, the forecast errors are modest (less than 110 basis points for emerging economies and below 12 basis points for mature economies) for all the countries considered (Tables 10 for the 1998–2007 period and Table 15 for the 2004–2007 period). However, the funding liquidity and the default risk channels seem to be quite important. Interest rate risk is relatively small, but larger than in any other previous period. Other channels of contagion from emerging markets are, once again, tiny. Idiosyncratic factors vary.[30]

[30] Idiosyncratic factors move from positive during the 1998–2007 sample to negative in the shorter 2004–2007 sample based on the actual cost of default insurance. Since the idiosyncratic factors in the specification are essentially the residuals, negative contributions suggest that the contributions of other risks may be overestimated. However, the forecast errors are fairly small in most of the specifications where idiosyncratic factors contribute negatively to the difference between the actual spread and the benchmark, which reduces the importance of negative idiosyncratic factors.

Turkey's Crisis (2006)

During Turkey's crisis in May-July of 2006, spreads in other emerging markets widened significantly, albeit resuming their downward trend by the second half of 2006 (Figures 1-3).[31] The forecast errors are relatively small (less than 62 percent for emerging markets, and less than 7 basis points for mature markets) for all countries other than Turkey. This episode is characterized by funding liquidity risks and, by a lesser amount, default risk and market volatility (Tables 11 and 16). Market liquidity and interest-rate risks are small or offsetting. The idiosyncratic components are important for all countries, except the United States. Other venues of contagion from emerging markets are minute or offsetting.

China's Shanghai Stock Exchange Correction (2007)

Although short-lived, China's Shanghai stock market went through a sizeable correction on February 27, 2007, dubbed in the international press as "black Tuesday." Emerging markets also experienced a (short-lived) melt-down. During this episode, the forecast errors are again fairly small: for emerging markets, less than 70 basis points in the 1998–2007 sample (Table 13) and less than 30 basis points in the 2004–2007 sample (Table 17). The forecast errors for mature economies are tiny (less than 3 basis points). In terms of the forecast error decomposition, the risks that explain the increase in risk spreads relatively to the benchmarks are: funding liquidity (which is especially large in the shorter sample), volatility, default risk, and interest rate risk. Market liquidity risks are fairly small.[32]

U.S. Subprime Mortgage Crisis (2007)

The final episode of stress in global financial markets examined in this paper is the U.S. subprime mortgage crisis and the subsequent liquidity squeeze in mid-2007. During this period, the forecast errors are relatively small (less than 70 basis points for emerging markets and less than 13 basis points for mature markets), but larger than in any previous episode of global financial stress since the Ford/GM downgrades in 2004 (Tables 13 and 18). All risk factors except market liquidity seem to have a significant contribution to the forecast errors. Contagion effects from emerging markets seem to have little effect on spreads during this period, which is not too surprising since this crisis was originated in mature economies. Idiosyncratic factors tend to be important in explaining the difference between benchmark and actual spreads. However, in a number of cases, idiosyncratic factors explain little, or even contribute negatively by offsetting the increase in spreads caused by aggregate global market factors.

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[31] The crisis in Turkey surfaced a few months after the March 2006 crisis in Iceland. However, the Icelandic episode is not analyzed explicitly in this paper because it appears that it did not have significant spillovers to other markets. It is interesting that the two crises were very close in time, suggesting that there might have been some spillovers from Iceland into Turkey—though the trigger for the problems in Turkey appear to have been largely driven by political factors.

[32] Canada is an exception, but its forecast error is zero or slightly negative.

The result is that market liquidity was generally an unimportant contributor to explain the difference between the benchmark and the actual spreads is somewhat surprising since market illiquid in certain segments of financial markets in mature economies was at the heart of the mid-2007 financial crisis.[33] However, this puzzle may be explained by the possibility that market illiquidity was only characteristic of certain asset market classes, some of which are not considered in this paper. The data in this study focuses on bond spreads for sovereigns in the case of emerging markets and BBB corporates for mature economies (see Table 1 for details). The pervasive illiquidity observed during the 2007 crisis was largely in short-term markets (e.g., asset-backed commercial paper) as banks hoarded liquid assets to cover for potential losses incurred by their special investment vehicles (SVI) and other conduits. These bank-related SVIs (which are off-balance sheet vehicles) held mortgages which had been distributed after having been originated by banks. The SVIs and conduits funded themselves by issuing asset-backed commercial paper (ABCP), which investors decided not to roll-over when the subprime mortgage crisis was exposed.

Thus, it may have been the case that market illiquidity was not a generalized phenomena in all financial markets everywhere during this period. The second potential explanation is that the mean decomposition provides a limited snapshot to analyze factors that change over time. As discussed in the next Section VI.B below, when looking at this from this perspective, market liquidity appeared to be more important during this last crisis episode. The third possibility to explain this puzzle is that the sample period in this study is simply not long enough to explain a crisis episode that was still unraveling, with several waves developing, at the time of writing.[34] This puzzle should be a subject for future research, perhaps by also examining other asset market classes such as ABCP and short-term markets, and also more micro structure data such as ask-bid spreads and volumes in those markets.

B. Empirical Results: Spread Decomposition Over Time

Figures 5–31 plot the spread decompositions over time, capturing the various crisis episodes discussed above by individual country. Figures 5–14 represent the full period 1998–2007, while Figures 15–31 are based on the subsample 2004–2007 which rely on a larger number of countries and include credit default swaps.

For example, Figure 5 summarizes the decomposition of Brazil's sovereign bond spreads over time. The benchmark conditional expectation of Brazil's spreads (in basis points) are taken before the beginning of each of the periods of stress in financial markets discussed above, with information available prior to that event. The difference between the benchmark and the actual spreads are then explained proportionally by the various global financial market factors, as well as by other potential contagion from emerging markets and the

[33] See International Monetary Fund (2007).

[34] However, extending the period after the policy interventions have been introduced (i.e., after the ECB injected substantial amount of funds on August 10, 2007 and other central banks followed suit), also poses some challenges as this would have changed monetary liquidity conditions in itself.

idiosyncratic element.[35] The charts suggest, for example, that contagion from emerging markets was essentially not existent, contributing to less than 2 percent of the forecast error at any time, even during the Russian/LTCM crisis in 1998. This result is at odds with other studies that have found evidence of contagion to Brazil from the Russian/LTCM crisis (Dungey, Fry, González-Hermosillo, and Martin (2006, 2007); and Baig, and Goldfajn, (2001)). However, those studies focused on the unusual comovements among emerging markets during crises periods to explain contagion, rather than considering the potential indirect effects from international investors' changes in their risk appetite that may have resulted from the Russian/LTCM crisis. These results suggest that the spillovers observed to Brazil from the Russia/LTCM crisis may have indeed occurred through global financial market risk factors.

In contrast to the 1999 crisis in Brazil, the 2002 period of financial stress occurred despite the fact that global default risk and volatility interest rate risk were largely offsetting factors during this period, possibly reflecting the significant easing of monetary liquidity conditions during 2001–2002. As discussed earlier, this period was characterized by political uncertainty in Brazil (which is reflected in the idiosyncratic component). However, Brazil's problems also coincided with the WorldCom accounting scandal which led to a certain amount of stress in global financial markets−reflected, for example, in elevated market liquidity and volatility risks (see Figure 4) which together may have accounted for about 15 percent of the difference between Brazil's actual spreads and its conditional expectation (Figure 5). However, it appears that the increase in spreads in Brazil in 2002 was largely due to idiosyncratic factors.

The results from all countries throughout the key periods of financial stress during the past decade point to some stylized facts, discussed below.

First, global financial market conditions appear to be significant in all the crisis episodes examined. These global market conditions are far from constant. The testing of exactly how these global risks interact with each other was not examined directly in this paper, but it is clearly a fundamental question in need of further research. However, this paper went beyond the *status quo* which assumes that investors' risk appetite can be neatly encapsulated in a given index by adding up all the potential risk factors.

Second, once global financial market factors are explicitly considered, contagion from emerging markets is very small or essentially not existent.

Third, although emerging markets have largely been more volatile than mature economies, global financial market risk factors are important for all countries.

Fourth, some of the episodes of stress which were seemingly benign in that they were resolved relatively quickly, may have actually altered investors' risk appetite importantly.

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[35] All the figures show a discontinuity from September 11–17, 2001, as several financial markets were temporarily closed after the terrorist attacks.

For example, by examining the spread decomposition figures for the 2004–2007 period (Figures 15–31), it appears that the Turkey crisis in the spring of 2006 (which was preceded by a crisis in Iceland) increased default, as well market and interest rate volatility risks fundamentally by marking an upswing inflection point for all countries, including mature markets.

Similarly, the Shanghai stock market meltdown in February 2007 was short-lived and apparently innocuous when compared to the subsequent take off of that market in the subsequent months. However, in terms of global market factors, this event was associated with a significant increase in funding liquidity risks for all the countries considered. The connection is not straight forward, as funding liquidity is proxied here by monetary conditions in the United States and measured by the 3-month ahead Federal Funds futures rate. However, funding liquidity has been particularly difficult to gauge since 2004 when the Federal Reserve began its tightening cycle that ended in September 18, 2007 in response to the subprime mortgage and liquidity crisis in the United States. During much of this period of tightening, long-term interest rates were largely unchanged even as short-term interest rates increased considerably in response to a number of hikes in the Federal Funds rate. This peculiar extended period of flat or inverted yield curves in the United States has been associated in part with the "excess savings" of emerging-market economies which found their way into U.S. financial markets (Warsh (2007)). China happens to be the chief investor in U.S. assets among emerging markets. It is possible, then, that the China meltdown in February 2007—which was too small to derail the subsequent bullish tendency of the Chinese markets—was sufficient to cause international investors to revalue their expectations about the potential for tighter funding liquidity conditions, perhaps as a result of China being likely to invest less heavily in U.S. dollar assets in response to less bullish Chinese market conditions or because of expectations of depreciation of the U.S. dollar as a means to narrow global trade imbalances. The Chinese episode was also associated with an important increase in market liquidity risks for most countries examined, with the exception of the United States, Canada, the Eurozone, Ukraine, and Peru.

Fifth, the recent U.S. mortgage subprime crisis appeared to cause market liquidity strains in financial markets, particularly in mature economies. This effect is depicted most clearly in the 2004–2007 sub-period which is relies on new financial instrument as proxies (Figures 15–31). In particular, market liquidity risks increased in all the countries examined.[36] However, globally, default risk increased more sharply, and accounted for a larger share of the difference between the actual spreads and their benchmark, than market illiquidity. Thus, whereas a higher market liquidity risk accounted for up to about 8 percent of the innovations, increased default risk accounted for 20–30 percent of the innovations in emerging markets. A similar relationship is evident in most mature markets, except that default risk, although increasing sharply, accounted for much smaller amount than in the case

[36] This time series snapshot appears to give a clearer picture during this period of the trends in market liquidity risks, than the mean spread decomposition analysis (Tables 13 and 18) discussed in Section VI.A above.

of emerging markets.[37] In the United States, the contributions were roughly the same, as default risk and liquidity risk accounted for around 4 percent of the innovations each.

Increased funding liquidity risk as a result of the U.S. subprime mortgage problems is also evident in all countries.[38] Funding liquidity risks also increased for mature economies, contributing by about 4 percent of the innovations in the United States, less than 1 percent in Canada, and about 8 percent in the Eurozone.

Interestingly, Japan is the exception as global market risk factors did not appear to affect this country during the U.S. subprime mortgage crisis, at least not directly through the first round of effects.[39] This observation is consistent with the argument proposed earlier that Japan moved in an opposite direction during this recent period of stress in other markets because of the Yen being a carry-trade currency. Crises abroad would lead investors to sell their overseas investments and repay their low interest rate yen loans, resulting in capital inflows and increased funding liquidity conditions in Japan.

In sum, although the U.S. subprime mortgage crisis was experienced globally as a market liquidity shock , the contribution of default and funding liquidity risks were generally more important. While not exactly the same for all countries, default risk may have been slightly more important than funding liquidity risk (at least during the period prior to the injection of liquidity by several central banks). Japan is an exception in the sample examined. It may have been that what started as a market liquidity shock (as banks hoarded liquidity in response to the meltdown in the ABCP market as subprime mortgages defaulted), quickly became a default and a funding liquidity crisis. This paper is unspecific as to the exact mechanisms through which this may have occurred, and it should be a subject of future research.

One other interesting question is the issue of timing with regards to this latest period of financial stress. Why mid-2007, given that the U.S. housing prices and activity had been declining since mid-2005 when the housing market reached a peak, and it was common knowledge that this market was likely to suffer a correction? What triggered the U.S. mortgage crisis that began as a default shock, before it became a market liquidity shock when the ABCP market froze? Some of the available explanations for this are based on structural characteristics related to when different vintages of subprime mortgages were reset (see International Monetary Fund (2007)). However, based on the results of this paper, it is interesting that the correction in the Chinese stock market on February 27, 2007 translated into a funding liquidity shock for all the countries considered (with the exception of Japan) of

[37] For example, default risk in Canada accounted for around 6 percent of the innovations (compared to market liquidity amounting to less than 1 percent). In the case of the Eurozone, default risk accounted for close to 15 percent (vs. market liquidity accounting for less than 1 percent).

[38] Contributing by about 15–30 percent of the innovations for most emerging markets, with the exception of Ecuador for which the contribution is smaller (around 6 percent).

[39] Of course, any potential weakness in the U.S. economy resulting from the subprime mortgage crisis would likely affect Japan's exports eventually.

roughly the same magnitude, or bigger, than the U.S. shock. It appears that the Chinese correction, which was short-lived otherwise, contributed importantly to the shift in international investors' risk appetite. Future research may be able to determine whether this event was a contributing trigger.

For emerging markets, in particular, the U.S. subprime mortgage crisis largely represented a default risk and a funding liquidity shock, rather than a market liquidity shock, based on the relative contributions of the different risk factors. This is consistent with the fact that financial market development in emerging countries lags that in mature economies and therefore market liquidity shocks may be transmitted across borders, through this channel, less easily than across mature financial markets. Also, contrary to the common view that emerging markets were largely unaffected by the U.S. subprime mortgage crisis, the results in this paper suggest that this was a global shock affecting all the countries examined. It is true, however, that the increase in spreads observed in emerging markets since mid-2007 still place them at historically low levels. But it is also evident from the results in this paper that spreads have largely widened as a result of the U.S. subprime mortgage shock as investors have reduced their appetite for risky assets, with the main channels being an increase in the perceived risk of default and of tighter funding liquidity conditions.

Finally, the fact that idiosyncratic factors account for a relatively small proportion of the difference between the actual spreads and their benchmark for all the countries examined (at less than 20 percent of the innovations) further suggests that the global financial markets factors examined account for most of the innovations during the U.S. subprime mortgage crisis period. The only exception is Ukraine which was embroiled in uncertainty about its own presidential elections during mid-2007, showing a contribution from idiosyncratic factors amounting to close to 40 percent of the innovations.[40]

VII. Conclusions

This paper developed an empirical model for bond spreads which takes into account several variables associated with investors' risk appetite. The bond markets considered consist of a variety of sovereign bond spreads for emerging markets and corporate bond spreads for mature markets. The paper examined the various key periods of financial stress during the past decade. A shorter subperiod 2004–2007 was also examined based on new financial instruments as the relevant proxies.

In contrast with much of the current approach to measure investors' risk appetite, which largely relies on ready-made composite indexes of different global risk proxies, this paper examines the relevant global components in a systematic fashion during the past decade. In particular, international investors' risk appetite is framed as being determined by funding liquidity risk, which is proxied monetary liquidity conditions and is measured by the 3-month ahead Federal Funds futures rate. Investors' risk appetite is also a function of default risk,

[40] In Ukraine, a presidential election took place on September 30, 2007. In the run-up to the elections, there was significant uncertainty from the apparent dead heat contest between pro-Soviet and pro-Western European candidates.

proxied by the 10-year USD swap spread and the Itraxx 10-year Europe crossover credit default swap index for the shorter subperiod 2004–2007. As well, investors' risk appetite is assumed to be determined by market liquidity risk proxied by the spread between the 20-year and the 10-year U.S. Treasury bond (where the latter is a more liquid asset and both are equivalent in terms of default risk), market volatility risk (proxied by the VIX index) and interest volatility risk (proxied by the swaption-implied interest rate volatility). The model also allows for direct channels of contagion from emerging markets and idiosyncratic factors not captured by the model's specification.

The model is used to identify and analyze the contribution of the several risk factors to the widening of spreads during periods of financial stress. The unexpected changes in the spreads during periods of financial stress are decomposed into changes caused by funding liquidity conditions, aggregate risk factors, contagion effects, and idiosyncratic factors. The aggregate risk factors are default risk, market liquidity, market volatility, and interest-rate volatility risk.

By using daily data, the model is able to capture short-lived episodes of crisis which would have appeared innocuous if based on their longevity alone. Some of them, like the financial crisis in Turkey during the Spring of 2006, appears to have fundamentally changed market volatility risk. Similarly, the meltdown of the Shanghai stock exchange in late February 2007, also seemingly innocuous if based on its duration alone, led to a significant increase in the perceived global funding liquidity risk—similar in size to the effect derived from the U.S. subprime mortgage debacle.

The role of the different global risk components is examined through the various periods of financial stress during the past decade by country and over time. The main results are summarized below.

First, global financial market conditions appear to be significant in all the crisis episodes examined. They themselves are far from constant. The testing of exactly how these global risks interact with each other was not examined directly in this paper, but it is clearly a fundamental question in need of further research. However, this paper went beyond the *status quo* which assumes that investors' risk appetite can be neatly encapsulated in a given index by adding up all the potential risk factors.

Second, once global financial market factors are explicitly considered, contagion from emerging markets is very small or essentially not existent. This result is at odds with some of the results in the empirical literature of contagion. The literature on contagion examines the links that exist over and above the market fundamental mechanisms that link countries and asset markets during noncrisis periods, which only appear during a crisis. However, the empirical literature on contagion does not identify exactly how these additional channels are formed during periods of stress. One potential channel of contagion is that shocks in any given market may impact international investors' risk appetite through their rebalancing of portfolios or simply by a revised set of expectations. Often investors would first run the most liquid markets where exiting is less costly. Almost a decade ago, Allan Greenspan noted that a rise in the default risk of a given country can impact upon the liquidity of other markets as a result of international investors offloading liquid assets, despite their relatively low default risk (Greenspan, 1999). The results in this paper suggest that contagion essentially dissappears when identifying the actual channels of spillovers.[41]

Third, although emerging markets have been historically more volatile than mature economies, global financial market risk factors are important for all countries. An area of future research is to examine how global financial market risk are interconnected.

Fourth, although the U.S. subprime mortgage crisis was experienced globally as a market liquidity shock , the contribution of default and funding liquidity risks were generally more important. While not exactly the same for all countries, default risk may have been slightly more important than funding liquidity risk (at least during the period prior to the injection of liquidity by several central banks). It may have been that what started as a market liquidity shock (as banks hoarded liquidity in response to the meltdown in the ABCP market as subprime mortgages defaulted), quickly became a default and a funding liquidity crisis. This paper is unspecific as to the exact mechanisms through which this may have occurred, and it should be a subject of future research. Interestingly, Japan behaved quite differently, likely as a result of the carry-trade as crises elsewhere are associated with larger capital inflows into Japan as low interest rate yen loans are repaid.

Finally, in general, the various crises are characterized differently by changes in the global market risk factors, and sometimes some risk factors work in different directions and partially offset each other. This type of analysis should be helpful in elaborating a framework to assess global financial stability, another area for future research, as investors' risk appetite may play an important role in increasingly integrated global financial markets.

[41] A similar result is found for a different class of variables and periods in Dungey et. al. (2003).

References

Baig, T., and Goldfajn, I., 2001, The Russian default and the contagion to Brazil. In S. Claessens and K. Forbes (Eds.), *International Financial Contagion,* pp. 267–300. Boston: Kluewer Academic Press.

Barberis, N., Huang, M. and Santos, T., 2001, “Prospect Theory and Asset Prices,” *Quarterly Journal of Economics*, Vol. 116, pp. 1–53.

Blanchard, O., and D. Quah, 1989, “The Dynamic Effects of Aggregate Demand and Supply Disturbances,” *American Economic Review*, 79.

Bliss, R. and Panigirtzoglou, N., 2004, “Option-implied Risk Aversion Estimates,” *Journal of Finance*, Vol. 59, pp.407–446.

Committee on the Global Financial System, 1999, *A Review of Financial Market Events in the Autumn 1998*, Bank for International Settlements, Basel, Switzerland, October.

Coudert, V., and M. Gex, 2007, “Does Risk Aversion Drive Financial Crises? Testing the Predictive Power of Empirical Indicators”, Centre d’Etudes Prospectives et d’Informations Internationales, Working Paper No. 2007 – 02.

Cochrane, J., 2001, *Asset Pricing*, Princeton University Press, Princeton NJ.

Dornbusch, R., Park, Y.C. and Claessens, S., 2000, "Contagion: How it Spreads and How it can be Stopped," *World Bank Research Observer*, 15, pp. 177–197.

Dungey, M., R. Fry, B. González-Hermosillo, and V. Martin, 2003, “Characterizing Global Investors’ Risk Appetite for Emerging Market Debt during Financial Crises,” IMF Working Paper 03/251.

Dungey, M., Fry, R., González-Hermosillo, B. and Martin, V.L., 2005, "Empirical Modelling of Contagion: A Review of Methodologies," *Quantitative Finance*, 5, pp. 9–24.

Dungey, M., R. Fry, B. González-Hermosillo and V.L. Martin, 2006, "Contagion in International Bond Markets During the Russian and LTCM Crises," *Journal of Financial Stability*, 2, pp. 1–27.

Dungey, M., R. Fry, B. González-Hermosillo and V.L. Martin, 2007a, "Contagion in Global Equity Markets in 1998: The Effects of the Russian and LTCM Crises," *North American Journal of Economics and Finance*, 18, pp. 155–174.

Dungey, M., R. Fry, B. González-Hermosillo, V.L. Martin, and C. Tang, 2007b, "Are Financial Crises Alike?–From the 1998 Russian/LTCM Crisis to the 2007 Subprime Debacle and Liquidity Crisis,” manuscript, International Monetary Fund, October.

European Central Bank, 2007, *Financial Stability Review*, Section D: Measuring Investors' Risk Appetite, June.

Financial Times, 2007, various issues (9/26/07 and 10/26/07).

Fitch Ratings, 2007, *Russian Federation Special Report- Premium*, October.

Gai, P. and N. Vause, 2005, "Measuring Investors' Risk Appetite," Bank of England Working Paper 283.

González-Hermosillo, B. and J. Li, 2008, "A Banking Firm Model: The Role of Market, Liquidity and Credit Risks," *Computational Methods in Financial Engineering* (forthcoming).

Greenspan, A., 1999. Risk, Liquidity and the Economic Outlook. *Business Economics*, January, pp. 20–24.

International Monetary Fund, 2007, *Global Financial Stability Report*, October.

J.P. Morgan, "Emerging Markets Bond Index Plus (EMBI+) Rules and Methodology," December 2004.

Kaminsky, G.L., and Reinhart, C.M., 2003, "The Center and the Periphery: The Globalization of Financial Turmoil", NBER Working Paper, No. 9479.

Kashiwase, K., and L. Kodres, 2005, "Emerging Market Spread Compression: Is it Real or is it Liquidity?" manuscript, International Monetary Fund.

Kodres, L. and Pritsker, M., 2002, "A Rational Expectations Model of Financial Contagion," *Journal of Finance*, 57, pp. 769–799.

Kumar and Persaud, 2002, "Pure Contagion and Investors' Shifting Risk Appetite: Analytical Issues and Empirical Evidence," *International Finance*, Vol. 5, pp. 401–426.

Liu, J., F. Longstaff, and R. Mandell, 2006, "The Market Price of Risk in Interest Rate Swaps: The Roles of Default and Liquidity Risks," *Journal of Business*, Vol. 79, No. 5.

Pericoli, M. and Sbracia, M., 2003, "A Primer on Financial Contagion," *Journal of Economic Surveys*, 17, pp. 571–608.

Rasmus, Ruffer and Livio Stracca, 2006, "What is Global Excess Liquidity, and Does it Matter?" European Central Bank Working Paper Series, No. 696, November.

Warsh, Kevin, 2007), "Market Liquidity: Definitions and Implications," Speech delivered at the Institute of International Bankers Annual Conference, Washington D.C., March.

APPENDIX I. DATES OF FINANCIAL DISTRESS

The Russian Default/LTCM crisis episode (1998) starts with Russia's announcement on August 17th of its intention to default on its international debt obligations and to devalue the Ruble. However, several events prior to this announcement had already created some distress in financial markets. Therefore, the benchmark spread is computed based on information prior to June 1, 1998. On September 23, the U.S. Federal Reserve announced a rescue plan for the hedge fund Long-Term Capital Management (LTCM). The crisis period is assumed to end just before the second cut in the U.S. federal funds rate which occurred in a surprised fashion between FOMC meetings on October 15, 1998. Given the proximity of the Russian crisis and the LTCM bail-out, these events are examined jointly during the period June 1 through October 14,1998.

The Brazilian crisis (1999) starts on January 13, with the effective devaluation of the Real. The benchmark spreads are computed with information up to one week before the devaluation and the episode is assumed to end on January 29, 1999 when the Brazilian stock market rallied after the central bank further increased interest rates to support the currency. On that date it was also announced that an IMF team was in Brasilia to discuss an adjustment program with the authorities.

The NASDAQ Bubble Burst (2000) episode is assumed to begin on April 3, when Microsoft is ruled to have violated antitrust laws causing the NASDAQ Composite index to fall by 8 percent. The benchmark spreads are constructed with information up to March 10, when NASDAQ reached an all-time high. The end of this episode of stress is assumed to be May 10, 2000.

The Turkish crisis (2001) is assumed to start on February 19, when the Turkish President and the Prime Minister had a confrontation that prompted a sell-off of Turkish assets, forcing the devaluation of the Lira three days later. The benchmark spreads are constructed with information available two weeks before the crisis began. The crisis is assumed to end on March 5, 2001, coinciding with the appointment of a new Minister in charge of Treasury, State Planning Organization and Privatization.

The 9/11 (2001) episode is assumed to begin on September 17, when the U.S. stock markets reopened a few days after the terrorist attacks in New York and the Pentagon. The end of this episode of stress is assumed to be November 6, 2001, coinciding with one of the FOMC's interest rate cuts which appeared to calm global financial markets.[42]

The WorldCom Accounting Scandal/ Brazilian Elections (2002) episode of financial stress is assumed to start on June 19th, at the time when there was a generalized sell-off of risky assets. On June 25, 2002 the accounting malpractices of WorldCom become public, leading

[42] Although foreign markets and U.S. bond markets were open before September 17, there is incomplete data for some of the variables used in this paper until that date.

to its bankruptcy on July 21 and to a period of in uncertainty about corporate integrity practices. The benchmark spreads are computed based on information up to April 23, coinciding with increasing concerns by investors regarding the anticipated Brazilian elections. This episode of financial stress is assumed to end on October 29, 2002, the day after Lula's election when the head of the ruling party gave public assurances of fiscal responsibility and Brazil announced the successful rollover of its remaining foreign exchange swap contracts.

The run-up to the tightening of monetary policy in the United States (2004) was also a period of uncertainty and apparent stress in global financial markets. The episode marking expectations of an imminent monetary policy tightening in the United States is assumed to begin following the release of a strong payroll data (for March) on April 2, 2004. Against increasing speculation and uncertainty as to when monetary conditions might be tightened, and in light of a FOMC meeting, emerging markets experienced a generalized sell-off on May 3, 2004. The benchmark spreads are, therefore, computed based on information up to April 2, 2004. The end of this episode of uncertainty about the exact timing of the monetary policy tightening is assumed to be June 30, 2004 at the time when the U.S. Federal Reserve actually increased its federal funds rate (by 25 basis points) for the first time in more than four years.

The Ford/General Motors downgrade episode (2005) is assumed to start on March 16, at the time when Moody's announced its intention to review the credit ratings of General Motors (GM) for a possible downgrade. In the event, GM was assigned 'junk' status on May 5, 2005. During this period, Ford's rating was also downgraded. The benchmark spreads are computed based on information up to February 14, when it is disclosed that GM's outlook had become "negative." The end of this period of financial market stress is assumed to be May 19, 2005 when bullish conditions appeared to have been reestablished in equity markets.

The Turkish crisis (2006) spans from May 11 to July 24 as a result of political instability in that country. This crisis came on the heels of financial difficulties in Iceland a couple of months earlier.[43] During that period, there were several reports pointing to increased nervousness about the outlook for emerging markets and spreads generally increased.

The Chinese stock market correction (2007) episode started on February 27 ("black Tuesday") as a hefty sell-off in the Shanghai stock exchange spread around the world. This period of stress period lasted until March 19, when stock markets in emerging market rebounded.

The final episode of stress in global financial markets examined in this paper is the U.S. subprime mortgage crisis and the subsequent liquidity squeeze in mid-2007. The start of the

[43] By the end-March 2006, Iceland's stock market had fallen 19.1 percent since reaching a peak on February 15, 2006; the Icelandic Krona had fallen 12 percent against the USD since end-2005; and the central bank raised interest rates by 75 basis points to 11.5 percent (more than doubled in the previous two years) in an attempt to head off a crisis of confidence (*Financial Times* 3/31/06).

U.S. subprime mortgages and liquidity crisis is assumed to start be June 15, 2007, coinciding with the announcement that two Bear Stearns' hedge funds were having financial difficulties with their assets backed by mortgages in the United States. Although the troubles in the subprime mortgage market started earlier as defaults began to mount in late 2006, it took some time for the difficulties in this market to be clearly related to other financial markets. It was not until July 9, 2007, when credit rating agencies began downgrading higher-rated assets, that the severity of the crisis was fully appreciated and global financial markets collapsed. Although at the time of writing this paper, the crisis is not clearly over, for purposes of this research the end of the crisis is assumed to be August 9, 2007 which is also the end of the sample and it is just before the European Central Bank (ECB) began a round of liquidity injections, which was followed by several central banks across the world. Thus, on August 10, 2007 the ECB injected €95 billion in an effort to avert the meltdown in global financial markets. Other central banks followed suit in countries such as Canada, the United Kingdom, Russia, and Argentina. The U.S. Federal Reserve cut its federal funds policy rate by 50 basis points on August 17, 2007 and by a further 25 basis points on October 30, 2007.

APPENDIX II. FIGURES, DATA, AND TABLES

Figure 1. Bond Spreads (bps, log scale)

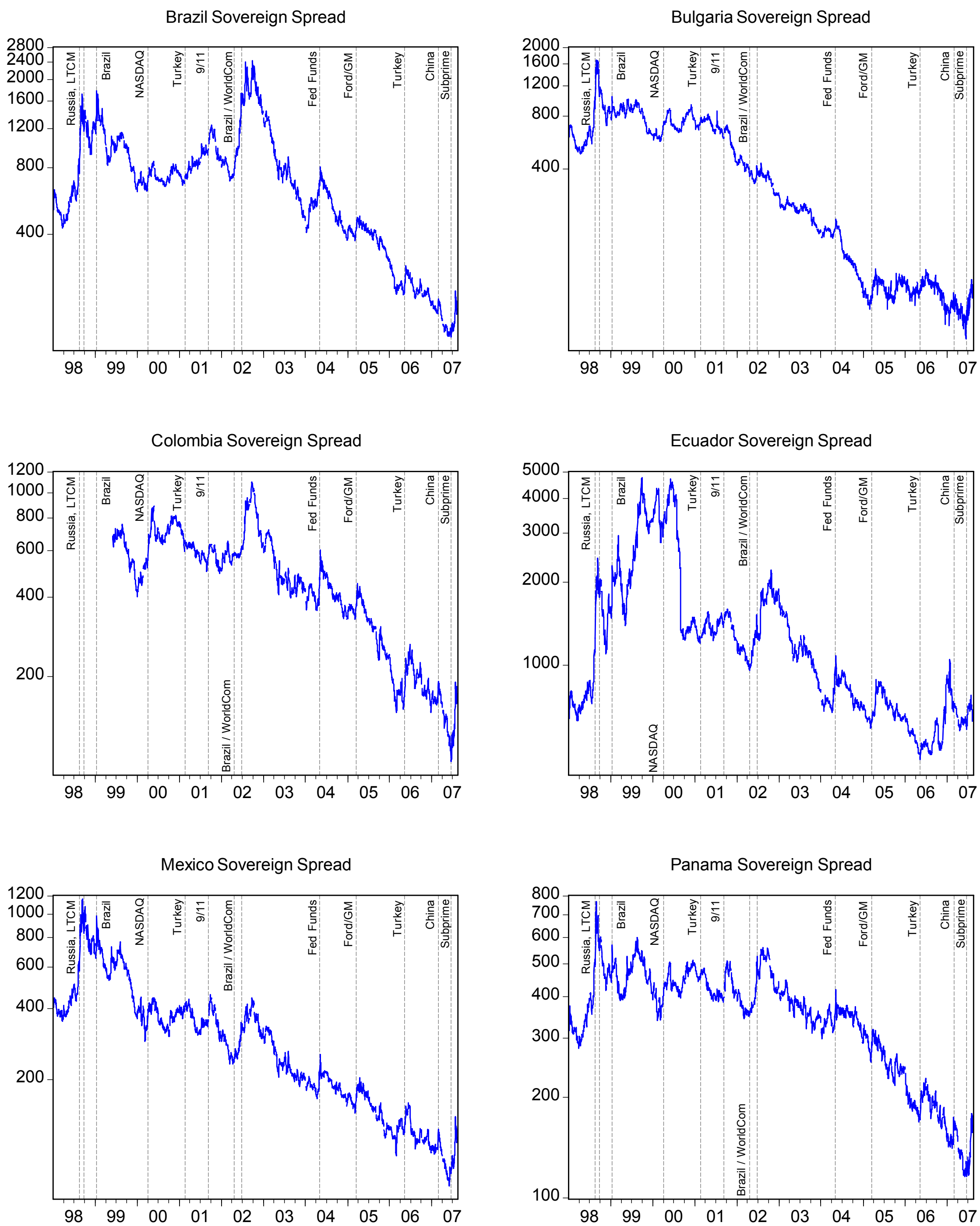

Figure 2. Bond Spreads (bps, log scale)

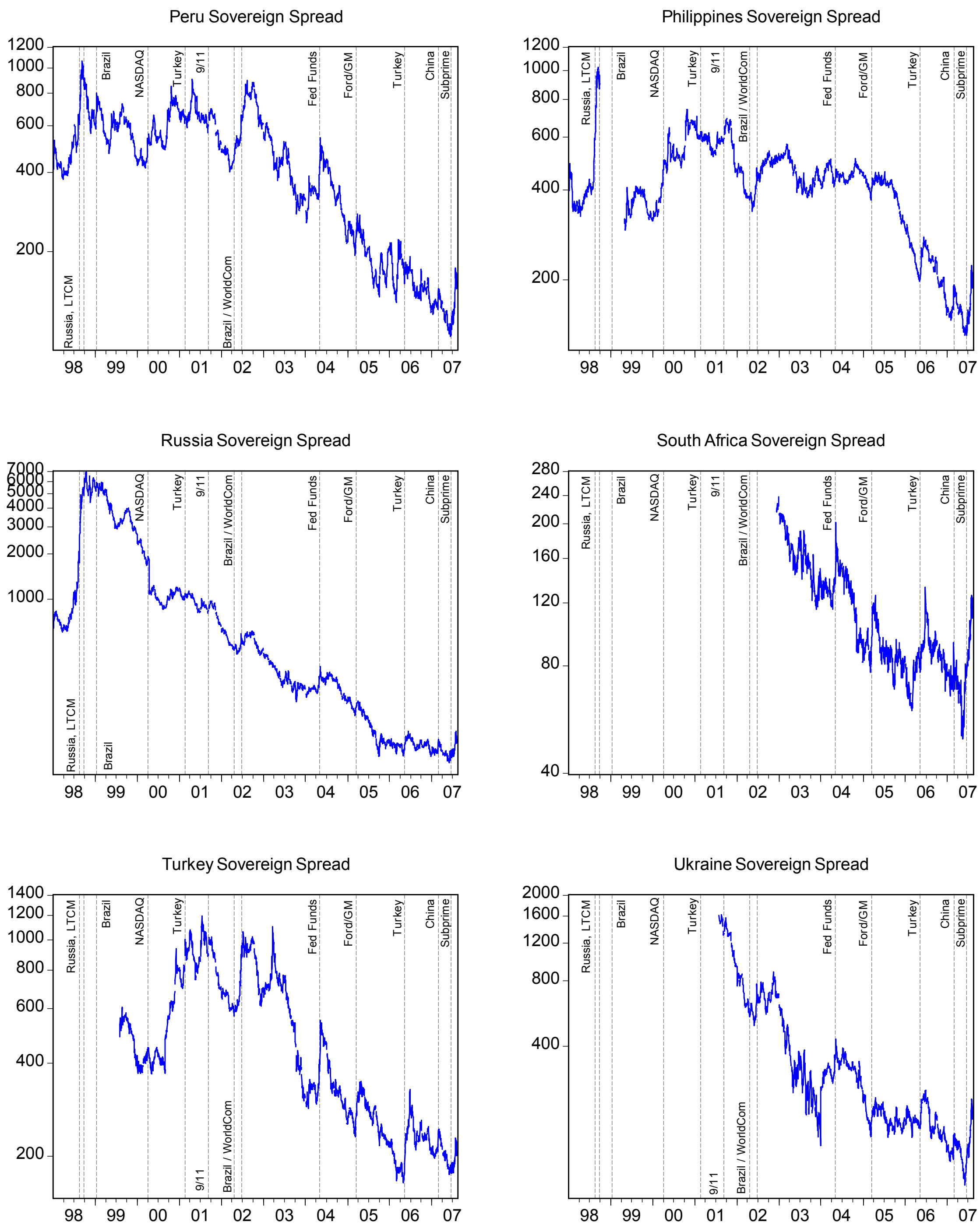

Figure 3. Bond Spreads (bps, log scale)

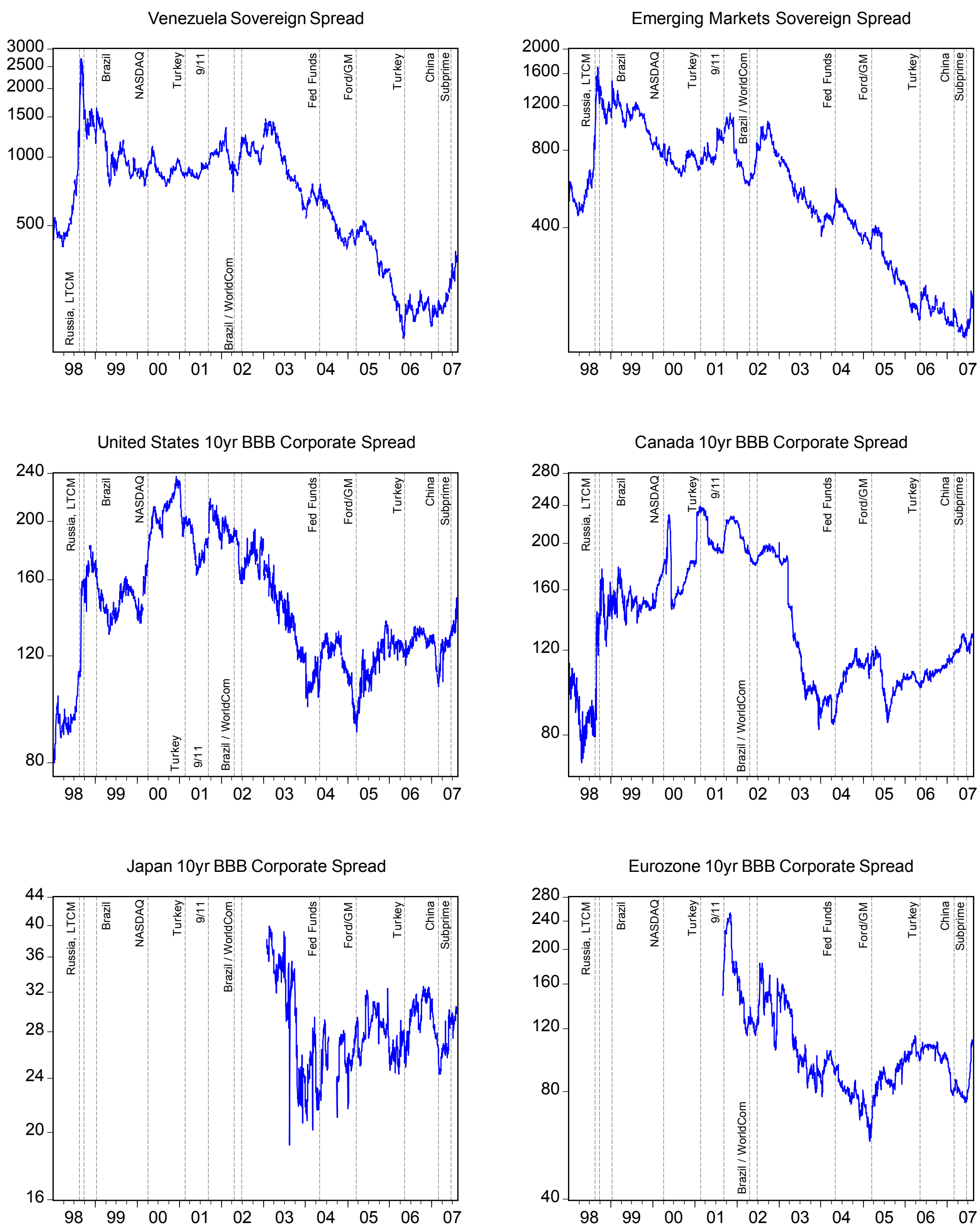

Figure 4. Monetary Policy and Risk Factors

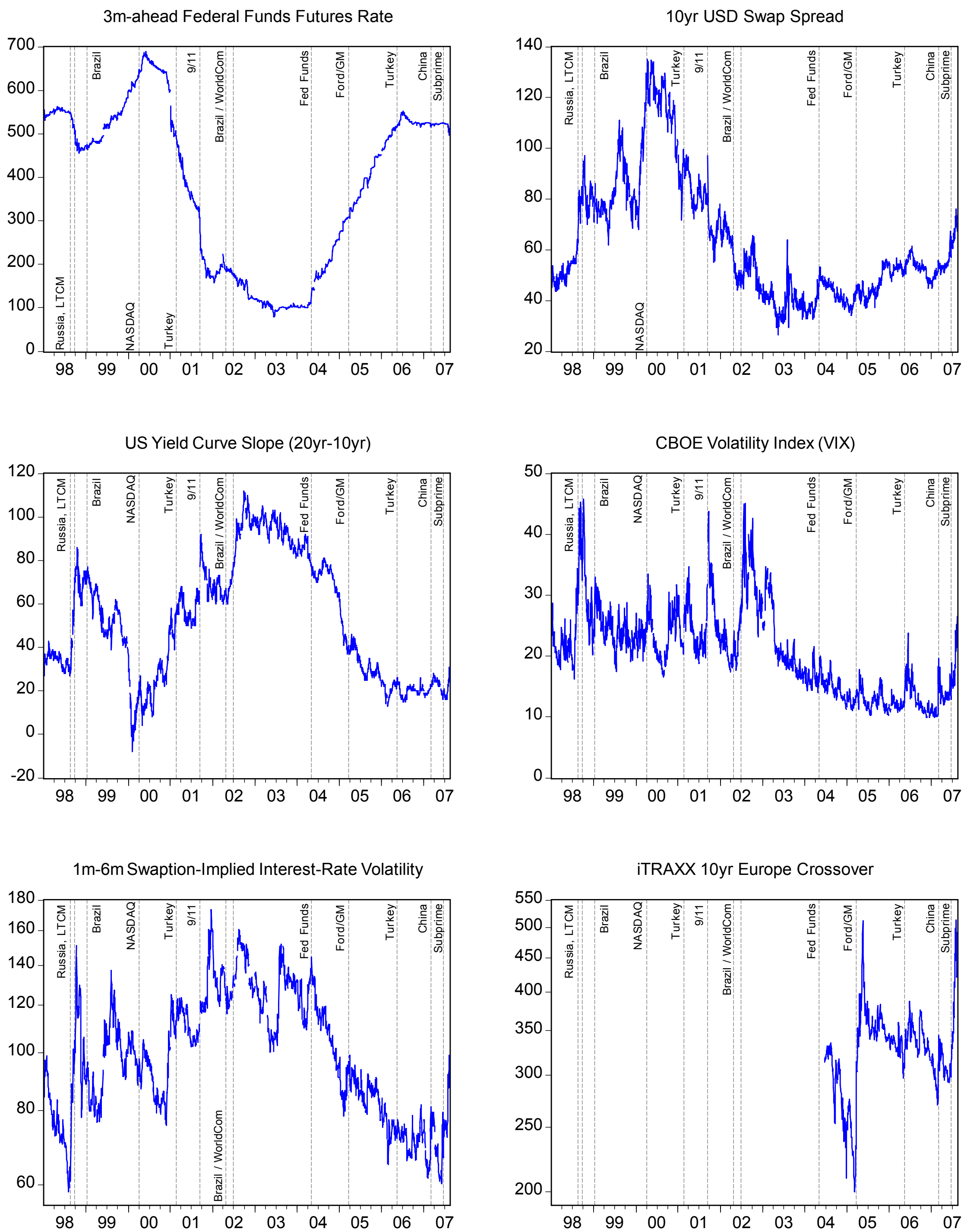

Figure 5. Spread Decomposition (1998–2007)—Brazil

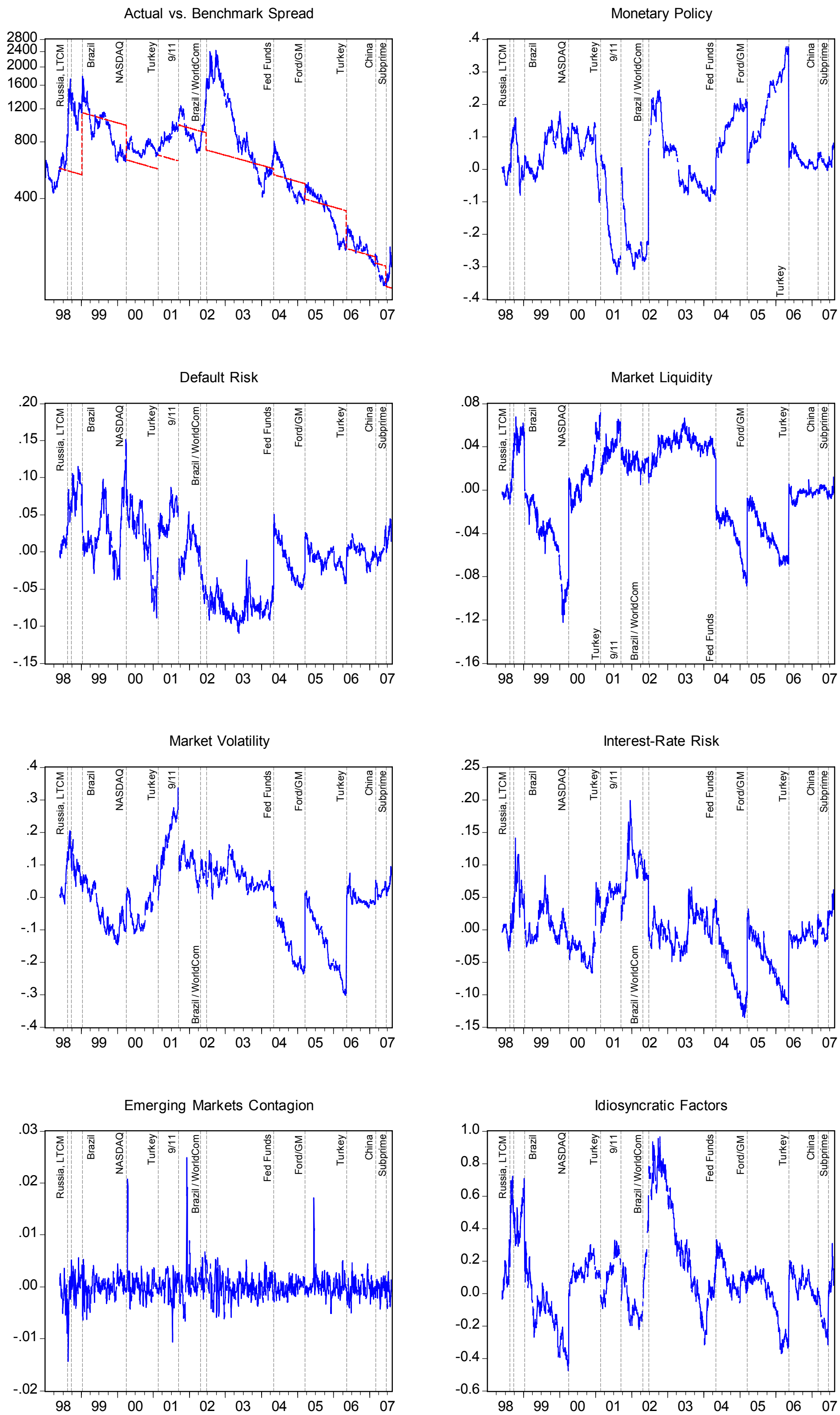

Figure 6. Spread Decomposition (1998–2007)—Bulgaria

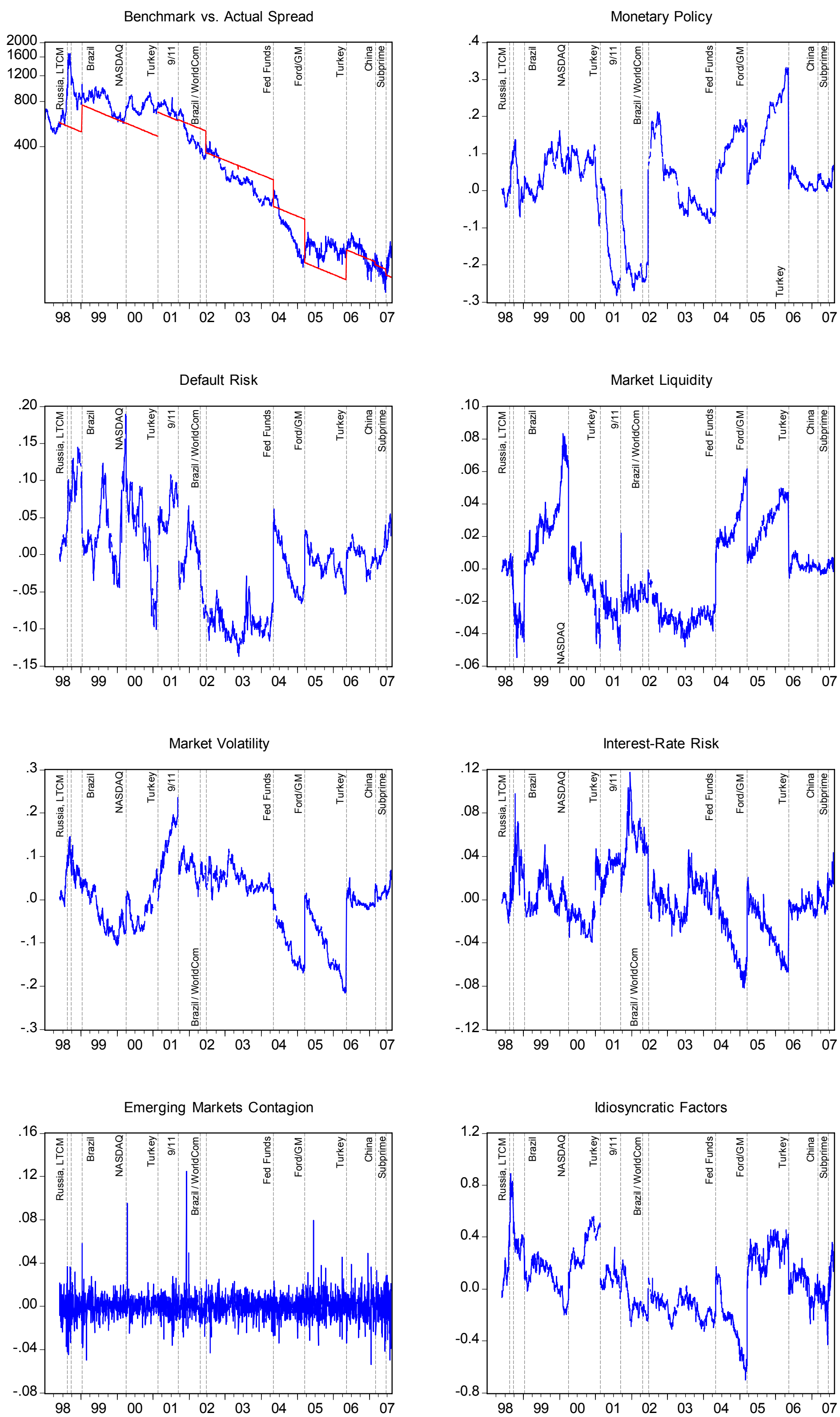

Figure 7. Spread Decomposition (1998–2007)—Ecuador

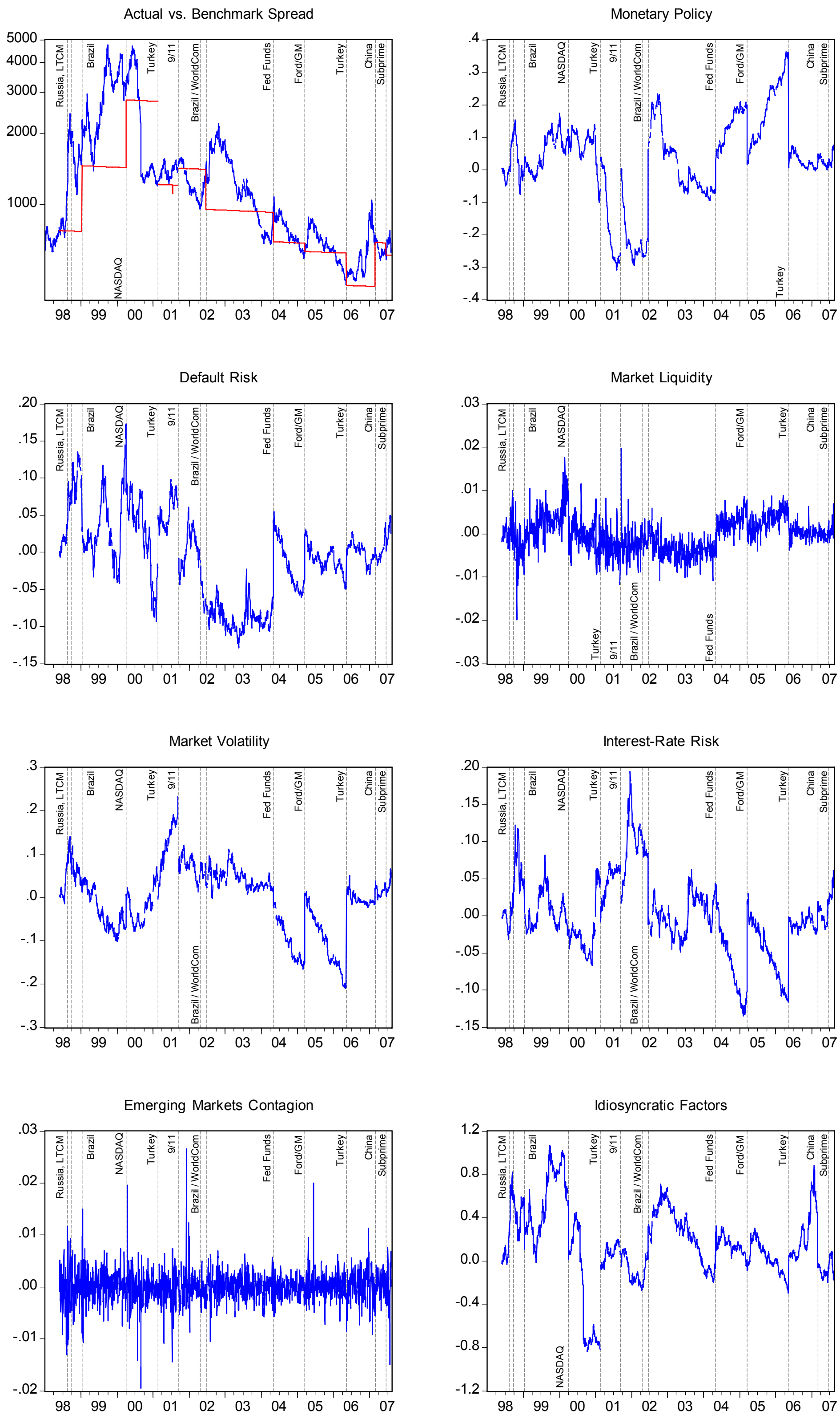

Figure 8. Spread Decomposition (1998–2007)—Mexico

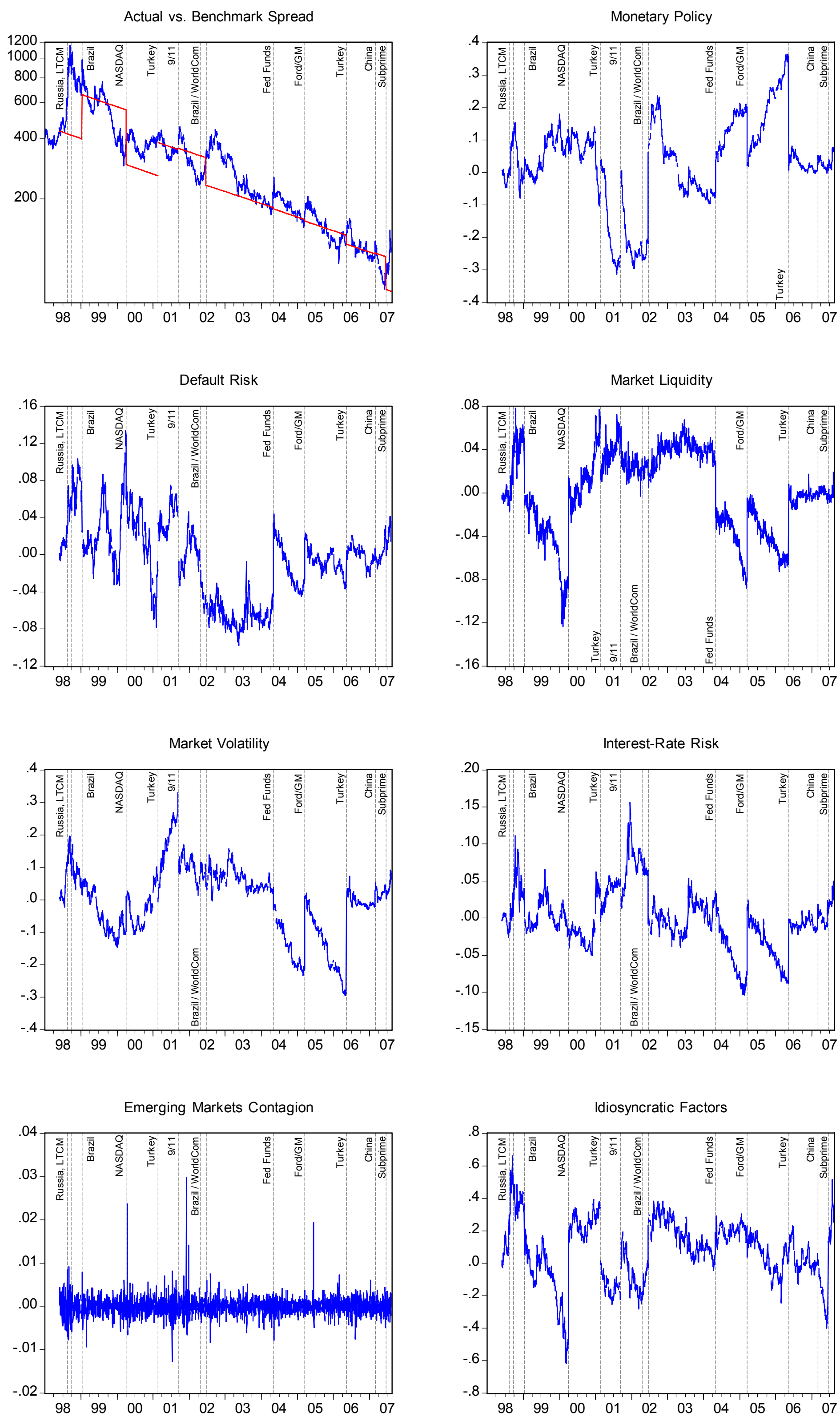

Figure 9. Spread Decomposition (1998–2007)—Panama

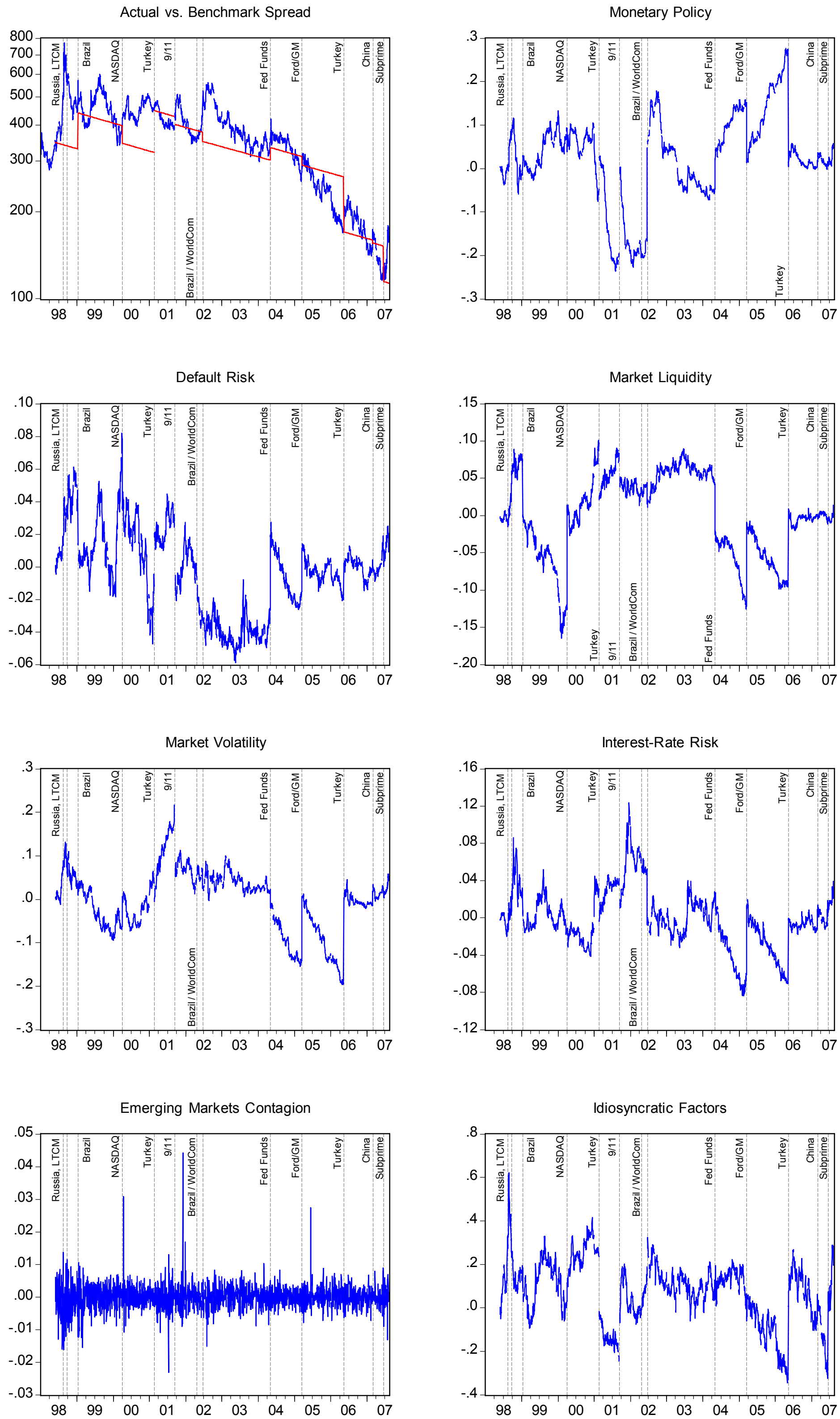

Figure 10. Spread Decomposition (1998–2007)—Peru

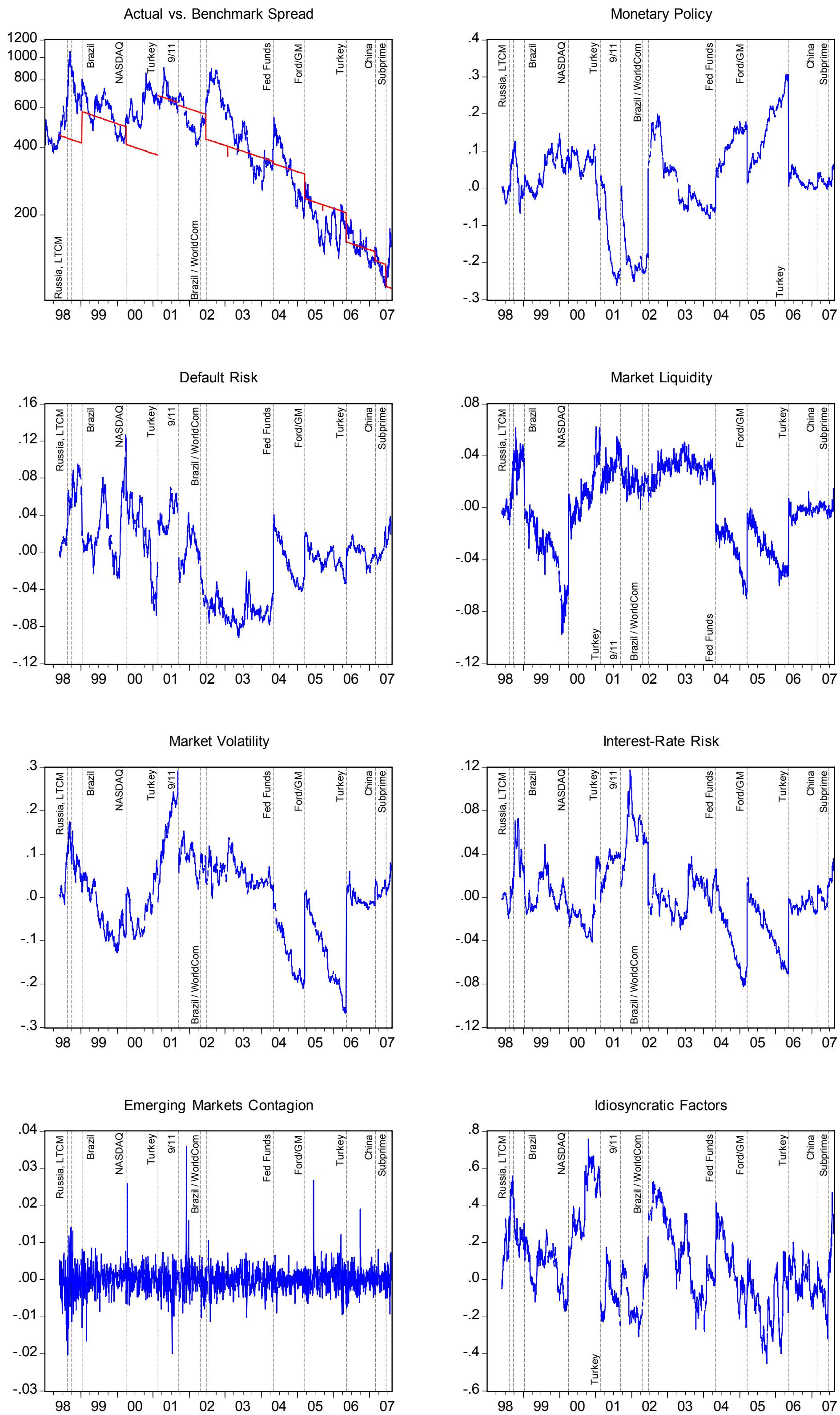

Figure 11. Spread Decomposition (1998–2007)—Russia

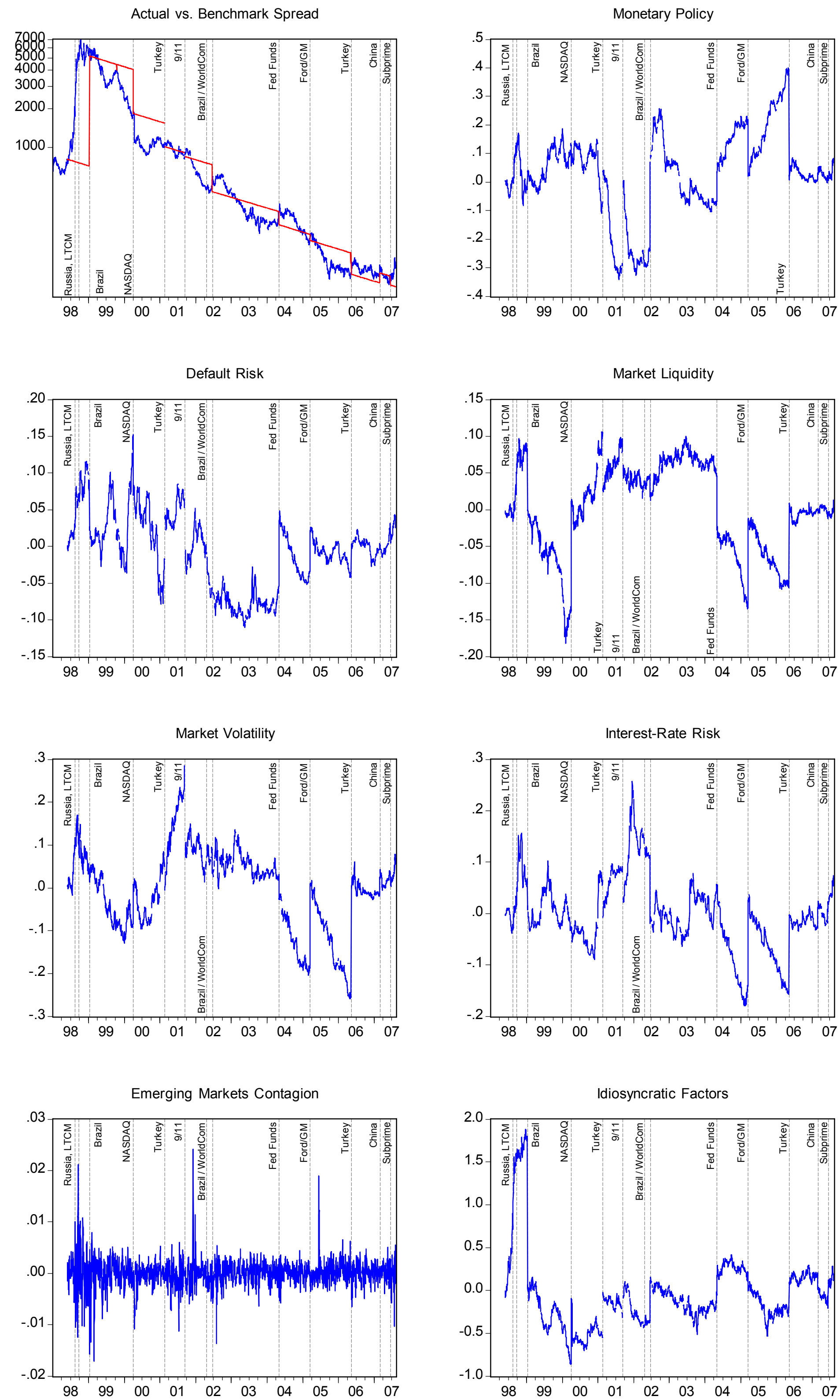

Figure 12. Spread Decomposition (1998–2007)—Venezuela

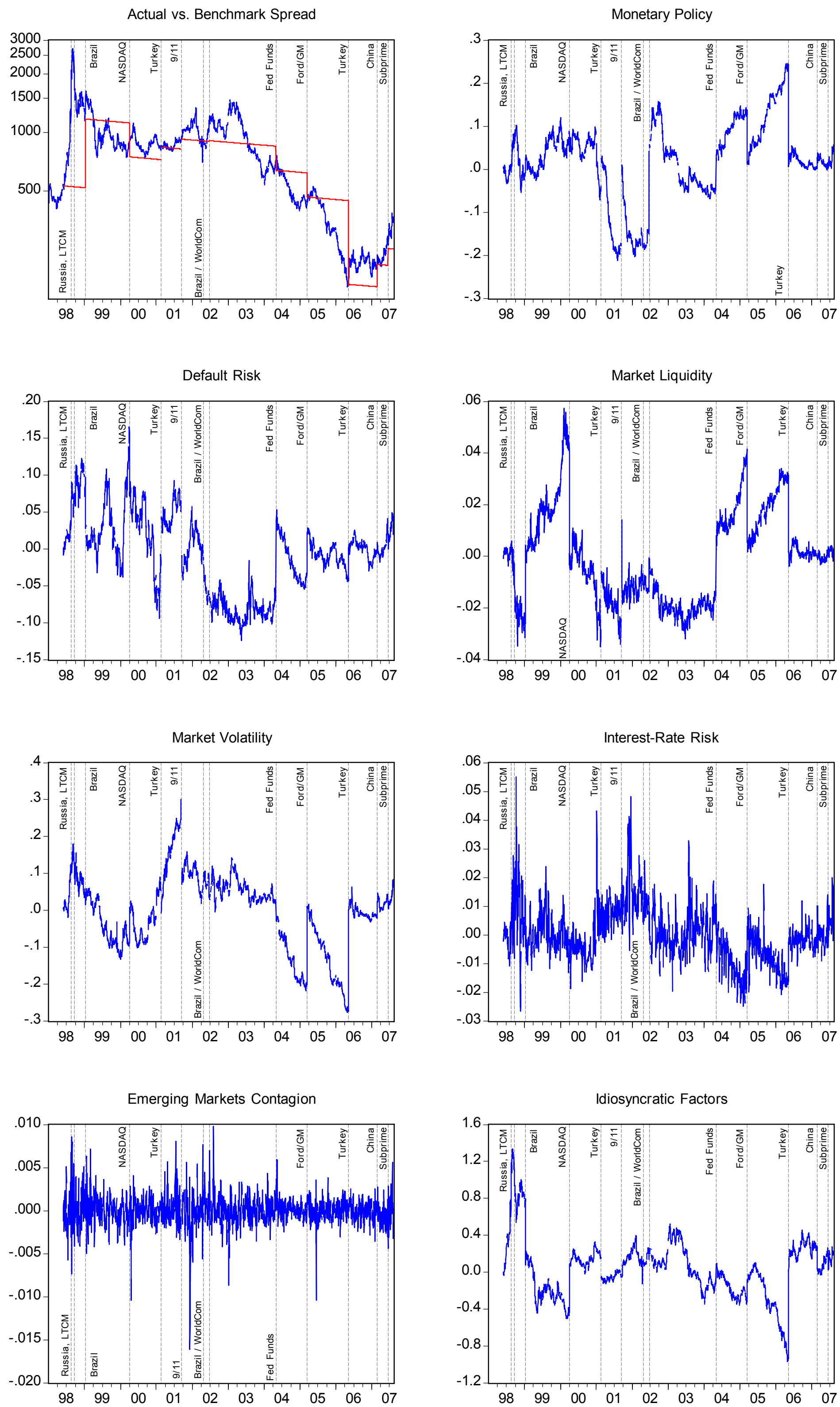

Figure 13. Spread Decomposition (1998–2007)—United States

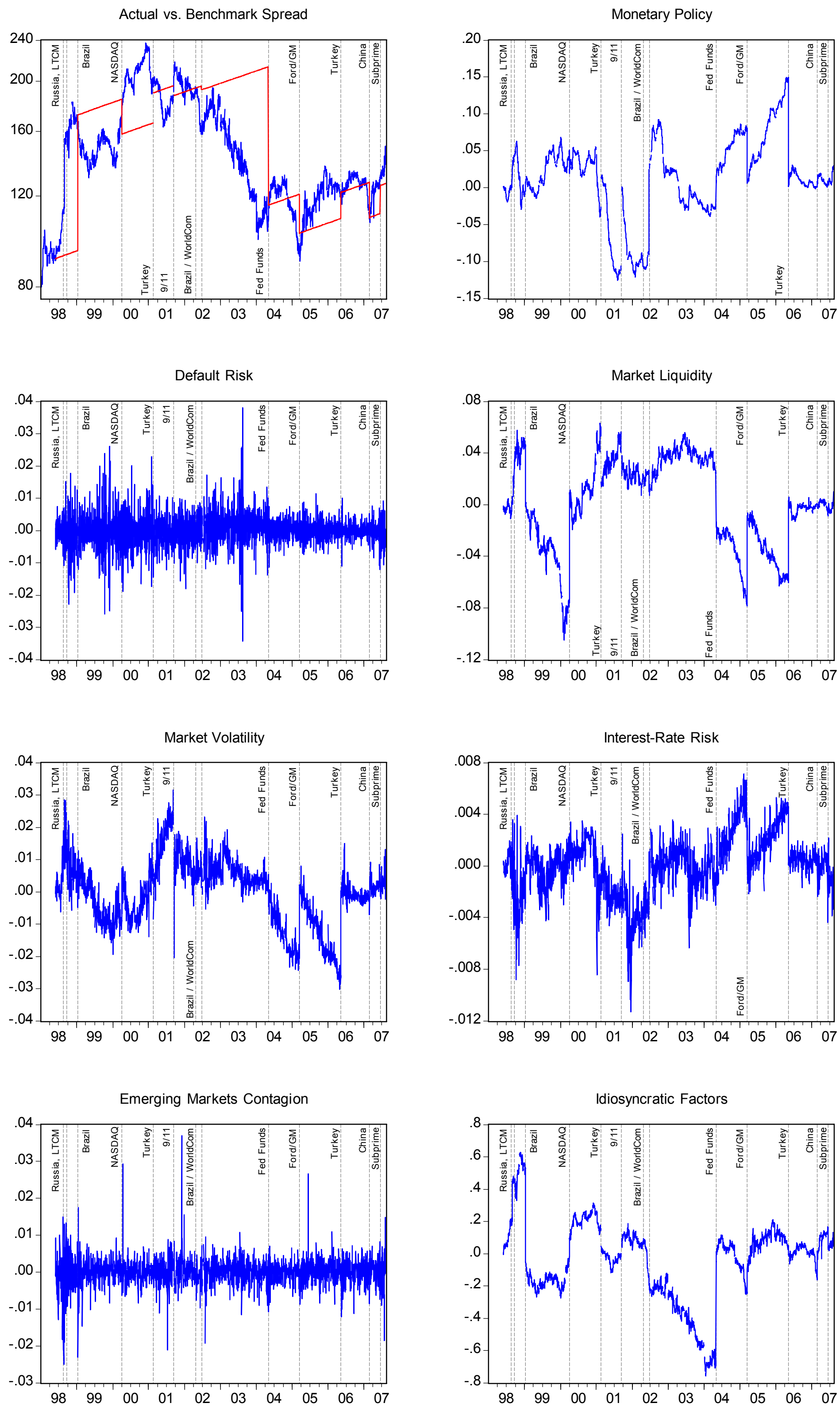

Figure 14. Spread Decomposition (1998–2007)—Canada

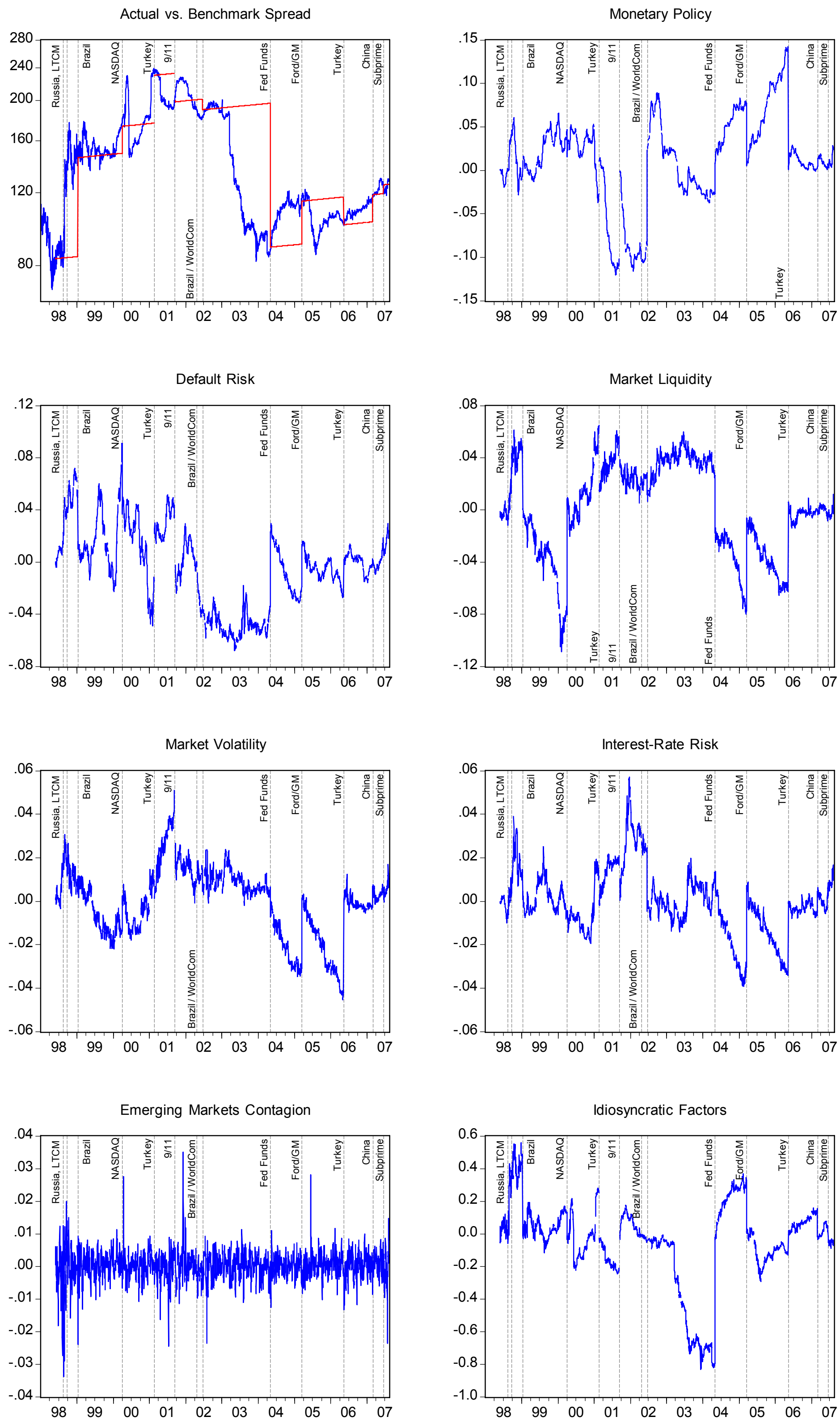

Figure 15. Spread Decomposition (2004–2007)—Brazil

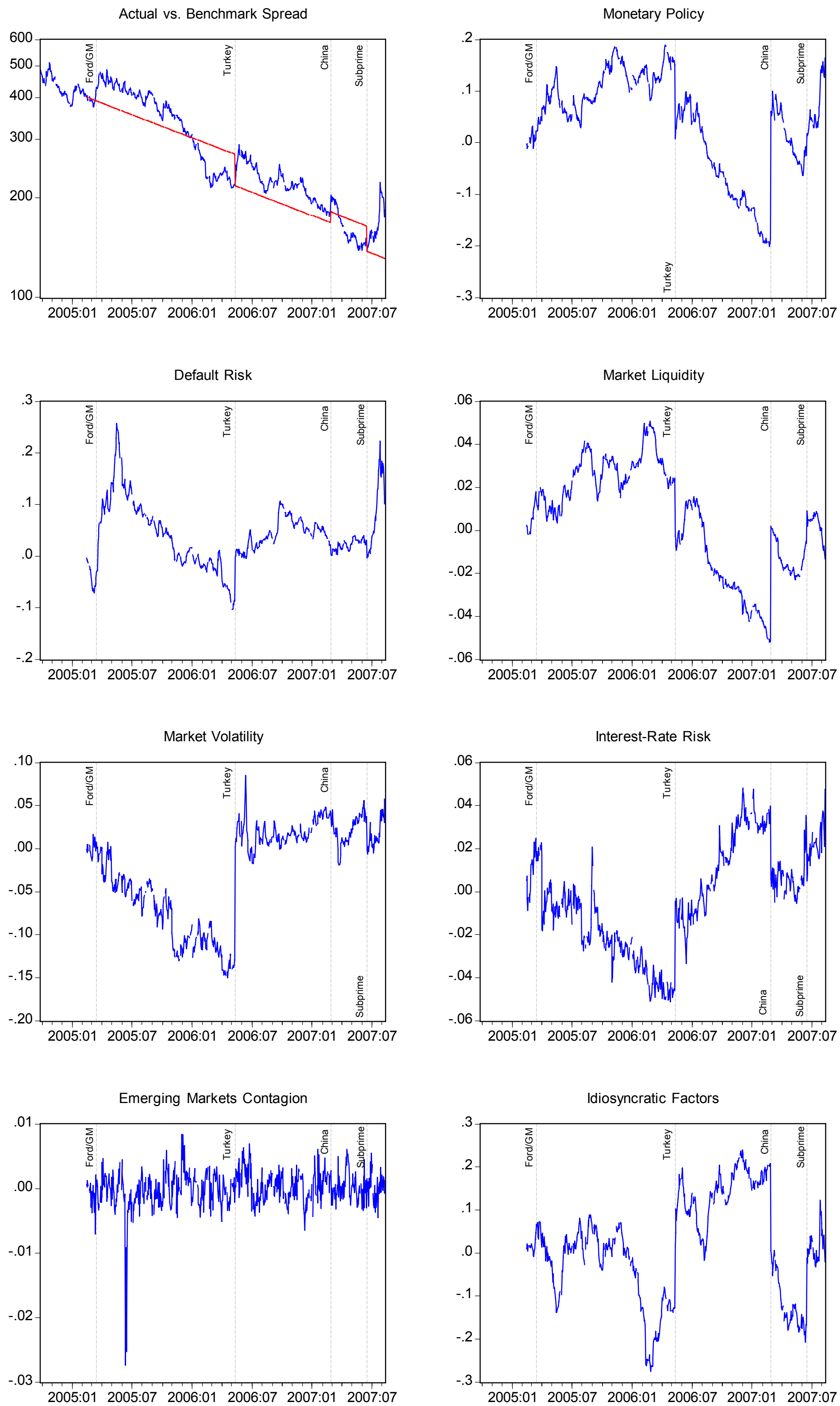

Figure 16. Spread Decomposition (2004–2007)—Bulgaria

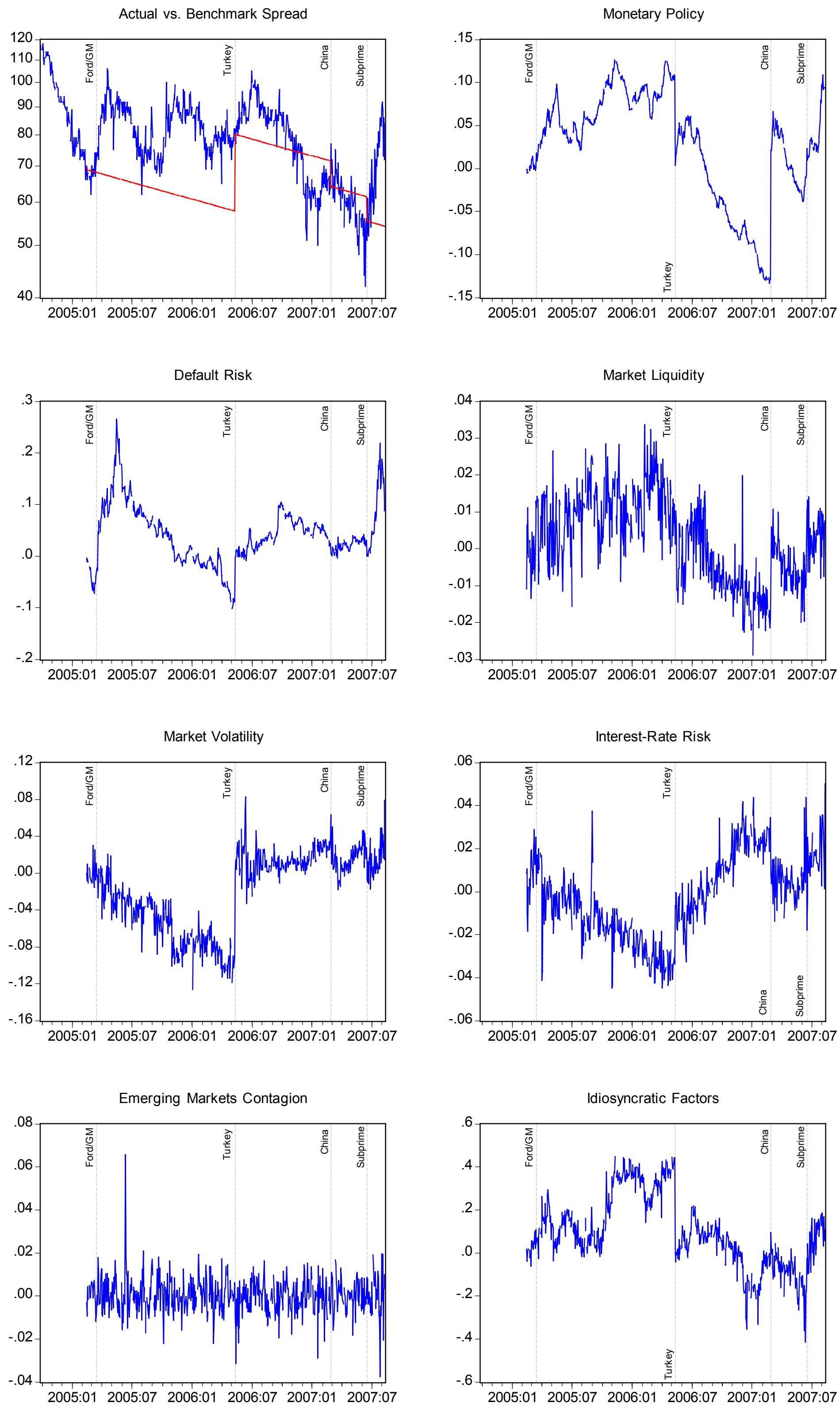

Figure 17. Spread Decomposition (2004–2007)—Colombia

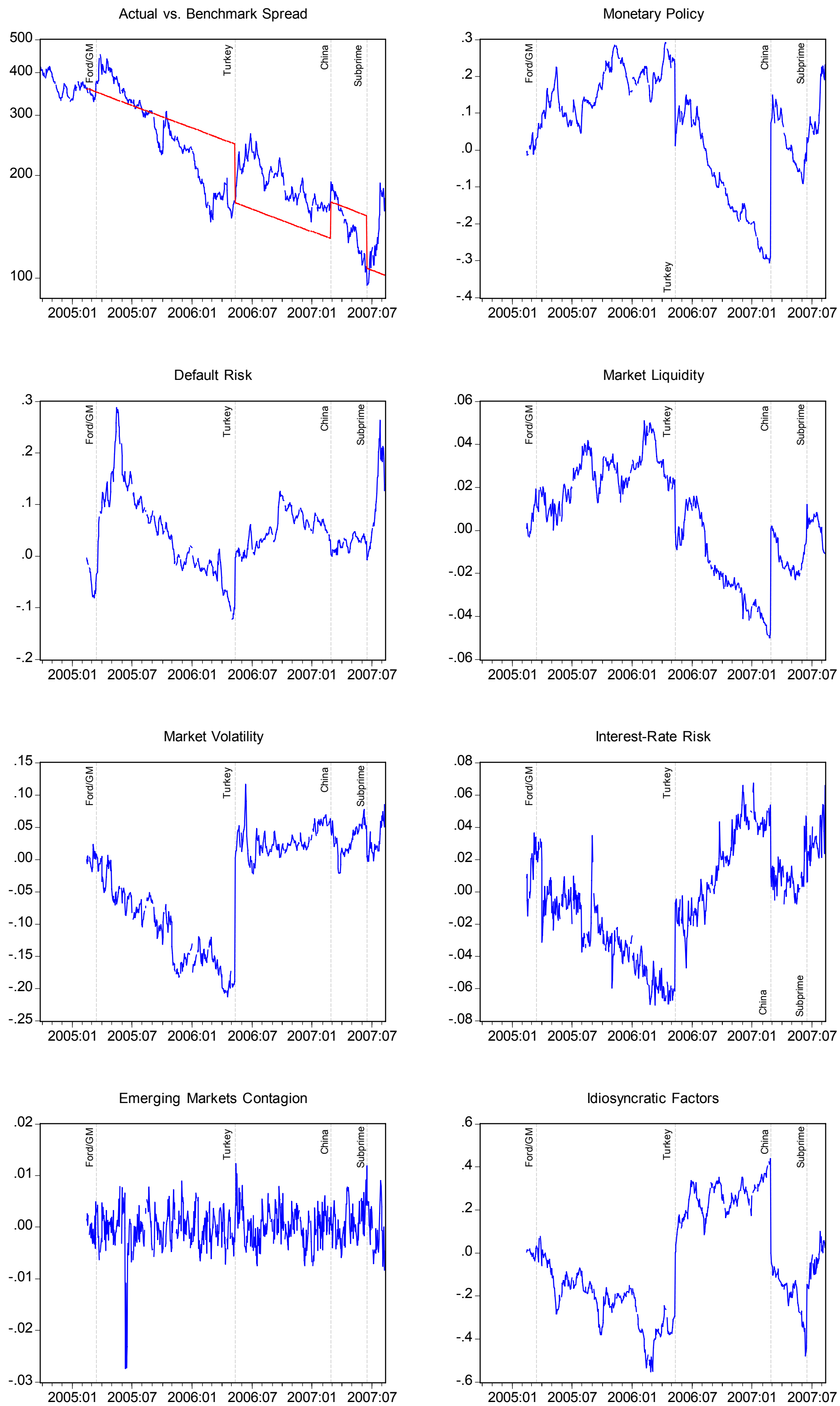

Figure 18. Spread Decomposition (2004–2007)—Ecuador

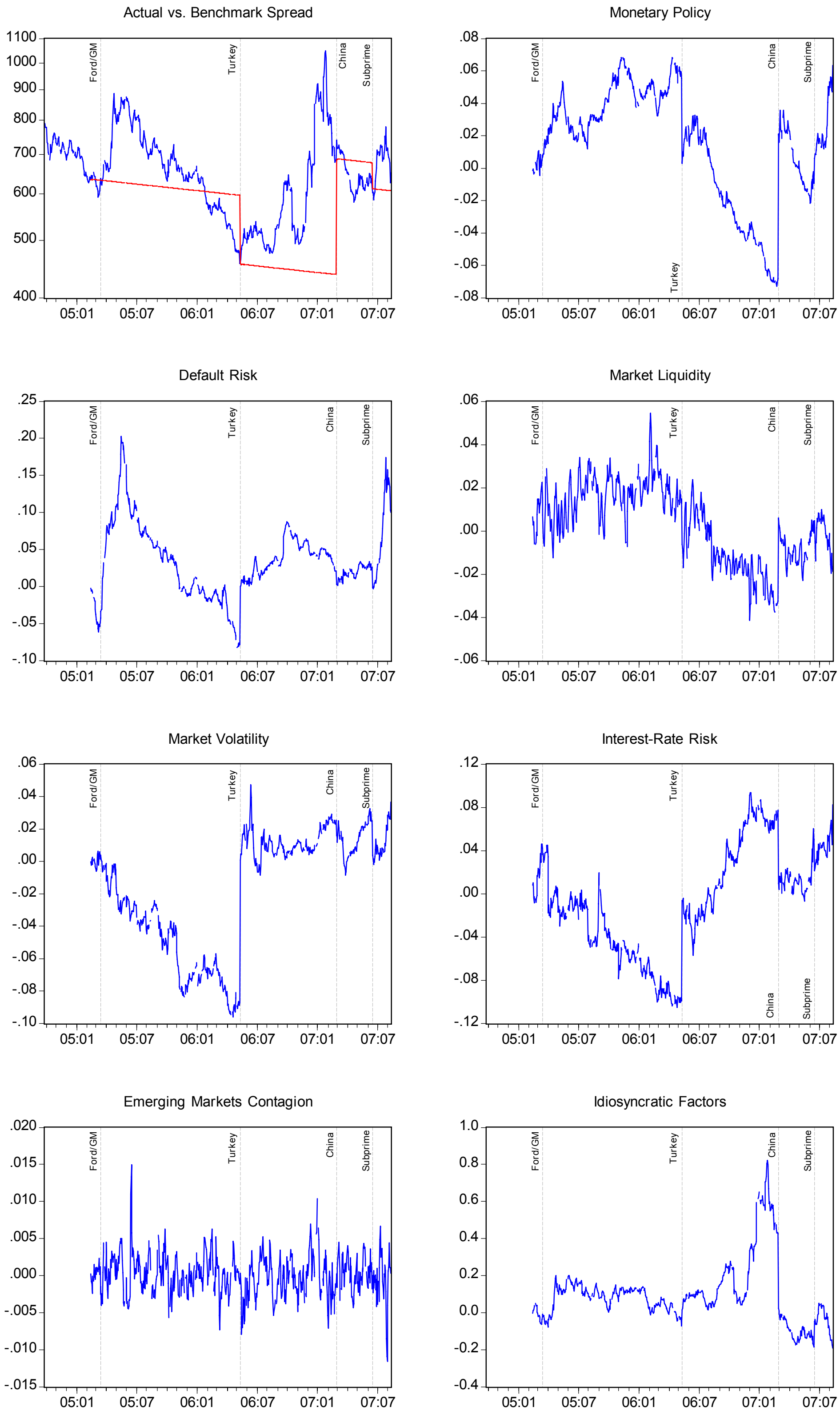

Figure 19. Spread Decomposition (2004–2007)—Mexico

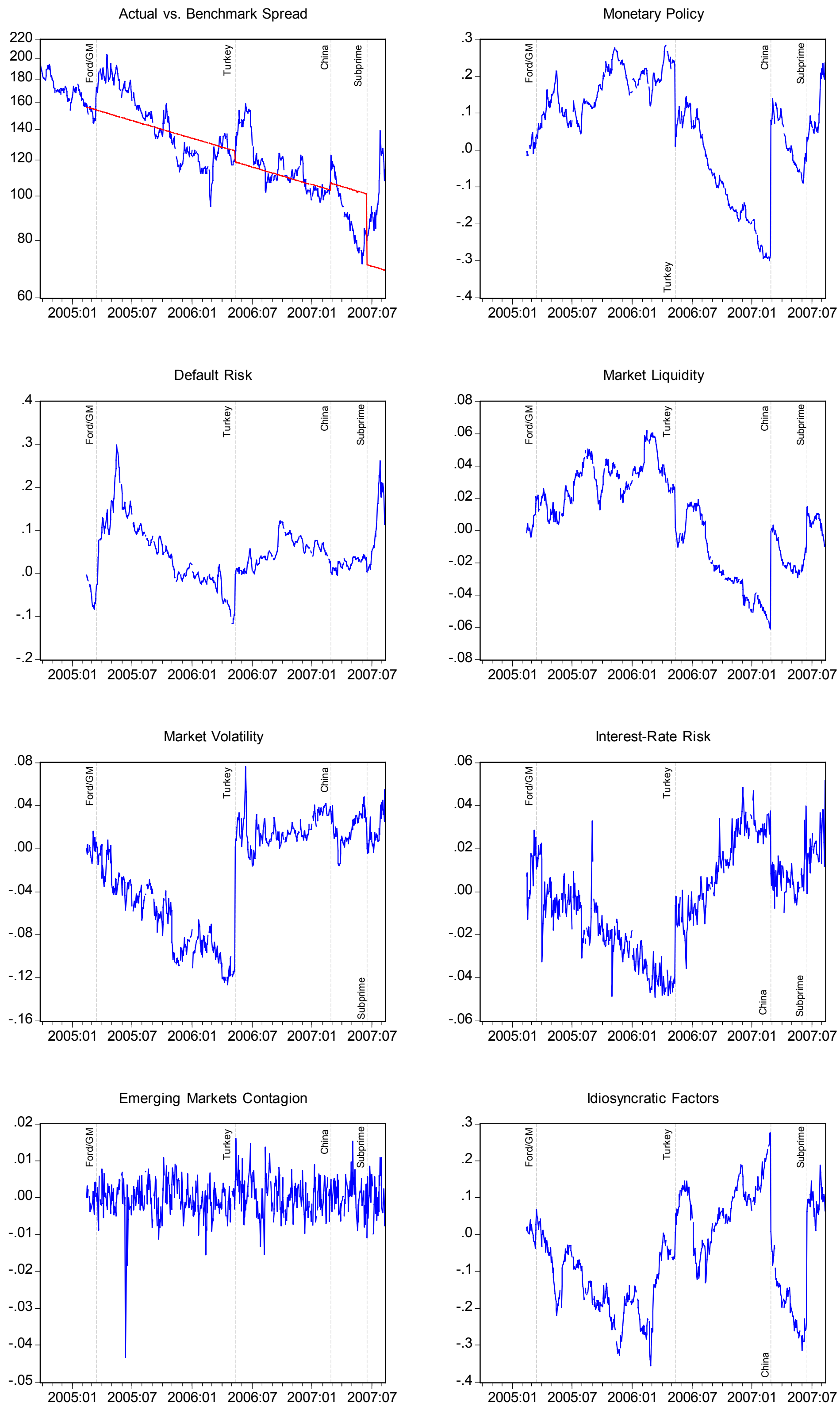

Figure 20. Spread Decomposition (2004–2007)—Panama

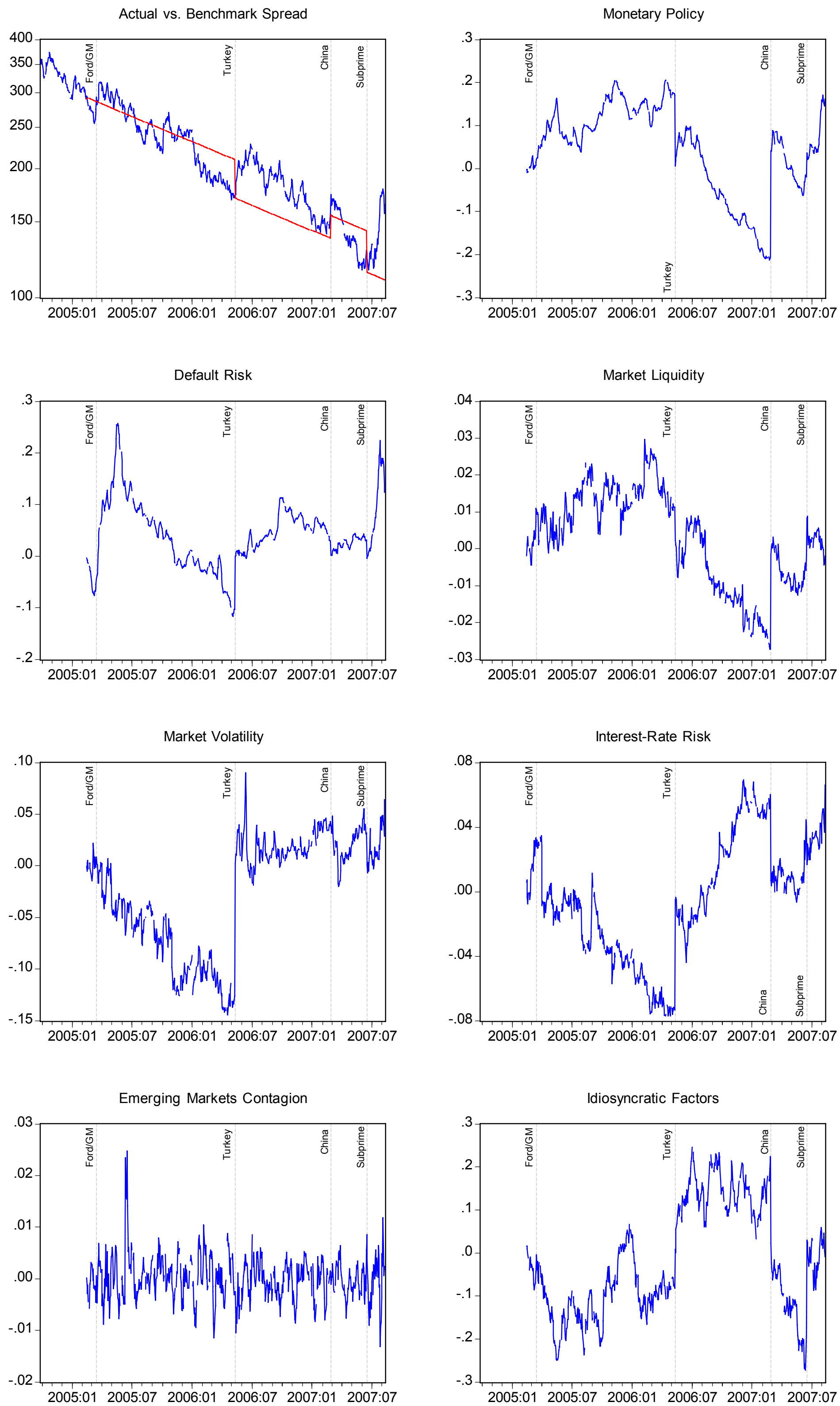

Figure 21. Spread Decomposition (2004–2007)—Peru

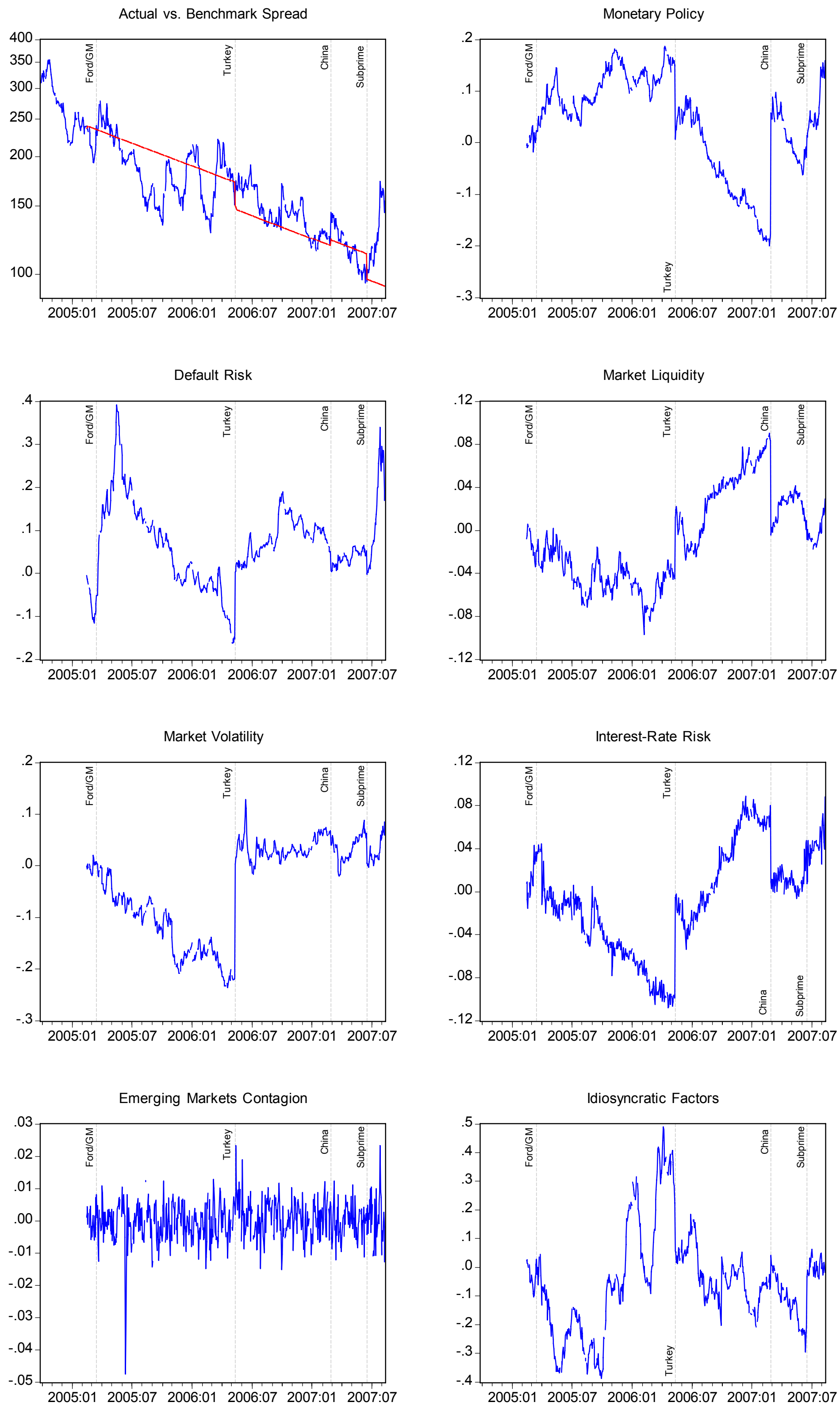

Figure 22. Spread Decomposition (2004–2007)—Philippines

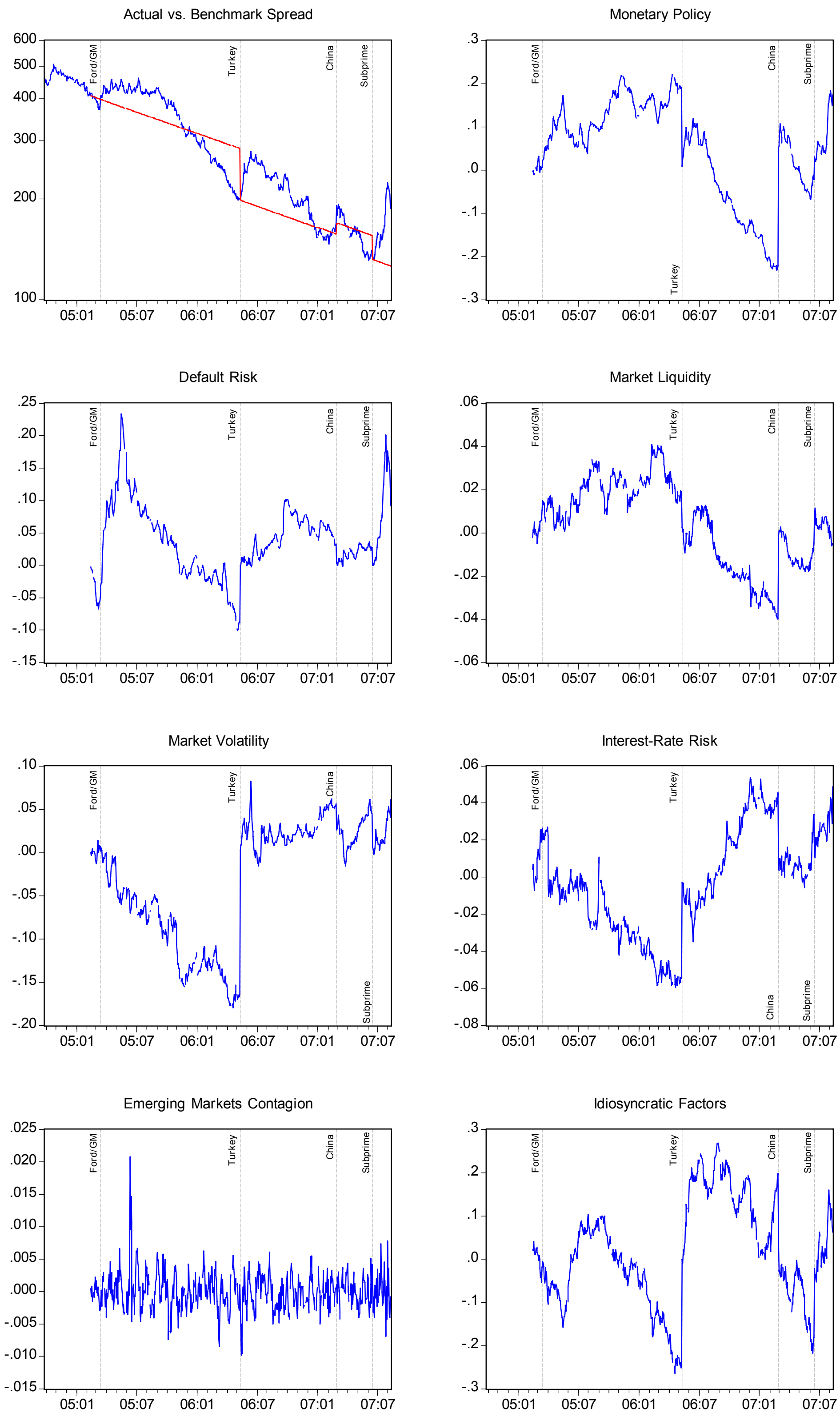

Figure 23. Spread Decomposition (2004–2007)—Russia

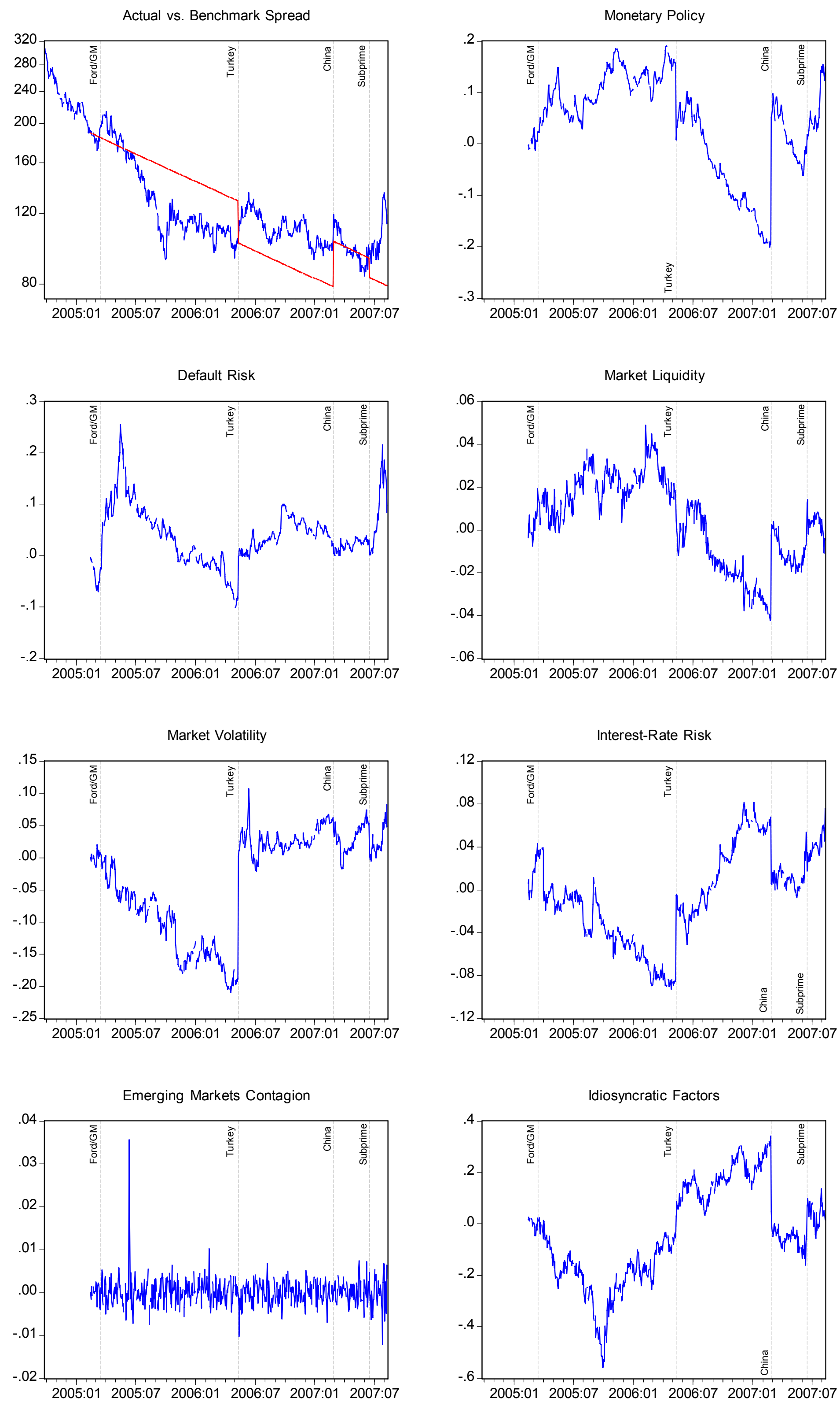

Figure 24. Spread Decomposition (2004–2007)—South Africa

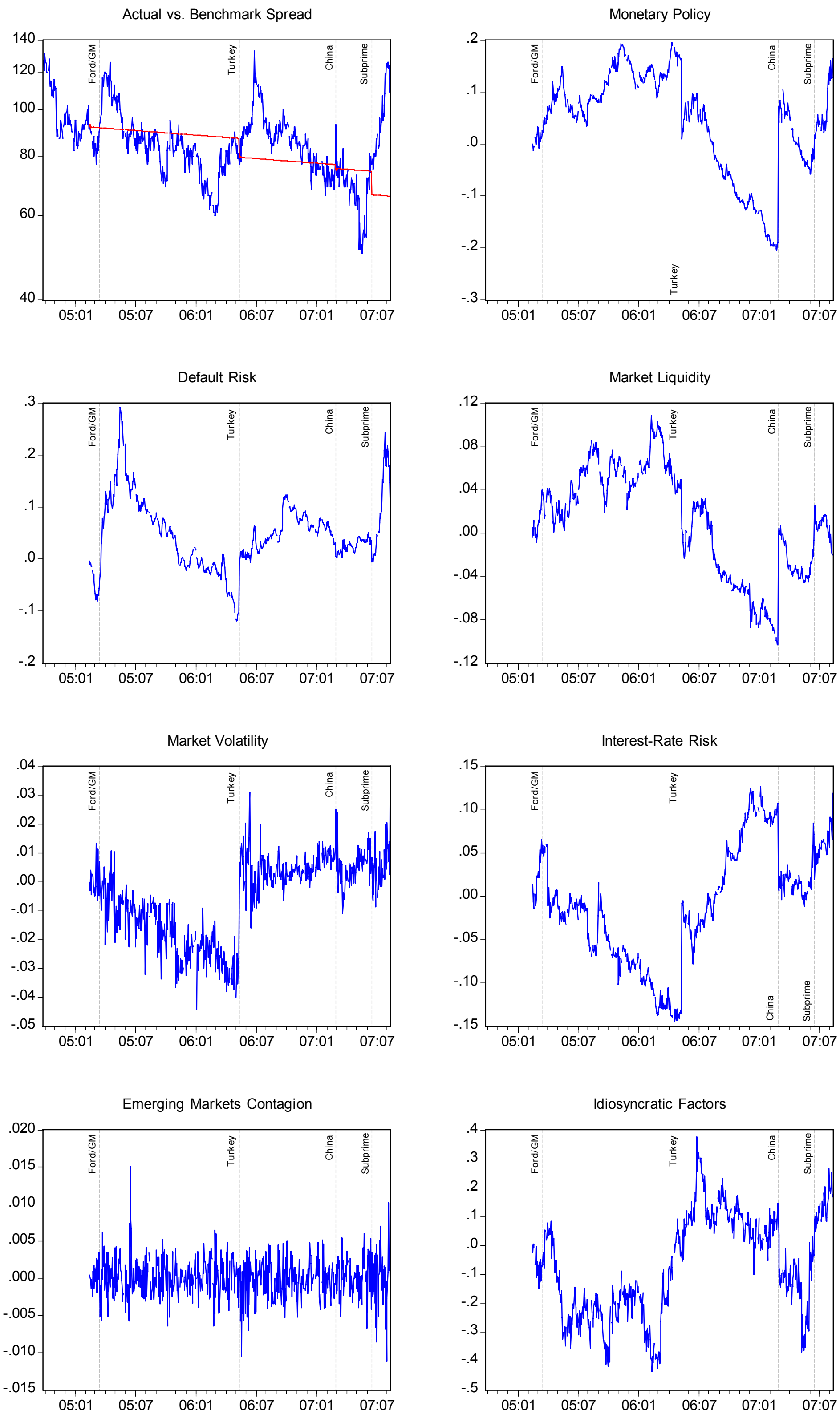

Figure 25. Spread Decomposition (2004–2007)—Turkey

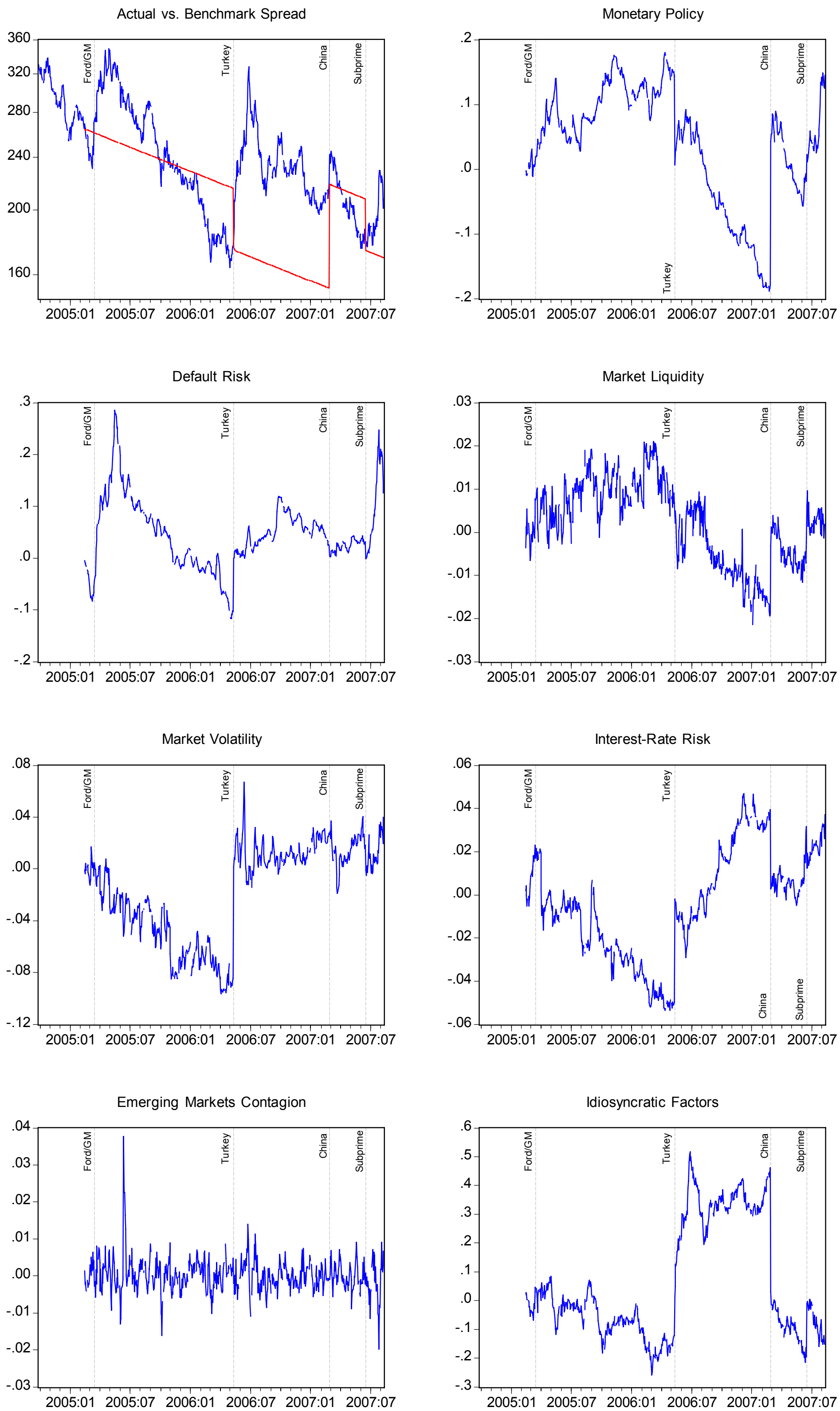

Figure 26. Spread Decomposition (2004–2007)—Ukraine

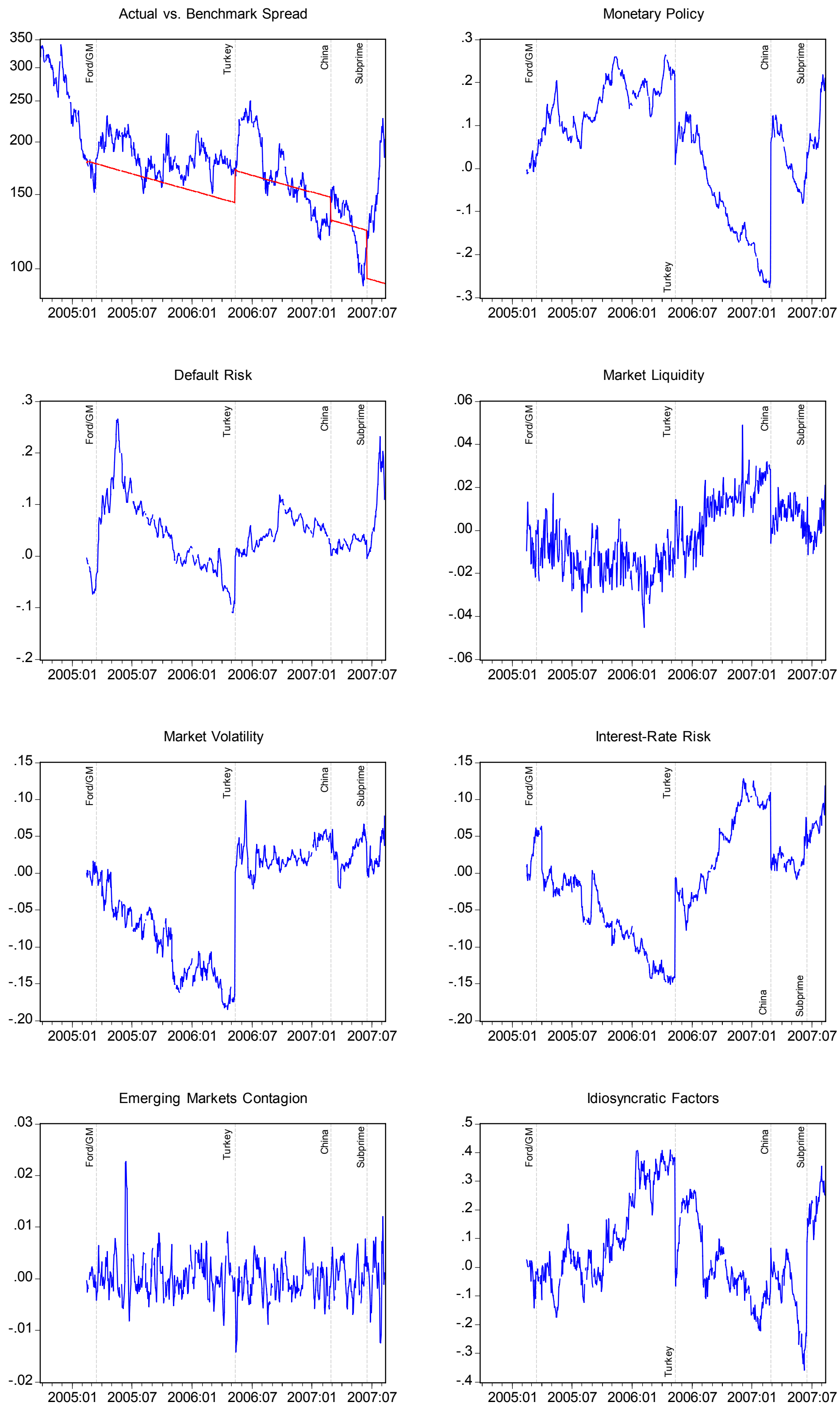

Figure 27. Spread Decomposition (2004–2007)—Venezuela

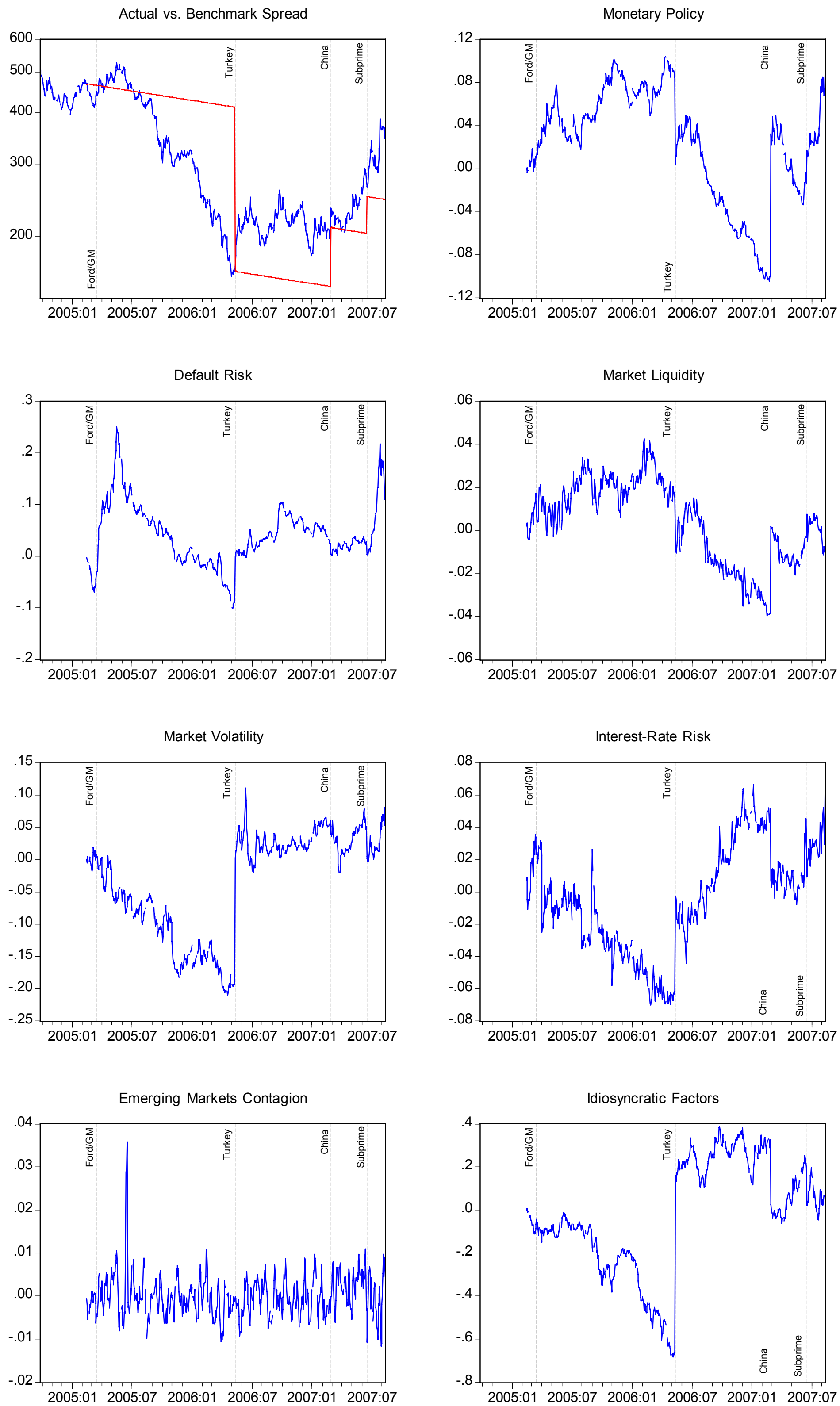

Figure 28. Spread Decomposition (2004–2007)—United States

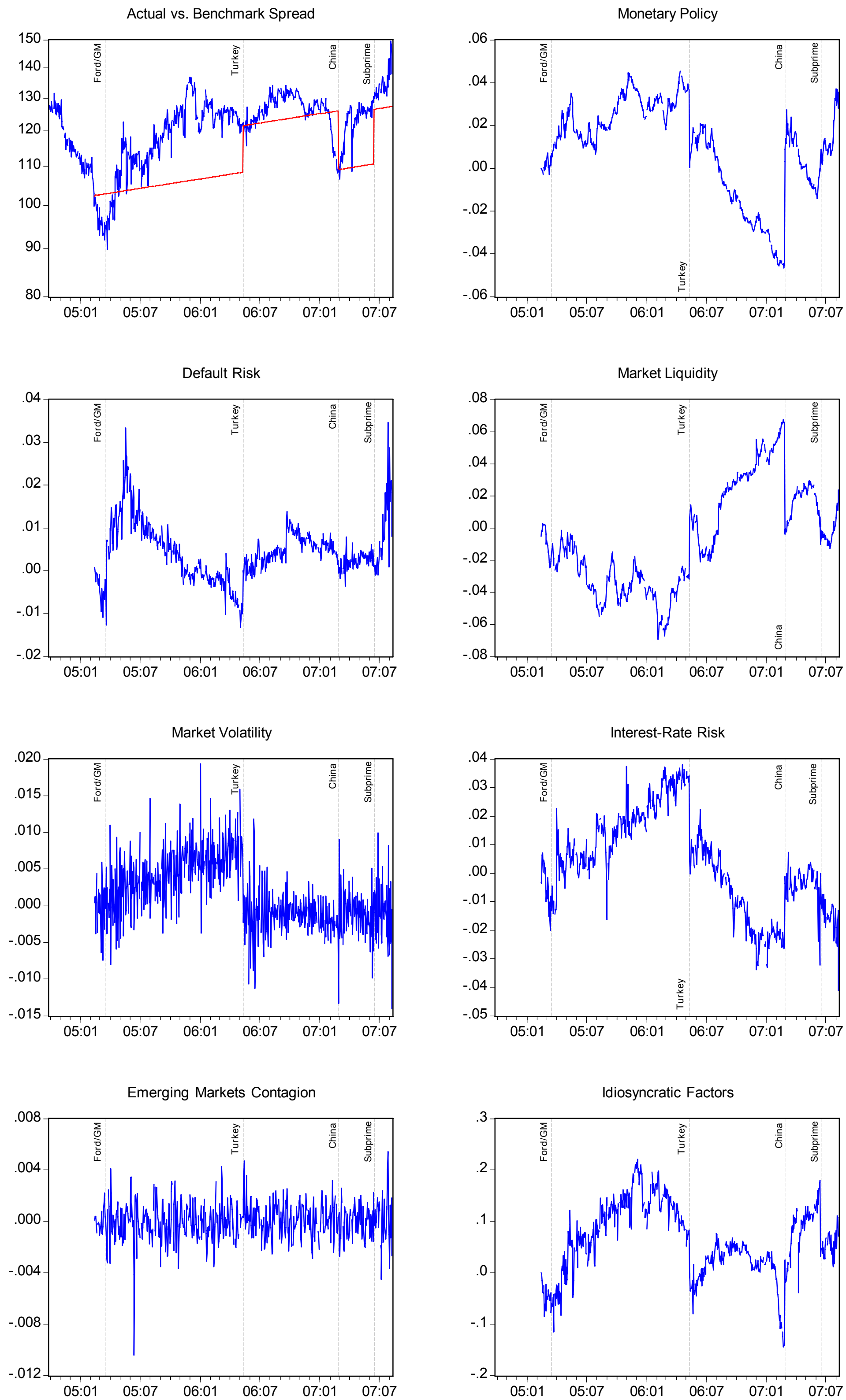

Figure 29. Spread Decomposition (2004–2007)—Canada

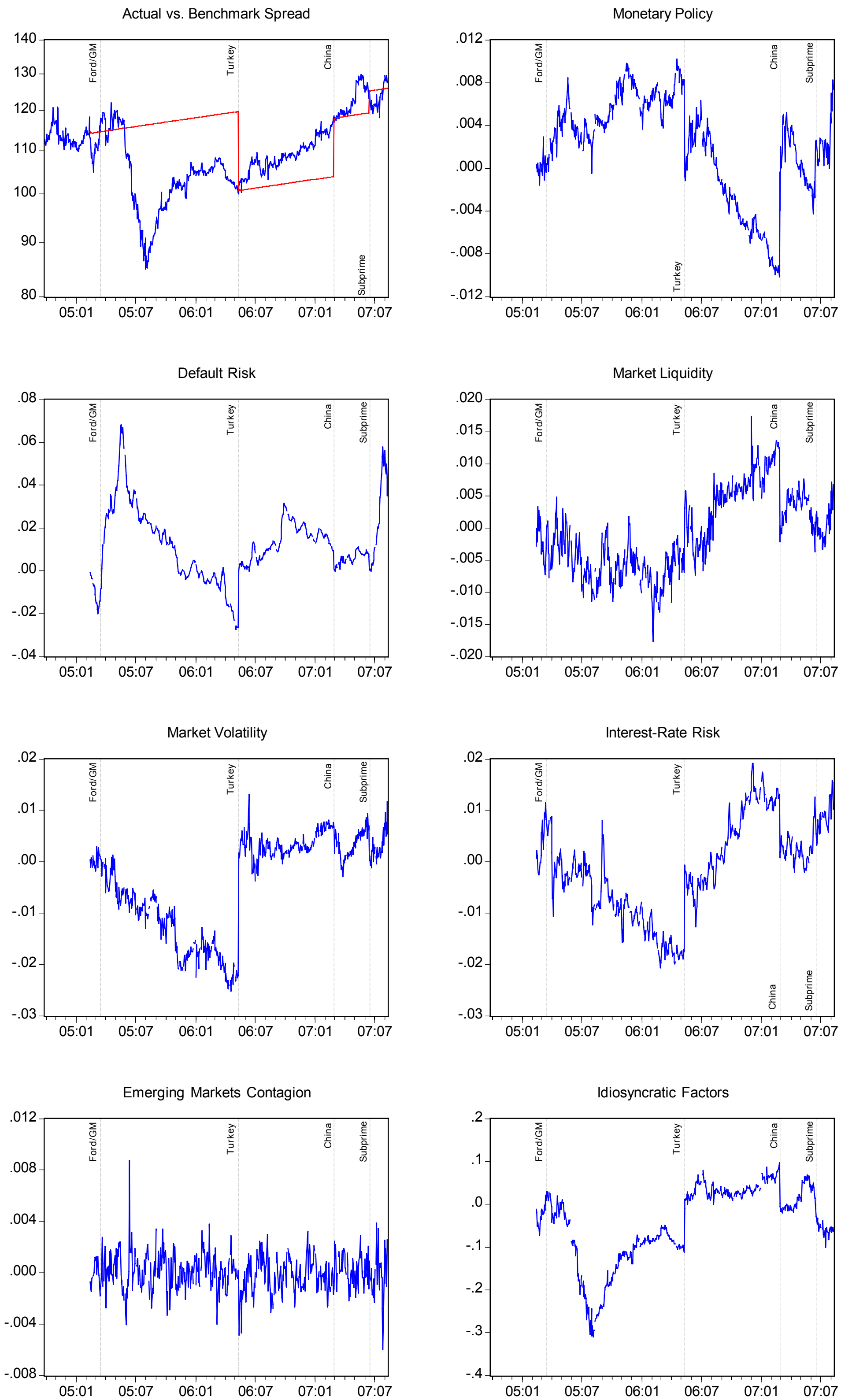

Figure 30. Spread Decomposition (2004–2007)—Japan

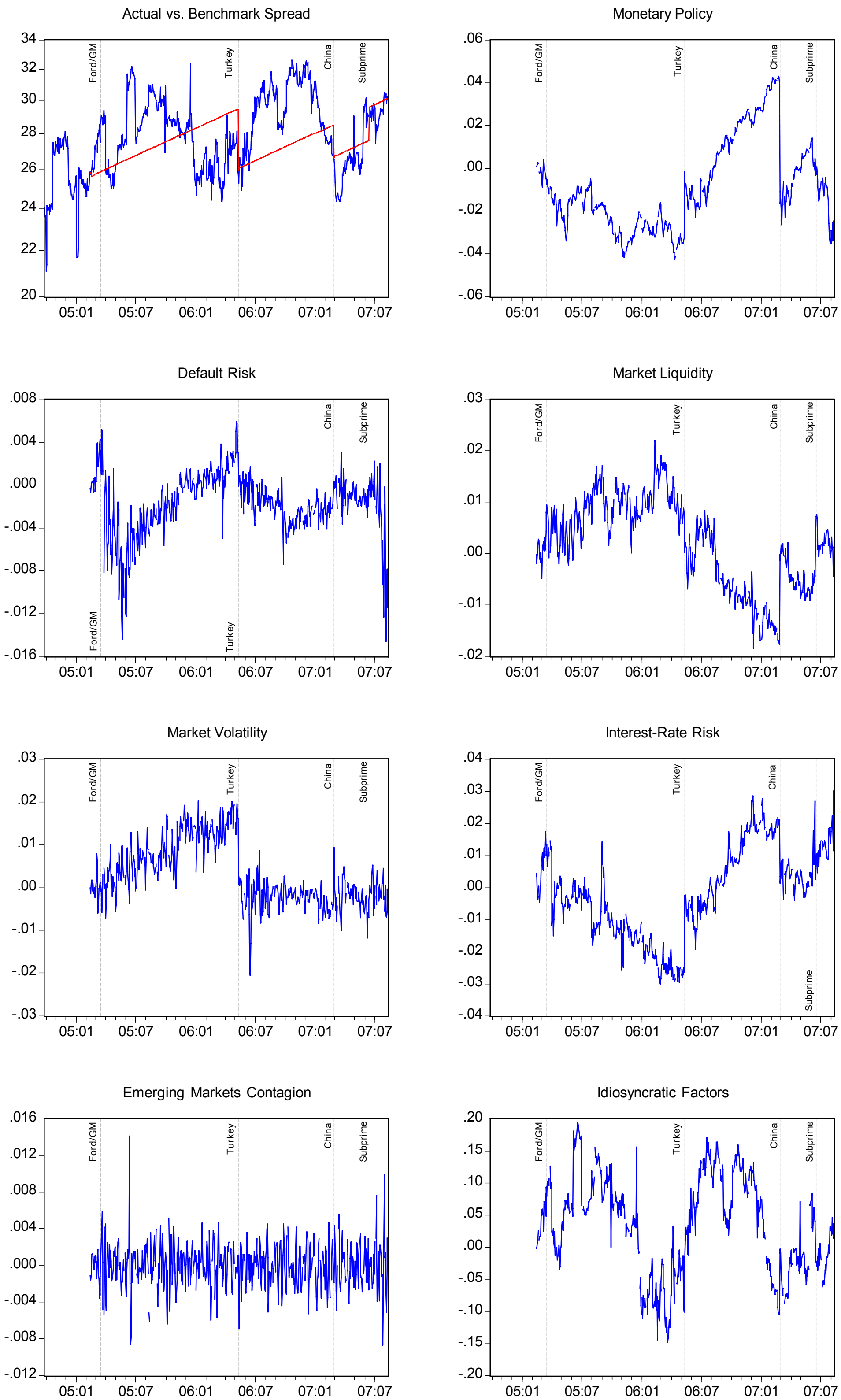

Figure 31. Spread Decomposition (2004–2007)—Eurozone

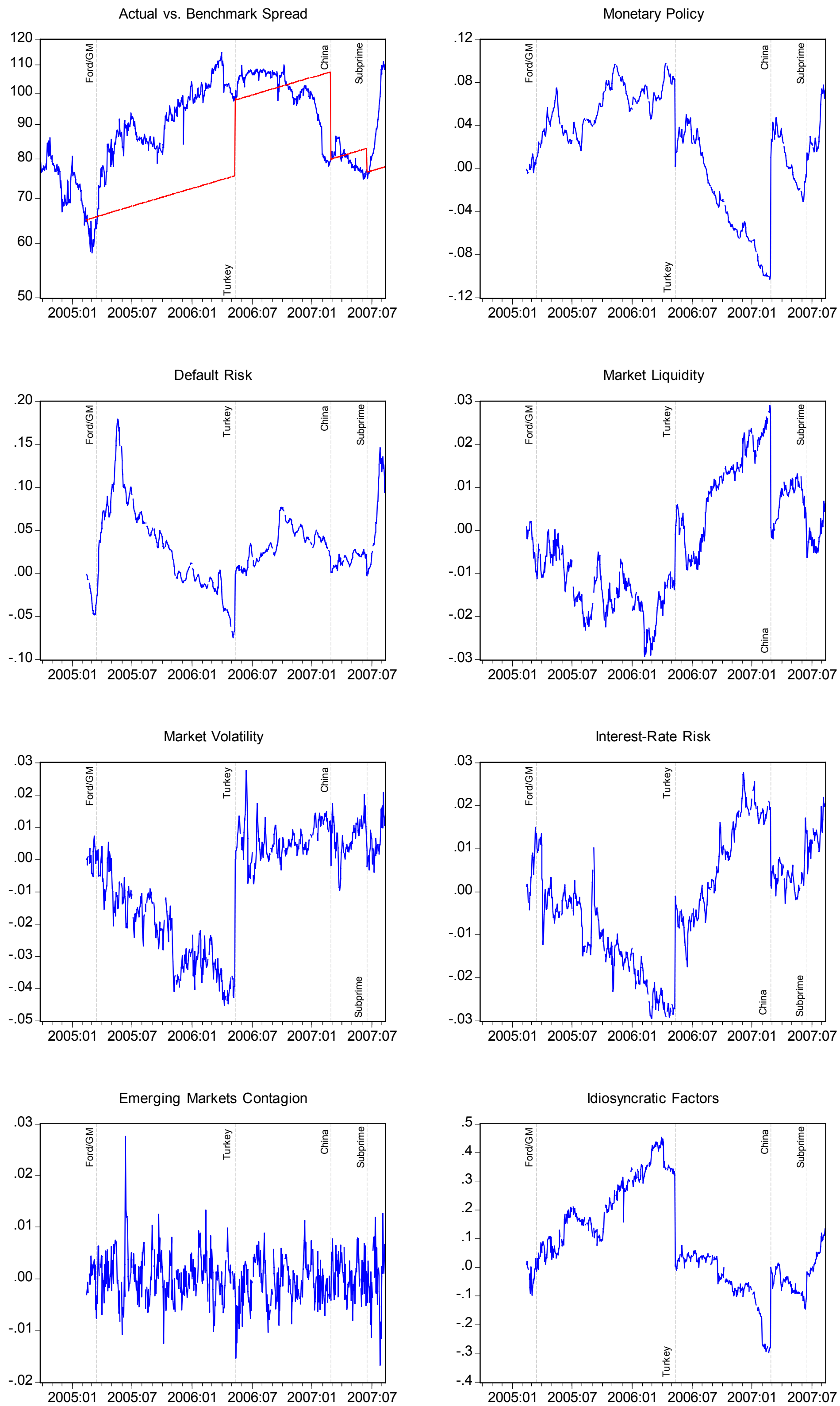

Table 1. Data Sources

Data Description	Source	Mnemonic
10yr Canada Benchmark DS Govt. Index (Redemption Yield)	Datastream	BMCN10Y(RY)
10yr Germany Benchmark DS Govt. Index (Redemption Yield)	Datastream	BMBD10Y(RY)
10yr Japan Benchmark DS Govt. Index (Redemption Yield)	Datastream	BMJP10Y(RY)
10yr USD Swap Rate (Semiannual fixed rate vs 3m LIBOR)	Bloomberg	USSW10 Index
30-day Fed Funds Futures - 3m ahead	Bloomberg	FF4 Comdty
BFV 10yr CAD Canada Corporate BBB Bond Yield	Bloomberg	C28810Y Index
BFV 10yr EUR Eurozone Industrial BBB Bond Yield	Bloomberg	C46810Y Index
BFV 10yr JPY Japan Industrial BBB Bond Yield	Bloomberg	C45410Y Index
BFV 10yr USD US Industrial BBB Bond Yield	Bloomberg	C00910Y Index
CBOE's SPX Volatility Index	Bloomberg	VIX Index
iTRAXX Europe Crossover 10yr, series 1	Bloomberg	ITRXEX01 Index
iTRAXX Europe Crossover 10yr, series 2	Bloomberg	ITRXEX02 Index
iTRAXX Europe Crossover 10yr, series 3	Bloomberg	ITRXEX03 Index
iTRAXX Europe Crossover 10yr, series 4	Bloomberg	ITRXEX04 Index
iTRAXX Europe Crossover 10yr, series 5	Bloomberg	ITRXEX05 Index
iTRAXX Europe Crossover 10yr, series 6	Bloomberg	ITRXEX06 Index
iTRAXX Europe Crossover 10yr, series 7	Bloomberg	ITRXEX07 Index
JP Morgan's EMBI Plus Brazil Sovereign Spread	Bloomberg	JPSSEMBR Index
JP Morgan's EMBI Plus Bulgaria Sovereign Spread	Bloomberg	JPSSEMBU Index
JP Morgan's EMBI Plus Colombia Sovereign Spread	Bloomberg	JPSSEMCO Index
JP Morgan's EMBI Plus Composite Sovereign Spread	Bloomberg	JPEMSOSD Index
JP Morgan's EMBI Plus Ecuador Sovereign Spread	Bloomberg	JPSSEMEC Index
JP Morgan's EMBI Plus Mexico Sovereign Spread	Bloomberg	JPSSEMME Index
JP Morgan's EMBI Plus Panama Sovereign Spread	Bloomberg	JPSSEMPA Index
JP Morgan's EMBI Plus Peru Sovereign Spread	Bloomberg	JPSSEMPE Index
JP Morgan's EMBI Plus Phillipinnes Sovereign Spread	Bloomberg	JPSSEMPH Index
JP Morgan's EMBI Plus Russia Sovereign Spread	Bloomberg	JPSSEMRU Index
JP Morgan's EMBI Plus South Africa Sovereign Spread	Bloomberg	JPSSEMSA Index
JP Morgan's EMBI Plus Turkey Sovereign Spread	Bloomberg	JPSSEMTU Index
JP Morgan's EMBI Plus Ukraine Sovereign Spread	Bloomberg	JPSSEMUK Index
JP Morgan's EMBI Plus Venezuela Sovereign Spread	Bloomberg	JPSSEMVE Index
Lehman Brothers Short Swaption Volatility Index (1m-6m)	Bloomberg	LBSPX Index
Yield on U.S. Treasury securities at 10-year, constant maturity	Bloomberg	H15T10Y Index
Yield on U.S. Treasury securities at 20-year, constant maturity	Bloomberg	H15T20Y Index

Table 2. Variance Decomposition, 1998–2007 (%)

	Federal Funds	Default Risk	Market Liquidity	Market Volatility	Int.-Rate Risk	Emerging Markets	Idiosyn.
Brazil	6.7	3.9	1.8	8.3	4.6	0.2	74.6
Bulgaria	2.0	1.7	0.5	2.9	1.7	12.3	79.0
Ecuador	3.6	2.4	0.5	3.6	2.4	0.8	86.8
Mexico	6.5	3.1	5.0	8.3	2.9	0.8	73.5
Panama	4.1	1.7	3.0	5.2	2.4	3.1	80.5
Peru	3.5	1.3	2.1	4.1	0.7	1.5	86.7
Russia	5.5	1.1	1.8	5.0	2.2	1.0	83.5
Venezuela	5.0	4.2	0.6	6.2	2.1	0.3	81.7
USA	0.9	11.1	1.2	2.2	0.2	4.1	80.2
Canada	0.5	1.0	2.1	0.8	0.6	2.8	92.1

Table 3. Mean Spread Decomposition (1998–2007)
Russian Default / LTCM Bailout (1998)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	Bench.	F. Err.	FF	Def	Liq	Vol	Int	EM	Idios
Brazil	1295	558	737	10.8	7.9	2.6	17.0	3.3	-0.1	58.5
Bulgaria	1291	539	752	9.1	9.7	-1.1	11.4	2.0	-0.4	69.3
Ecuador	1871	774	1097	9.9	9.0	0.1	11.0	2.9	0.0	67.1
Mexico	912	416	496	11.4	7.6	2.9	17.3	2.9	0.0	58.0
Panama	601	339	262	11.6	6.3	5.1	15.7	3.0	-0.3	58.5
Peru	869	434	435	10.5	8.2	2.8	18.1	2.2	-0.2	58.4
Russia	4664	758	3906	5.4	3.8	1.8	6.6	1.8	0.1	80.5
Venezuela	1881	526	1355	4.7	5.7	-0.6	9.9	0.8	0.1	79.3
USA	143	92	50	7.9	-0.2	4.4	3.1	-0.3	-0.2	85.3
Canada	126	84	42	7.8	10.1	4.9	4.9	1.7	-0.1	70.6

Table 4. Mean Spread Decomposition (1998–2007)
Brazil Devaluation (1999)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	Bench.	F. Err.	FF	Def	Liq	Vol	Int	EM	Idios
Brazil	1540	1140	401	9.8	5.2	-1.1	15.3	-1.7	0.0	72.5
Bulgaria	915	757	158	14.5	11.0	0.9	16.7	-1.9	-1.8	60.5
Ecuador	2066	1462	604	8.5	5.7	0.0	9.1	-0.7	0.0	77.5
Mexico	832	657	175	12.9	6.1	-1.6	18.5	-1.8	0.2	65.6
Panama	501	440	61	17.4	6.4	-4.0	21.8	-2.2	-0.9	61.5
Peru	739	573	165	9.8	5.4	-1.1	15.2	-0.6	-0.6	71.9
Russia	5516	5159	356	43.3	24.8	-8.7	54.2	-5.0	-5.8	-2.9
Venezuela	1504	1174	330	8.1	7.3	0.5	16.6	-1.8	0.4	68.8
USA	158	172	-14	-12.9	1.2	3.3	-4.3	-0.5	2.6	110.6
Canada	153	146	7	24.7	23.8	-6.2	15.1	-0.9	-6.5	50.0

Table 5. Mean Spread Decomposition (1998–2007)—NASDAQ Bubble Burst (2000)

	Spread Decomp. (bps)			**Forecast Error Decomposition (%)**						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	758	639	120	51.0	32.3	-2.0	4.0	-15.8	1.8	28.8
Bulgaria	767	568	199	25.7	24.0	-0.2	1.3	-5.3	1.3	53.2
Ecuador	3479	2778	701	37.8	30.2	-0.6	1.9	-12.1	0.4	42.5
Mexico	400	293	107	27.9	15.6	-1.4	2.3	-6.5	0.1	62.1
Panama	433	344	89	27.9	13.1	-1.8	1.4	-7.2	0.5	66.1
Peru	529	408	121	27.3	18.7	-1.7	2.2	-6.6	0.4	59.7
Russia	1323	1819	-496	-28.8	-18.7	1.6	-1.2	11.4	0.6	135.1
Venezuela	965	749	215	23.2	24.4	0.1	2.0	-1.6	-0.5	52.5
USA	188	158	30	19.0	-0.5	-1.9	0.4	0.7	0.4	82.0
Canada	187	174	13	42.7	50.5	-5.6	0.9	-11.1	1.9	20.7

Table 6. Mean Spread Decomposition (1998–2007)—Turkish Crisis (2001)

	Spread Decomp. (bps)			**Forecast Error Decomposition (%)**						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	734	680	54	46.3	39.3	25.1	30.7	10.8	-0.8	-51.3
Bulgaria	774	677	96	22.3	31.7	-8.0	12.3	4.7	1.1	35.9
Ecuador	1261	1219	41	96.8	119.0	-1.1	51.2	18.1	0.1	-184.1
Mexico	418	380	38	33.6	28.9	20.3	26.6	7.5	-0.4	-16.5
Panama	470	448	22	50.4	35.2	54.1	32.1	10.7	0.2	-82.7
Peru	639	676	-37	-50.1	-50.8	-26.9	-31.1	-6.1	1.7	263.3
Russia	1064	1007	57	63.5	64.5	51.6	35.0	12.8	-1.1	-126.3
Venezuela	850	842	8	228.3	365.0	-79.7	211.3	59.4	2.5	-686.8
USA	201	190	11	24.0	-1.2	28.7	1.6	-1.6	0.1	48.4
Canada	235	230	5	56.6	106.1	77.5	20.3	8.0	-1.2	-167.4

Table 7. Mean Spread Decomposition (1998–2007)—September 11th (2001)

	Spread Decomp. (bps)			**Forecast Error Decomposition (%)**						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	1155	974	181	-59.5	-11.4	17.6	73.8	25.7	-0.6	54.3
Bulgaria	666	595	71	-79.7	-21.7	-15.5	79.8	24.1	-2.4	115.4
Ecuador	1534	1427	107	-134.0	-31.8	-0.8	121.3	59.5	-1.2	87.1
Mexico	408	352	56	-67.9	-11.8	20.6	84.0	23.4	-0.2	51.9
Panama	479	400	80	-40.4	-5.9	23.2	44.5	14.9	-0.2	63.9
Peru	663	608	56	-94.6	-18.9	28.3	125.6	30.1	-1.7	31.2
Russia	923	832	91	-102.6	-19.5	44.4	103.2	54.3	-1.1	21.4
Venezuela	1017	924	94	-70.6	-22.4	-13.0	117.7	10.3	0.5	77.5
USA	208	188	20	-37.8	0.3	26.4	10.6	-2.0	-1.0	103.4
Canada	219	199	21	-35.8	-12.0	28.6	18.9	12.5	-1.6	89.4

Table 8. Mean Spread Decomposition (1998–2007)—Brazilian Elections / WorldCom Accounting Scandal (2002)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	1904	709	1195	19.0	-6.5	2.9	7.0	0.0	0.0	77.6
Bulgaria	366	349	17	345.9	-175.2	-39.8	105.0	1.7	-3.6	-134.0
Ecuador	1703	953	750	30.8	-13.1	-0.3	8.0	0.1	0.0	74.4
Mexico	375	227	148	35.5	-11.1	5.7	13.3	0.1	0.0	56.5
Panama	513	346	167	34.6	-8.5	10.0	10.5	0.1	-0.1	53.5
Peru	780	424	356	24.8	-8.9	3.7	9.8	0.1	0.0	70.6
Russia	565	432	134	72.9	-24.8	16.4	21.0	0.0	-0.2	14.8
Venezuela	1109	904	205	57.9	-34.4	-6.0	28.7	0.5	0.2	53.1
USA	174	194	-20	-66.3	-1.0	-23.7	-6.1	0.1	0.4	196.6
Canada	193	191	2	590.5	-358.1	223.5	84.3	-0.5	-6.5	-433.2

Table 9. Mean Spread Decomposition (1998–2007)—Federal Funds Tightening (2003)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	697	531	166	22.5	9.9	-9.3	-18.1	0.6	-0.2	94.6
Bulgaria	179	156	23	39.9	24.9	11.6	-25.9	-0.2	-2.2	51.9
Ecuador	901	696	205	23.1	12.5	0.5	-13.3	1.2	-0.2	76.2
Mexico	215	176	39	30.3	11.9	-12.5	-24.3	0.2	0.0	94.5
Panama	367	332	34	45.3	14.9	-35.7	-31.9	1.4	-0.2	106.2
Peru	456	335	121	16.4	7.7	-6.5	-13.8	0.8	-0.1	95.6
Russia	302	243	60	29.7	13.1	-17.8	-19.2	2.5	-0.2	91.9
Venezuela	658	638	20	133.8	97.4	36.9	-147.6	-8.8	3.1	-14.7
USA	122	116	6	45.2	-1.0	-42.3	-7.7	0.3	-1.0	106.5
Canada	96	89	7	29.7	24.0	-28.8	-9.1	1.4	-0.9	83.8

Table 10. Mean Spread Decomposition (1998–2007)—Ford/GM Downgrades (2004)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	450	394	56	49.6	7.9	-9.4	-11.0	1.5	-0.5	61.9
Bulgaria	88	65	23	19.5	4.9	2.9	-3.4	0.4	0.2	75.4
Ecuador	736	634	103	41.9	8.7	0.6	-7.1	2.0	0.0	53.8
Mexico	184	153	31	34.4	5.1	-6.4	-8.1	0.7	0.0	74.2
Panama	299	289	10	138.0	17.8	-49.6	-29.3	4.7	-0.7	19.2
Peru	241	233	8	167.2	30.9	-29.8	-39.9	6.9	-2.2	-33.1
Russia	194	183	11	115.4	19.6	-32.2	-21.5	6.8	-1.4	13.3
Venezuela	476	464	12	175.3	50.0	23.5	-54.9	-3.1	1.3	-92.1
USA	104	102	2	151.3	-0.8	-65.1	-5.9	0.4	-3.0	23.2
Canada	117	115	2	110.5	34.9	-52.8	-10.5	3.6	-5.7	20.0

Table 11. Mean Spread Decomposition (1998–2007)—Turkish Crisis (2006)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	257	215	42	31.1	5.2	-4.0	8.2	-7.2	-0.5	67.3
Bulgaria	90	79	11	36.8	8.6	3.0	6.8	-5.9	-0.4	51.0
Ecuador	509	455	54	46.5	10.2	0.1	7.9	-10.4	-0.4	46.2
Mexico	138	117	21	31.8	5.1	-4.3	8.0	-5.8	-0.1	65.4
Panama	206	169	37	20.3	2.7	-4.9	4.2	-3.8	0.0	81.6
Peru	169	150	20	34.2	6.5	-4.7	10.2	-6.6	-0.7	61.1
Russia	121	99	22	29.0	4.8	-5.5	5.5	-8.1	-0.2	74.4
Venezuela	215	165	51	13.5	3.9	1.1	4.3	-0.8	0.1	78.0
USA	123	123	1	291.4	-2.2	-88.1	17.6	7.4	-7.8	-118.3
Canada	105	101	4	45.9	13.4	-15.3	4.5	-8.2	-2.2	62.0

Table 12. Mean Spread Decomposition (1998–2007)—Chinese Correction (2007)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	196	182	14	49.0	-3.7	-1.0	47.0	16.1	-0.4	-7.1
Bulgaria	68	64	4	61.7	-5.2	0.8	45.7	13.7	0.8	-17.5
Ecuador	715	692	24	108.1	-7.6	0.0	74.0	35.9	-0.5	-109.9
Mexico	114	107	7	56.7	-3.8	-0.8	52.6	14.0	-0.7	-18.1
Panama	167	156	11	40.3	-2.4	-2.1	33.7	11.3	0.2	18.9
Peru	138	125	14	29.3	-1.8	-0.6	29.8	7.0	0.2	36.0
Russia	112	103	10	44.3	-2.6	-1.4	33.0	17.3	0.0	9.5
Venezuela	225	209	15	36.1	-3.5	0.4	44.8	4.2	0.1	17.8
USA	112	109	3	53.0	-0.6	-3.1	11.4	-1.8	0.8	40.3
Canada	118	118	0	-578.0	63.9	47.4	-264.9	-170.1	0.9	1000.8

Table 13. Mean Spread Decomposition (1998–2007)—Subprime Mortgages Crisis (2007)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	167	136	31	15.8	11.5	-1.5	18.8	14.6	-0.5	41.3
Bulgaria	70	54	16	11.1	11.9	1.3	10.5	7.1	0.5	57.7
Ecuador	682	612	70	27.3	26.2	0.8	24.1	28.1	-0.7	-5.8
Mexico	99	70	29	9.2	6.2	-0.7	10.3	6.8	0.0	68.2
Panama	139	114	25	11.5	6.5	-2.1	12.0	9.6	0.0	62.6
Peru	126	95	31	8.8	7.4	-0.6	11.8	6.7	0.0	66.0
Russia	106	82	24	12.7	9.7	-1.9	12.3	15.5	-0.3	52.0
Venezuela	318	253	65	9.0	11.2	0.9	14.2	2.5	0.3	62.0
USA	135	126	8	18.6	-0.7	-4.2	4.8	-1.9	-1.1	84.6
Canada	124	125	-2	-76.9	-105.6	17.9	-38.8	-60.0	10.5	352.9

Table 14. Variance Decomposition, 2004–2007 (percent)

	Federal Funds	Default Risk	Market Liquidity	Market Volatility	Int.-Rate Risk	Emerging Markets	Idiosyn.
Brazil	16.2	14.7	0.6	12.9	5.1	1.7	48.8
Bulgaria	0.7	3.6	1.9	6.8	2.3	2.4	82.3
Colombia	14.5	10.8	0.6	10.1	6.7	1.4	56.0
Ecuador	1.8	6.9	3.7	2.0	7.9	0.7	76.9
Egypt	0.5	2.7	1.2	6.2	1.5	0.9	87.0
Mexico	20.1	14.4	1.0	8.0	6.3	3.6	46.6
Panama	8.0	9.0	0.7	12.9	4.8	1.6	63.0
Peru	7.8	13.0	2.4	6.2	6.1	3.4	61.2
Philippines	15.1	12.2	1.6	8.2	4.0	1.7	57.0
Russia	7.1	10.1	1.6	8.2	3.4	1.3	68.3
South Africa	4.3	4.1	1.4	2.1	3.6	0.6	84.0
Turkey	9.7	12.2	1.6	6.8	1.8	2.3	65.5
Ukraine	7.7	5.8	3.7	6.2	4.0	0.5	72.0
Venezuela	3.8	9.8	1.5	10.9	6.4	1.3	66.3
USA	1.1	1.9	1.7	4.4	3.9	0.3	86.5
Canada	0.5	1.9	2.9	1.8	1.6	0.9	90.4
Japan	0.9	0.6	0.6	1.5	1.9	0.9	93.5
Eurozone	2.4	4.6	0.6	2.5	0.9	4.0	84.9

Table 15. Mean Spread Decomposition (2004–2007)—Ford/GM Downgrades (2005)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	Bench.	F. Err.	FF	Def	Liq	Vol	Int	EM	Idios
Brazil	450	380	70	48.3	64.9	6.6	-12.7	0.0	-0.1	-7.1
Bulgaria	88	67	21	19.3	40.1	2.1	-5.9	-0.2	0.8	43.8
Colombia	402	341	61	75.1	76.6	6.7	-17.9	0.5	-0.1	-40.8
Ecuador	736	630	106	18.9	54.6	3.7	-8.3	0.8	0.8	29.5
Mexico	184	152	32	61.6	65.8	7.3	-9.2	0.1	-0.2	-25.4
Panama	299	280	19	135.1	165.2	9.1	-32.3	2.8	0.6	-180.5
Peru	241	230	11	168.0	340.3	-39.3	-68.8	9.1	-1.9	-307.5
Philippines	431	388	43	89.1	93.9	8.7	-23.6	2.0	0.7	-70.9
Russia	194	180	14	104.8	136.1	12.0	-36.9	3.7	0.3	-119.9
South Africa	109	91	17	47.9	72.2	13.3	-3.2	2.7	0.2	-33.0
Turkey	315	257	58	37.0	59.3	2.3	-7.2	0.1	0.6	7.9
Ukraine	203	175	28	74.1	75.6	-3.2	-16.9	3.6	0.9	-34.0
Venezuela	476	460	16	131.6	322.0	23.6	-85.5	1.3	6.9	-299.9
USA	104	103	1	258.4	148.3	-202.1	15.4	19.6	-4.0	-135.5
Canada	117	115	2	18.6	160.9	-10.5	-18.7	1.2	2.8	-54.3
Japan	27	26	1	-75.8	-13.8	18.7	6.5	0.4	1.3	162.7
Eurozone	78	66	12	25.4	46.1	-3.7	-3.8	0.5	1.0	34.4

Table 16. Mean Spread Decomposition (2004–2007)—Turkish Crisis (2006)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	257	210	46	30.9	6.9	3.1	8.0	-6.0	0.6	56.6
Bulgaria	90	79	11	31.2	10.3	1.1	9.8	-7.0	-0.9	55.5
Colombia	223	161	62	29.4	4.3	1.9	7.3	-5.1	0.1	62.1
Ecuador	509	454	55	18.5	12.2	4.8	10.0	-20.1	-0.9	75.4
Mexico	138	117	21	53.7	8.6	3.7	8.4	-6.8	1.7	30.8
Panama	206	166	40	30.9	6.5	1.3	8.0	-8.5	-0.3	62.2
Peru	169	143	26	33.3	20.8	-4.7	20.0	-14.7	1.0	44.2
Philippines	250	193	57	29.6	5.2	1.6	7.6	-5.5	-0.1	61.7
Russia	121	98	23	29.3	6.2	2.2	10.9	-10.9	-0.1	62.4
South Africa	98	79	19	29.8	8.5	5.2	2.0	-16.4	-0.1	71.0
Turkey	255	171	84	14.6	4.8	0.4	3.1	-3.1	0.3	79.9
Ukraine	219	168	51	32.1	6.3	-1.6	8.1	-13.6	-0.3	69.1
Venezuela	215	163	52	11.8	5.3	1.7	8.9	-6.1	-0.2	78.7
USA	123	122	1	126.6	14.6	-74.9	-9.6	76.5	2.3	-35.6
Canada	105	101	4	7.7	11.8	-4.5	7.2	-13.0	-1.3	92.2
Japan	28	26	1	-23.9	-1.1	3.5	-3.5	-13.3	-0.2	138.5
Eurozone	106	99	7	47.2	15.9	-5.0	7.3	-10.7	-2.0	47.4

Table 17. Mean Spread Decomposition (2004–2007)—Chinese Correction (2007)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	196	180	17	80.3	9.6	-1.5	30.2	5.2	-1.0	-22.8
Bulgaria	68	64	4	77.4	14.9	1.2	36.6	6.9	4.5	-41.4
Colombia	180	166	14	132.7	9.2	-1.5	44.7	8.8	0.2	-94.2
Ecuador	715	687	29	60.7	18.2	-5.6	39.5	24.4	2.0	-39.3
Mexico	114	106	8	145.8	8.7	-1.2	30.5	7.7	1.1	-92.6
Panama	167	154	12	94.6	11.0	0.1	34.8	10.0	0.4	-51.0
Peru	138	122	16	54.1	11.8	3.3	33.4	7.0	-1.6	-8.0
Philippines	185	169	16	87.5	5.6	-0.1	29.8	6.5	0.5	-29.7
Russia	112	101	11	70.7	7.3	-0.4	33.7	8.7	0.5	-20.6
South Africa	76	75	1	463.9	61.3	-12.4	50.7	84.2	-1.0	-546.7
Turkey	238	218	20	77.1	10.5	0.6	21.6	5.5	1.4	-16.7
Ukraine	150	130	20	68.6	6.3	1.4	22.4	9.4	0.8	-9.0
Venezuela	225	210	15	52.3	11.3	-2.5	53.4	9.6	2.2	-26.4
USA	112	109	3	62.1	3.1	7.8	-5.4	-11.5	-1.7	45.7
Canada	118	118	0	196.5	155.2	74.9	397.2	215.2	50.4	-989.4
Japan	25	27	-2	23.6	0.3	-0.3	2.2	-4.4	-0.7	79.4
Eurozone	82	80	2	132.3	21.5	1.8	31.1	12.3	6.7	-105.6

Table 18. Mean Spread Decomposition (2004–2007)—Subprime Mortgages Crisis (2007)

	Spread Decomp. (bps)			Forecast Error Decomposition (%)						
	Actual	**Bench.**	**F. Err.**	**FF**	**Def**	**Liq**	**Vol**	**Int**	**EM**	**Idios**
Brazil	167	134	32	31.8	42.3	1.3	7.8	10.3	0.1	6.3
Bulgaria	70	55	15	18.2	37.5	1.5	6.1	6.9	0.3	29.4
Colombia	131	104	27	43.8	47.9	1.0	11.9	13.3	-0.1	-17.9
Ecuador	682	610	72	22.7	65.1	-1.2	9.8	38.2	-0.6	-34.1
Mexico	99	70	29	29.8	31.8	1.4	4.7	6.0	0.1	26.2
Panama	139	112	27	34.1	44.3	1.1	8.4	15.6	-0.1	-3.4
Peru	126	95	31	24.3	51.6	-1.1	9.9	15.3	0.1	-0.2
Philippines	165	129	36	32.2	34.3	1.3	8.0	10.6	0.0	13.5
Russia	106	81	25	25.5	33.5	1.3	9.2	15.3	-0.1	15.2
South Africa	96	66	30	17.0	27.7	1.6	1.5	16.0	0.0	36.2
Turkey	195	172	24	50.5	81.2	2.1	9.6	17.4	-1.4	-59.3
Ukraine	154	94	60	19.3	19.3	0.3	4.5	13.0	0.1	43.5
Venezuela	318	248	70	15.8	37.8	0.4	10.4	11.9	-0.4	23.9
USA	135	127	8	25.6	16.0	-4.1	-2.0	-25.9	0.1	90.4
Canada	124	126	-2	-16.7	-162.8	-3.8	-18.9	-54.6	0.8	356.0
Japan	29	30	-1	84.4	19.0	-11.4	6.2	-74.6	-0.2	76.6
Eurozone	90	77	13	22.4	43.7	-1.1	3.6	8.7	-0.1	22.8