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Emerging Market Spread Compression: Is it Real or is it Liquidity?

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Abstract

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Despite recent turmoil, spreads on emerging market countries' sovereign bonds have fallen dramatically since mid-2002. Some have attributed the fall to improved economic fundamentals while others to ample global liquidity. The paper models spreads and attempts to empirically distinguish between the two factors. The results indicate that fundamentals, as embedded in credit ratings, are very important, but that expectations of future U.S. interest rates and volatility in those expectations are also a key determinant of emerging market spreads.

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I. INTRODUCTION

The determinants of the difference between the yield on a country's emerging market debt securities and the U.S. 10-year Treasury note, denoted the emerging market spread, has been subject of academic inquiry for some time. The dramatic decline in spreads to record-low levels has renewed attention in the subject. This decline occurred alongside a dramatic decline in policy interest rates in industrial countries and a marked increase in money growth as these countries loosened monetary policy in an effort to revive their economies following the bursting of the equity bubble in 2000, leading some commentators to claim that the fall in spreads was based on "excess global liquidity." And despite a consistent tightening by major central banks up until recently, and the market turmoil of summer 2007, spreads have continued to remain quite low. The spread compression has also been accompanied by a seeming improvement in the "real" fundamentals of many emerging market countries—debt ratios declined in some countries, current account deficits improved, and other structural policies were adopted. Reflecting these improvements, the average credit rating of the countries included in the EMBI Global index improved from BB- to BB+ between early 2000 and 2007.[1]

As interest rates have continued their upward path, attempting to discern how much of the improvement in emerging market spreads is due to improvements in country fundamentals and how much is due to excess liquidity has important ramifications. If much of the compression in spreads is attributable to solid reforms undertaken in recent years, then tighter monetary conditions in industrial countries should have only a small effect on spreads. However, if much of the spread compression was due to liquidity, then tighter monetary policy and a drying up of liquidity could mean reversals in spreads, which could be especially pronounced if excessive liquidity had also led to leveraged positions.

This paper attempts to distinguish between the two factors—fundamentals and liquidity—by constructing a model that takes into account several features of emerging market spreads and how they adjust to domestic fundamentals and interest rates.[2] Compared to previous examinations of spreads, we innovate in several ways. First, we use data that capture the more forward-looking character of market prices reflected in spreads, namely, by adding credit rating agency *outlooks*, in addition to the ratings themselves, for country fundamentals and using 3-month Fed Funds futures rates rather than the Fed Funds rate itself, as a measure of liquidity. Second, we develop a more accurate relationship between credit ratings and their likely effect on spreads by modeling the observed non-linear relationship between the two.

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[1] Improvement in the ratings is based on the average of Moody's and Standard & Poor's ratings for each country aggregated using EMBIG weights.

[2] The model represents a type of forecasting model for spreads and, as such, does not distinguish between supply and demand factors for debt securities and their influence on spreads.

Many studies use credit ratings because it encapsulates a host of economic variables.[3] While a handy and efficient measure, the measure is relatively "coarse;" that is, there are a fixed number of categories (e.g. AAA, AA+, A, ... C-, and SD, referring to default), and alterations among them are not associated with a fixed (or linear) response in spreads. The model below attempts to enrich the informational content of ratings by: (i) using the indications for future up- or down-grades represented by the rating outlook; and (ii) scaling the ratings variable using logarithms to account for their non-linear relation with spreads.

One of the motivations for adding the credit rating outlook to the series of actual ratings is an observation that markets react first and foremost to hints of future ratings changes rather than the actual event when it occurs. Sy (2002) provides formal evidence of the early reaction by market participants. He observes that when a country's spreads are "excessively high," a rating downgrade frequently follows; similarly, "excessively low" spreads are often followed by upgrades, suggesting markets anticipate future ratings changes (or alternatively that credit rating agencies are late to alter ratings).[4] Below we look more carefully at spreads and changes in the outlook and show a somewhat stronger and more timely response to the outlooks than the actual rating changes.

Previous studies that have examined the influence of global interest rates on emerging market spreads have variously used a short-term interest rate, such as a 3-month eurodollar deposit rate or the Fed Funds rate, a long-term interest rate, such as the U.S. 10-year Treasury note or some weighted average of 10-year government securities from industry countries, or the slope of the yield curve, as measured by, say the difference between the U.S. 10-year note and 3-month Treasury bill. The use of this latter variable is prompted by the use of "carry trades" in which participants borrow funds at the Fed Funds rate or similar rate and then invest in longer-term higher yielding securities.

In many cases, the results have been less than satisfactory, with some authors finding support for the global liquidity story in a positive relation between the given interest rate and spreads and other finding either no relation or a negative relation.[5] We chose to use a forward-looking short-term interest rate—the Fed Funds 3-month ahead futures rate to better capture the view that financial markets are forward-looking and therefore incorporate expectations of future interest rates into their current trading decisions. We also use the volatility of the Fed Funds futures rates to proxy for the uncertainty surrounding changes in liquidity conditions—another way to capture forward-looking trading behavior.

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[3] See for example, the Global Financial Stability Report (April 2004) and Sy (2002).

[4] Rating agencies, however, may in turn argue that higher debt spreads increase borrowing costs and implying a greater risk of default. Thus, changes to ratings are not "behind the curve" but accurately reflect the increased risk of default as spreads widen.

[5] Eichengreen and Mody (1998), Kamin and von Kleist (1999), Sløk and Kennedy (2003), and McGuire and Schrijvers (2003) all find a negative or inconclusive relationship.

In the next section we describe the data in more detail and then move to the results. We then examine the proportion of spread dynamics explained by fundamentals and external factors. Finally, we sum up our results and suggest some areas of further research.

II. DATA

A. Variables

We collected a number of daily and monthly series during the period of January 1991 and February 2007 for 33 major emerging market economies as well as financial data from the U.S. economy.

Emerging Market Bond Spreads

To examine the factors that determine emerging market spreads, we collected daily observations of the Emerging Market Bond Index (EMBI), and the EMBI Global for individual countries, as well as the composite index. Due to specific criteria for country inclusion and liquidity, the two bond indices consist of a varied number of member countries and financial instruments. Hence, starting points of the series differ across countries and the indices (Table 1).[6] There are some instances where a country's index has missing observations in the middle of its series.[7] For this reason, when necessary, the spreads based on these indices are spliced to obtain a longer time series in the sample period of

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[6] To be included in the EMBI index, bonds had to meet strict liquidity criteria. For this reason, there were only five countries in the original EMBI. Their series start at the end of 1991. The EMBI Global, introduced in January 1998, uses more relaxed liquidity criteria. Countries' admission requirements under the EMBI Global are different from those under the EMBI. Countries to be included in the EMBI must be rated BBB+ or lower by Standard & Poor's. On the other hand, countries under the EMBI Global only need to satisfy one of the following criteria: (i) classified as having low or middle per capita income by the World Bank; (ii) has restructured external or local debt in past 10 years; or (iii) currently has restructured external or local debt outstanding.

[7] Nigeria, for example, has missing observations during the period between April 1998 and April 1999. Likewise, Pakistan has missing observations during the period of February 2003 through March 2004. In case of the Philippines, its EMBI series terminated in January 1997 (Table 1).

Table 1. Availability of EMBI and EMBI Global

	EMBI	1/	EMBI Global	
Aggregate Index	91M1~02M6		97M12~07M2	
Algeria	*n.a.*		99M3~03M2	1/
Argentina	93M4~02M6		93M12~07M2	
Brazil	91M12~02M6		94M4~07M2	
Bulgaria	94M11~02M6		94M7~07M2	
Chile	*n.a.*		99M5~07M2	
China	*n.a.*		94M3~07M2	
Colombia	*n.a.*		97M2~07M2	
Cote d'Ivoire	*n.a.*		98M4~07M2	
Croatia	*n.a.*		96M8~04M6	1/
Dominican Republic	*n.a.*		01M11~07M2	
Ecuador	95M6~02M6		95M2~07M2	
Egypt	*n.a.*		01M7~07M2	
El Salvador	*n.a.*		02M4~07M2	
Hungary	*n.a.*		99M1~07M2	
Lebanon	*n.a.*		98M4~07M2	
Malaysia	*n.a.*		96M10~07M2	
Mexico	91M12~02M6		93M12~07M2	
Morocco	*n.a.*		97M12~06M5	1/
Nigeria	92M1~02M6	2/	93M12~07M2	
Pakistan	*n.a.*		01M6~07M2	2/
Panama	97M2~02M6		96M7~07M2	
Peru	97M5~02M6		97M3~07M2	
Philippines	91M12~97M1	1/	97M12~07M2	
Poland	94M11~02M6		94M10~07M2	
Russia	98M12~02M6		97M12~07M2	
South Africa	*n.a.*		94M12~07M2	
South Korea	*n.a.*		93M12~04M4	1/
Thailand	*n.a.*		97M5~06M4	1/
Tunisia	*n.a.*		02M5~07M2	
Turkey	*n.a.*		96M6~07M2	
Ukraine	*n.a.*		00M5~07M2	
Uruguay	*n.a.*		01M5~07M2	
Venezuela	91M12~02M6		93M12~07M2	

1/ These series are terminated.
2/ There are some missing observations during the period. For Nigeria, the EMBI series does not have observations during April 1998 through April 1999. For Pakistan, the EMBI Global series has missing observations during March 2003 through March 2004.
Source: J.P. Morgan Chase.

January 1991 and February 2007. It is important to note that a sovereign's market weight changes over time as inclusions or exclusions of a country or various debt issuances occur.[8] Despite such complexities, the EMBI and the EMBI Global have become market benchmarks and provide us with the most comprehensive, readily available, and easy-to-analyze data.[9]

Graphically, the spreads appear to trend downward beginning in 1999, a year in which several countries are added to the sample. We test for non-stationarity and find that a large number of countries' spreads exhibit unit roots. We discuss this issue in the context of the panel data sets below.

Credit Ratings and Outlooks

Monthly sovereign credit ratings and their outlooks are collected from *Ratings Direct*, provided by the Standard & Poor's. We used long-term credit ratings for assessing the sovereign's foreign currency default risk since debt instruments included in the EMBI family are mostly long-term and denominated in U.S. dollars. In general, most rating agencies issue both long- and short-term credit ratings in domestic and foreign currencies. In addition, they assign credit outlooks for each country in both currencies, though the rating agencies note that their outlook does not guarantee any future changes in the ratings themselves. As shown in Figure 1, variation in the credit outlook appears to add information for examining country risk. There have been 234 and 300 monthly observations over the sample period that recorded changes in long-term credit ratings and outlooks, respectively.[10] Moreover, there have been 169 monthly observations for which changes in outlooks occurred when long-term credit ratings remained the same. Thus, we can enrich our variable on countries' risk by using the outlook.[11] Short-term ratings, however, do not appear to add very much fundamental information since the timing of their changes generally coincides with that of long-term ratings changes. There were only six monthly observations for which there was a change in short-term ratings but no simultaneous change in long-term credit ratings or outlooks.

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[8] Similarly, when a sovereign retires a debt instrument or amortizes principal of the debt, and if the issue's current outstanding face value falls short of a required level under the criteria, the issue is removed from the country's index. Market weight data are made available by J.P. Morgan Chase. This monthly series starts in December 1993.

[9] Sy (2002) uses EMBI Plus sovereign spreads, noting the additional advantage that they control for floating coupons, principal collateral, and rolling interest guarantees.

[10] There have been seven monthly observations which country's long-term credit rating and/or outlook changed twice during the same month, though they are counted as one monthly change.

[11] Kaminsky et al. (2003) and Sy (2002) also refer to the importance of outlooks in their analysis of the spreads.

Figure 1. Changes in Sovereign Credit Ratings and Outlook:
January 1991 ~ February 2007 1/
(Number of months)

Changes in:	
◯ Long-term Credit Rating - 234	
◌ Short-term Credit Rating - 122	
◯ Outlook - 300	

(A)   =   72 [18%]
(B)   =   6 [1%]
(C)   = 160 [39%]
(D)   =   31 [8%]
(E)   =   9 [2%]
(F)   =   55 [13%]
(G)   =   76 [19%]
(A) + (B) + (C) + (D) + (E) + (F) + (G)
      =409 [100%]

1/ Based on 33 emerging market economies included in J.P. Morgan Emerging Markets Bond Index (EMBI) and EMBI Global.

Source: Standard & Poor's, Moody's Investors Service, and Authors' calculations.
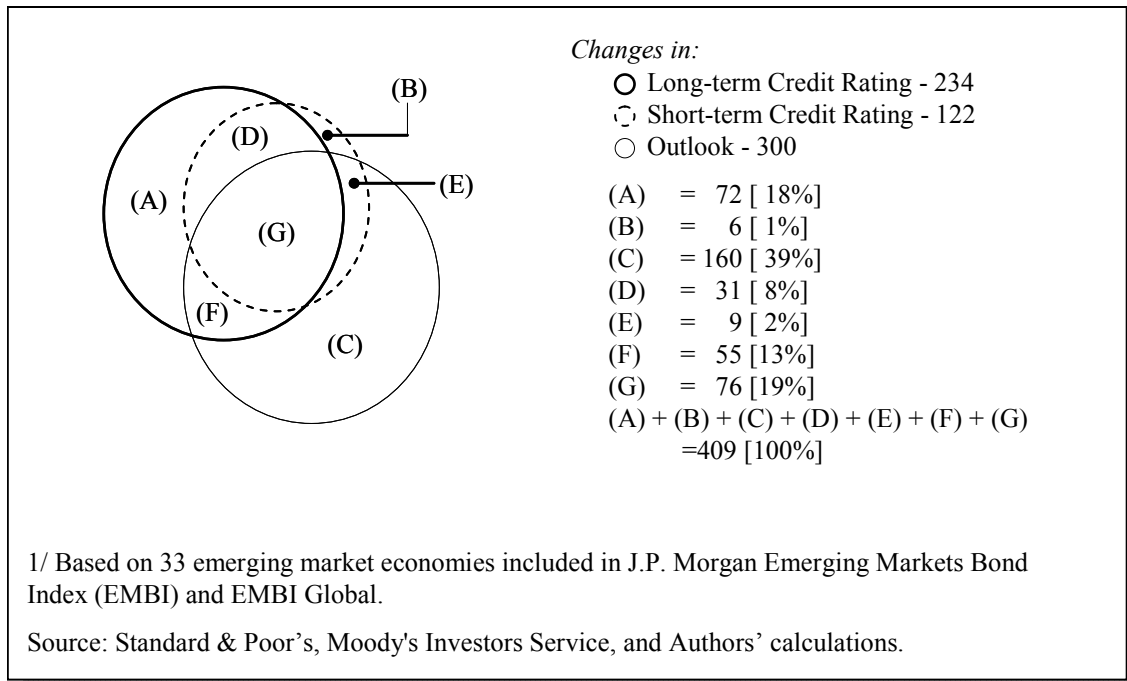
Fed Funds Futures

The Fed uses a target rate for Fed Funds to transmit of its monetary policy objectives and this rate has become a market-wide benchmark for various financial activities. Leveraged carry traders who borrow at the sho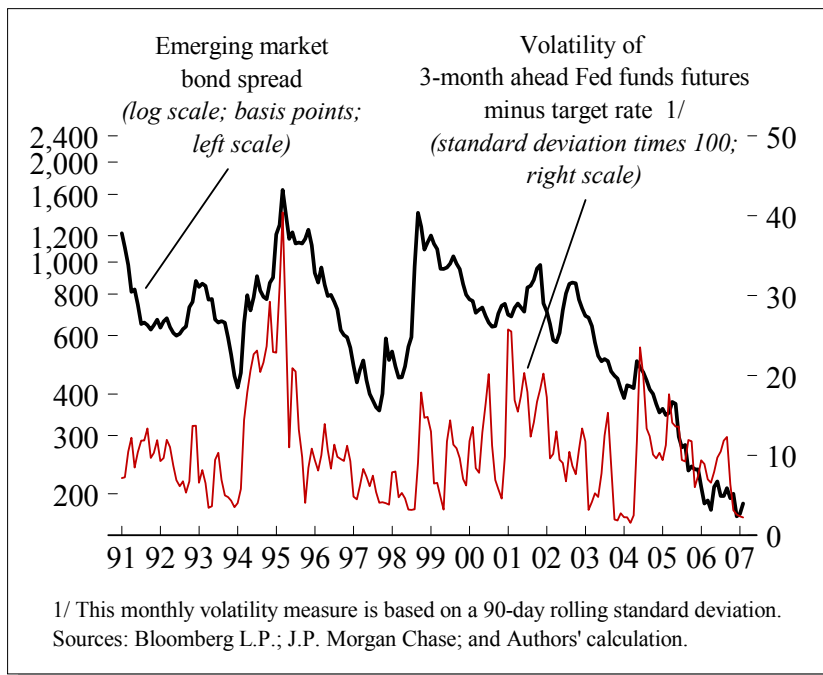rt-end of the yield curve to invest in emerging market bonds keenly watch short-term benchmark rates, such as the Fed Funds rate. For this reason, we look at the implied yield on the 3-month Fed Funds futures and evaluate how market expectations of future U.S. monetary policy affect the emerging market bonds. The Fed Funds futures rate has the advantage that it influences interest rates all along the U.S. yield curve.[12] It is noteworthy that the 3-month Fed Funds futures rate has a 0.99 correlation with 3-month LIBOR and U.S. Treasury bill rate, and 0.69 with 10-year U.S. Treasury notes at a daily frequency over the entire sample period. Despite the use of an *expected* Fed Funds rate, this variable exhibits a unit root using an Augmented Dickey-Fuller test (with a constant).

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[12] Using Fed Funds futures rates, Kuttner (2001) disentangled expected from unexpected policy actions, and concluded that the impact of unexpected rate decisions on the interest rates of both short- and long-term maturities were significantly positive.

Volatility in the Fed Funds Futures Market

Uncertainty of future U.S. monetary policy is perceived to have a large impact on the financial markets, making decisions about financial risk allocation more difficult. To measure this uncertainty, we used the difference between the implied yield of three-month Fed Funds futures contract and the target rate at a daily frequency. In a rolling 90-calendar-day window, we calculated the standard deviation of the difference. The daily series of standard deviation was then averaged over each month. This measure of uncertainty of future U.S. monetary policy, expressed in standard deviation, was closely linked to the widening of bond spreads during the tightening cycle of 1994–1995 (Figure 2). Heightened anxiety at the beginning of the most recent tightening cycle (beginning mid-2004) concerning the speed and magnitude of the tightening to come was also initially reflected in rising spreads.

Figure 2. Volatility of Fed Funds Futures Market and Emerging Market Bond Spread

1/ This monthly volatility measure is based on a 90-day rolling standard deviation.
Sources: Bloomberg L.P.; J.P. Morgan Chase; and Authors' calculation.

Volatility Index of S&P 500 (VIX)

The Chicago Board Options Exchange (CBOE) Volatility Index, denoted "VIX," is based on the S&P 500 options prices. The VIX is often used as a proxy for investor's attitude toward risk and appears to explain movements of the emerging market bond spread in recent years. The spread compression seems to coincide with the reduction of the VIX, which is generally interpreted as increased investor risk appetite.[13] However, during the Fed tightening cycle of

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[13] See Global Financial Stability Report (2004).

1994–1995, the relation between the fluctuations of the VIX and the emerging market bond spread appears to have broken down (Figure 3). In recent years, the VIX has mirrored bond spreads quite well.

Figure 3. VIX and Emerging Market Bond Spread

1/ The SPX Volatility Index, measuring the implied volatility in the prices of a basket of options on the S&P 500..
Sources: Bloomberg L.P.; J.P. Morgan Chase; and Authors' calculation.
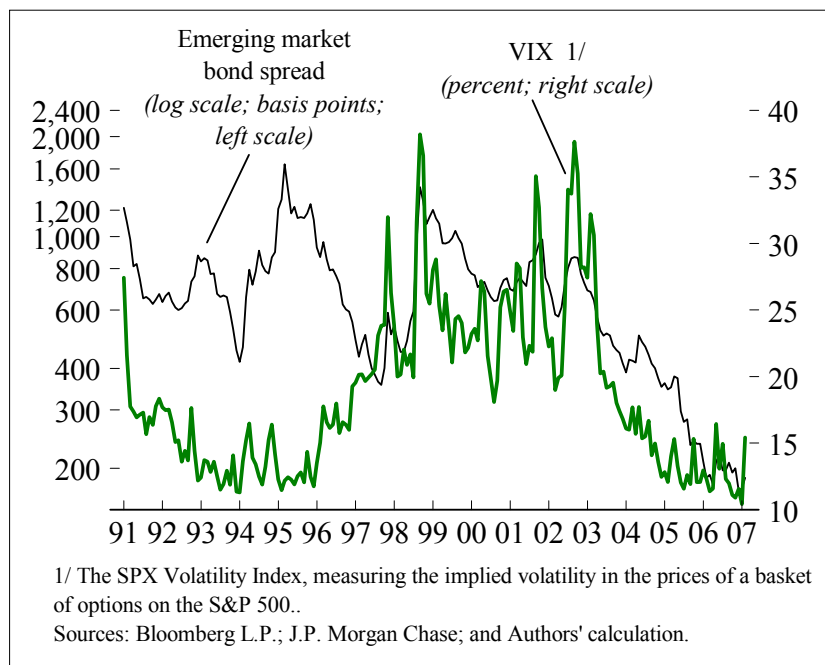
B. Total Credit Rating-Outlook Index (CROI)

One of the main contributions of this paper is to introduce a Total Credit Rating-Outlook Index (CROI) which encompasses both the information of sovereign long-term credit ratings and outlooks to better proxy for underlying fundamentals that influence emerging market bond spreads.

Log Linearity Between the Spreads and Ratings

Although many studies take a log of the spreads and look at the relationship between the spreads and an index of cardinal numbers assigned to sovereign long-term credit ratings, there is little supporting evidence provided for this specification. Often the index is constructed such that its value increases by some increment as the rating deteriorates, or vice versa. In this paper, we begin our exercise by observing a linear relationship in log between the spreads and an index of ratings increasing from 1 to 22 in log scale by an

Figure 4. Average vis-à-vis Estimated Bond Spreads on
Long-Term Sovereign Credit Ratings 1/
(log scale: basis points)

1/ Based on the monthly observations during December 1991 through May 2005 for the countries
included in the EMBI, EMBI Plus, and EMBI Global.
2/ Estimated spreads are from the univariate regression of the spreads in log on a constant term
and a dummy variable of long-term sovereign credit ratings in log. The dummy variable increases
by an increment of 1 in log, representing a one-notch decline in the rating.
Sources: Bloomberg L.P.; J.P. Morgan Chase; and Authors' calculation.

increment of 1 as the ratings deteriorate from AAA all the way down to SD. With this
logarithmic scaling, a one-notch decline in the ratings, (i.e., AA+ to AA), is represented by
an increase of 100 percent in the ratings index level. Figure 4 indicates that the log
relationship is linear, implying that there is a nonlinear relationship in level between the
spreads and the rating index.

Construction of the Total Credit Rating-Outlook Index (CROI)

To define the Total Credit Rating-Outlook Index (CROI), we use information on both the
long-term credit rating and outlook for a sovereign's foreign currency denominated
instruments. We use regression results to estimate the individual response to both the rating
and the outlook.[14] The index value of the CROI in logs is found on Table 2. At each time *t*
for each country *i* CROI takes on one of the values in the table depending on the
configuration of the current rating and the outlook.

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[14] A detailed discussion of how to construct the CROI is found in Appendix 1.A.

Table 2. Total Credit Rating-Outlook Index (CROI)
(Index value in log)

Category:	Sovereign Long-term Credit Ratings (R_i)	Credit Outlook (O)		
		Stable (*STB*)	Positive (*POS*)	Negative (*NEG*)
Investment Grade (G_1)				
	AAA	1.0	0.0	2.7
	AA+	2.0	1.0	3.7
	AA	3.0	2.0	4.7
	AA-	4.0	3.0	5.7
	A+	5.0	4.0	6.7
	A	6.0	5.0	7.7
	A-	7.0	6.0	8.7
	BBB+	8.0	7.0	9.7
	BBB	9.0	8.0	10.7
	BBB-	10.0	9.0	11.7
Noninvestment Grade: Tier 1 (G_2)				
	BB+	11.0	10.1	12.7
	BB	12.0	11.1	13.7
	BB-	13.0	12.1	14.7
	B+	14.0	13.1	15.7
	B	15.0	14.1	16.7
	B-	16.0	15.1	17.7
	CCC+	17.0	16.1	18.7
Noninvestment Grade: Tier 2 (G_3)				
	CCC	18.0	18.0	18.0
	CCC-	19.0	19.0	19.0
	CC	20.0	20.0	20.0
	C	21.0	21.0	21.0
	SD	22.0	22.0	22.0

Source: Authors' calculations.

It is important to recognize that the CROI is an index that, by construction, attempts to calibrate how ratings and outlooks relate to spreads—that is, it uses (past) information about how spreads react to changes in ratings and outlooks to make this calibration. Table 2 indicates that there are four unique properties embedded into the CROI that reflect various non-linear responses of spreads to changes in ratings or outlooks. For instance, given log linearity, a spread of a country with a credit rating above the first tier of non-investment grade category and an outlook of "positive" is lower than that of a country with a one-notch higher credit rating and an outlook of "negative." The CROI does not distinguish between "positive" and "stable," nor "negative" and "stable" outlooks for the countries in the second tier of noninvestment grade category. The index values depend entirely on the credit ratings since the addition of outlooks were statistically insignificant in this category. As well, when a country's outlook changes from "stable" to "positive" with its rating remaining the same, this improvement is reflected in a larger reduction of the CROI for countries in the investment grade category (-0.97) relative to those in the first tier of noninvestment grade category (-0.90). On the other hand, a deterioration in the outlook increases the value of the CROI by a larger degree for countries in the first tier of noninvestment grade category than those in the investment grade category. And, given a credit rating above the first tier of noninvestment
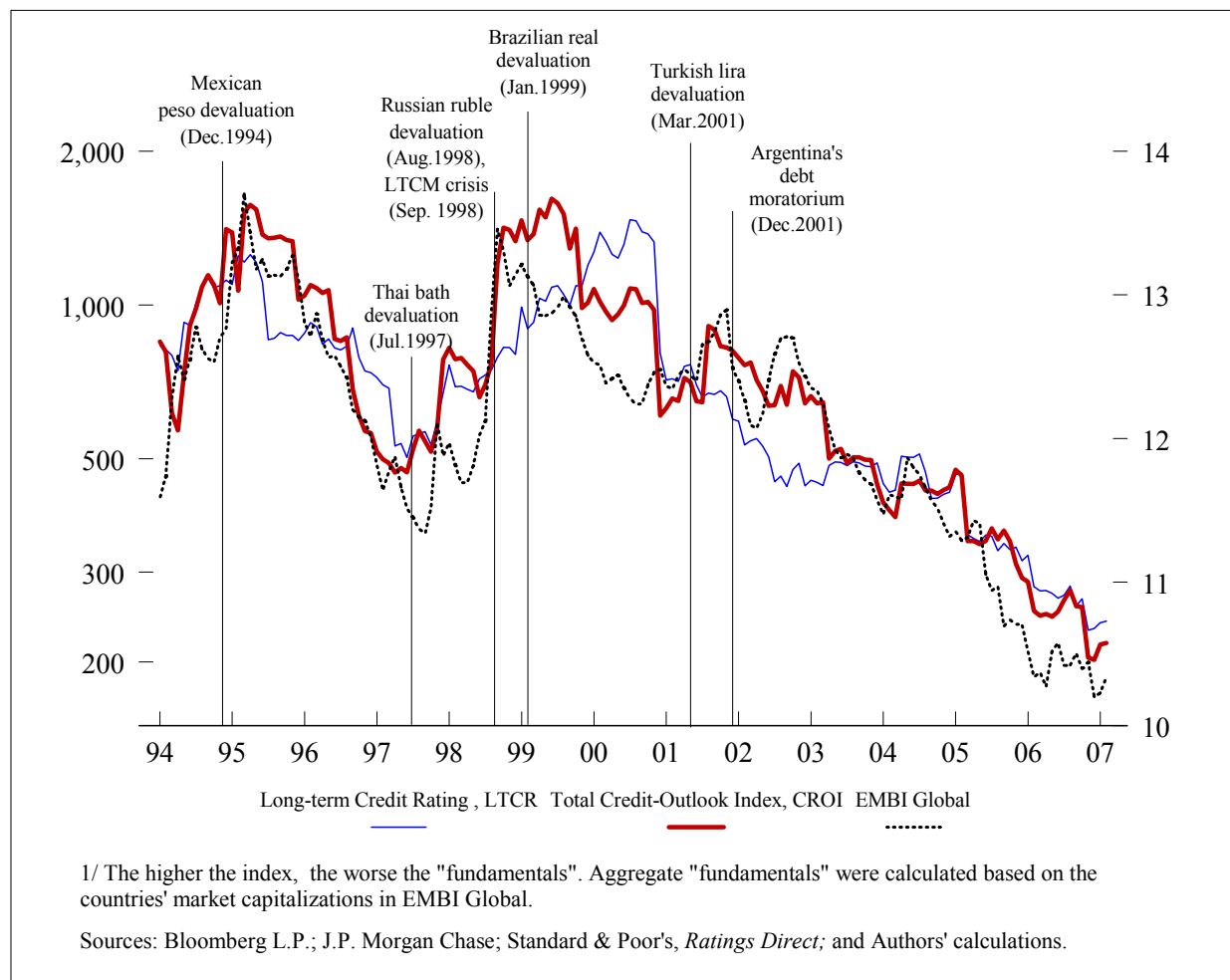
grade category, an increase in the CROI responding to a "negative" outlook is higher in an absolute magnitude than the decline in the index responding to a "positive" outlook.

Using market capitalization of EMBI Global for each member, we aggregated the newly constructed CROI and the Long-term Credit Rating (LTCR). Figure 5 compares the CROI and the LTCR in log level plotted against the EMBI Global in basis points. One of the most striking findings is that CROI appears to be more closely linked to spreads. In fact, during the period of January 1994 through February 2007 the correlation of spreads with the CROI is 89 percent compared to only a 74 percent with the LTCR.

III. RESULTS

We analyze both effects of economic fundamentals and liquidity on the bond spreads. The liquidity effects result from the examination of the following variables; (i) the anticipated level of U.S. interest rates, (ii) the volatility of the Fed Funds futures markets, and (iii) the level of risk appetite as proxied by the VIX index. In this analysis, we make comparisons of the results from regressions based on the newly constructed Total Credit Rating-Outlook Index (CROI) and the standard Long-term Credit Rating (LTCR).

Figure 5. Aggregate "Fundamentals":
Total Credit Rating-Outlook Index (CROI) vis-a-vis Long-term Credit-Rating Index (LTCR)

(EMBI Global: left scale in log,basis points and CROI and LTCR: right scale, index 1/)

1/ The higher the index, the worse the "fundamentals". Aggregate "fundamentals" were calculated based on the countries' market capitalizations in EMBI Global.

Sources: Bloomberg L.P.; J.P. Morgan Chase; Standard & Poor's, *Ratings Direct;* and Authors' calculations.

As a starting point, we examine the time series properties of our underlying variables. While there is little theoretical reason to believe that any of the variables are non-stationary in the long run, the trends from 1998 onward suggest non-stationary tests are warranted, particularly because many countries entered the sample in this latter period. According to several panel tests of non-stationarity, the EMBIG spreads and the credit ratings variables have unit roots over the sample. The Fed Fund's futures rate is also found to be non-stationary, while the volatility of Fed Funds and VIX are not. Since both independent and dependent variables in our model are non-stationary, we further test for cointegration in our preferred model below.

A. Basic Model

We first estimate a fixed effects panel regression model with the log of bond spreads *(SPRD)* as the dependent variable and only two explanatory variables; fundamentals as captured by

the *CROI* (or *LTCR*), and the 3-month ahead U.S. Fed Funds futures' rate (*FF3M*).[15] Table 3 indicates the regression results based on this basic model. Although we collected data for the spreads for 33 countries, due to limited data availability on the credit ratings and outlooks, 30 countries are included in the estimation.[16]

Table 3. Basic Model Results: CROI vs. LTCR, December 1991 ~ February 2007 1/

Dependent variable: Log of bond spreads (*SPRD*)							
Explanatory variables	Coefficient	Standard error	p-value	Explanatory variables	Coefficient	Standard error	p-value
CROI	0.246	0.023	0.000	*LTCR*	0.242	0.029	0.000
FF3M	0.022	0.017	0.222	*FF3M*	0.013	0.019	0.503
Constant	2.710	0.289	0.000	*Constant*	2.823	0.356	0.000
R2				R2			
within		0.414		within		0.327	
between		0.726		between		0.724	
overall		0.594		overall		0.554	

1/ The results are based on fixed effects regressions using 3038 monthly observations. Standard errors corrected for heteroskedasticity and autocorrelation within groups.
Sources: Bloomberg, L.P.; J.P. Morgan Chase; The PRS Group, *International Country Risk Guide* ; Standard & Poor's, *Ratings Direct.*

At an aggregate level, the correlation between the log of *SPRD* and log of *CROI* was significantly higher than that between the log of *SPRD* and the log of *LTCR*. However, the regression using *CROI* only explains 4 percent more of the variation in bond spreads (overall R^2 is 0.594 as opposed to 0.554). Although the coefficient values and R^2 statistics are similar, the improvement in R^2-within reflects the closer time-series association obtainable using the log of CROI where a country's outlook changes more frequently.

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[15] A Hausman test indicates that we cannot reject the null hypothesis of no systematic difference between the estimates of the random effect and those of the fixed-effect models. However, because we suspect that a country specific factor is not completely independent of the CROI or the LTCR, we apply the fixed-effect model of panel regression.

[16] Algeria and Cote d'Ivoire are excluded due to lack of the data on sovereign credit ratings and outlook. A total of 3,038 monthly observations are included for estimation. Initially, the basic model included Argentina, but because the crisis values for its spreads in 2001–2002 represented extreme outliers relative to any other historical period, Argentina is excluded from the remainder of the empirical work.

B. Extended Model with Volatility

Next, we estimate the following fixed-effect panel regression model by OLS.[17]

$$ln(SPRD_{i,t}) = \alpha_i + \beta_1 FUNDAMENTALS_{i,t} + \beta_2 FF3M_{i,t} + \beta_3 V\_FF_t + \beta_4 VIX_t + e_{it},$$

where e_{it} is a random error. The explanatory variables included in this regression are: 3-month Fed Funds futures rate (*FF3M*); the volatility of the Fed Funds futures market (*V_FF*) represented by the 90-day rolling standard deviation of the difference in *FF3M* and *FFTR*; the Volatility Index (*VIX*) for the S&P 500; and the fundamentals. For the measure of the fundamentals, we again apply both the log of *CROI* and the log of *LTCR*.

The use of the *CROI* improves the overall fit, yielding a higher R^2 of 0.704 relative to 0.682 under the model with *LTCR*. And again the embedded information in the outlooks better explains the variation of the spreads over time, but does not add much value to the explanation of spreads across countries.

Table 4. Extended Model Results: CROI vs. LTCR, January 1991 ~ February 2007 1/

Dependent variable: Log of bond spreads (*SPRD*)									
Explanatory variables	Coefficient	Standard error	t-statistics	p-value	Explanatory variables	Coefficient	Standard error	t-statistics	p-value
Fundamentals					Fundamentals				
CROI	0.193	0.017	11.5	0.000	LTCR	0.192	0.022	8.8	0.000
Other explanatory variables:					Other explanatory variables:				
FF3M	0.050	0.016	3.2	0.003	FF3M	0.045	0.016	2.9	0.008
V_FF	1.903	0.202	9.4	0.000	V_FF	2.039	0.241	8.5	0.000
VIX	0.041	0.004	10.2	0.000	VIX	0.045	0.004	11.6	0.000
Constant	2.176	0.209	10.4	0.000	Constant	2.130	0.252	8.5	0.000
R2					R2				
Within		0.635			Within		0.598		
Between		0.772			Between		0.776		
Overall		0.704			Overall		0.682		

1/ The results are based on fixed effects regressions using 3038 monthly observations. Standard errors corrected for heteroskedasticity and autocorrelation within groups.
Sources: Bloomberg, L.P.; J.P. Morgan Chase; The PRS Group, *International Country Risk Guide* ; Standard & Poor's, *Ratings Direct* ; and authors' calculation.

The *p*-values of explanatory variables suggest that they all be included in the models. The estimated coefficient for the *CROI* signifies that the spreads will increase by 0.193 in logs when the index value of the *CROI* increases by 1 unit in logs. Given a country with a rating of "B" and outlook of "stable," when its rating falls by a one-notch to "B-," ceteris paribus, the country's spread will increase by 21 percent from its initial level.

---

[17] As with the basic model, a Hausman test indicates that we cannot reject the null hypothesis of no systematic difference between the estimates of the random effect and those of the fixed-effect models. However, because we suspect that a country specific factor is not completely independent of the CROI or the LTCR, we apply the fixed-effect model of panel regression.

The 3-month Fed Funds futures rate (*FF3M*) has estimated coefficients of 0.050 and 0.045 in the regressions using the *CROI* and the *LTCR* for fundamentals, respectively, and they are both statistically significant at 1 percent level. When participants of the Fed Funds futures market expect there will be a one percent (100 bps) increase in the U.S. policy rate over the next three month window, the spreads today will increase by about 5 percent from their initial levels, ceteris paribus. Relative to the "fundamentals," the level in the expected interest rate contains less explanatory power for spreads.

Uncertainty about future U.S. monetary policy can have a significant effect on emerging market bond spreads. In fact, we find that the volatility of the Fed Funds futures market influences spreads to a greater degree than does the level of the interest rate. The estimated coefficients of *V_FF* are 1.903 and 2.039 for the regression of *CROI* and that of *LTCR*, respectively. They are both statistically significant at the 1 percent level. If the volatility of the Fed Funds futures market increases by a standard deviation, ceteris paribus, spreads widen by about 13.5 percent in the model using *CROI*.[18]

Lastly, the CBOE Volatility Index (*VIX*) captures volatility on the S&P 500 options prices and is viewed as a proxy for investor's attitude toward risk. Over the entire sample period, regardless of the choice of fundamental variables, the estimated coefficient of the *VIX* displays statistical significance at 1 percent level. An increase of the *VIX* by one standard deviation will increase spreads by about 30 percent in the model with *CROI*.[19] If the *VIX* surges to the level observed in September 1998, the regression with *CROI* estimates that spreads will leap by 238 percent if other factors remain constant.[20]

In this section, we have presented the results from fixed-effect panel regressions run by OLS. Since using several different tests we find spreads and the credit outlook variables to be non-stationary in the panel, we proceed to test for panel-based cointegration to assure that the coefficients are robust and spurious trending relationships are not responsible for our results. Using residual-based tests devised by Kao (1999) and Pedroni (1995), we reassuringly find that the variables in above specification cointegrate and thus the estimated coefficients are robust to possible time trends.[21]

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[18] The sample mean of *V_FF* is 12.2 percent, with a standard deviation of 6.6 percent.

[19] One standard deviation of the VIX is roughly 6.4 percent during the sample period of 1991 through 2007.

[20] At the dawn of the LTCM crisis on August 31, 1998, S&P 500 Index fell 6.8 percent from the previous day, and the VIX surged to 44.3. The VIX was jittery through the end of October 1998. It reached a historical high of 45.7 October 8, 1998.

[21] The tests were performed using the code provided by Chiang and Kao (2002). These tests can only be performed on balanced panels. Thus, we use two balanced samples, one including only June 1995 through February 2007 for Brazil, Mexico, Poland, South Africa, and Venezuela, and one shorter but broader panel for the period from January 1998 to February 2007 which additionally includes Colombia, Lebanon, Malaysia, Panama, Peru, Philippines, Russia, and Turkey. The results are robust across both panels.
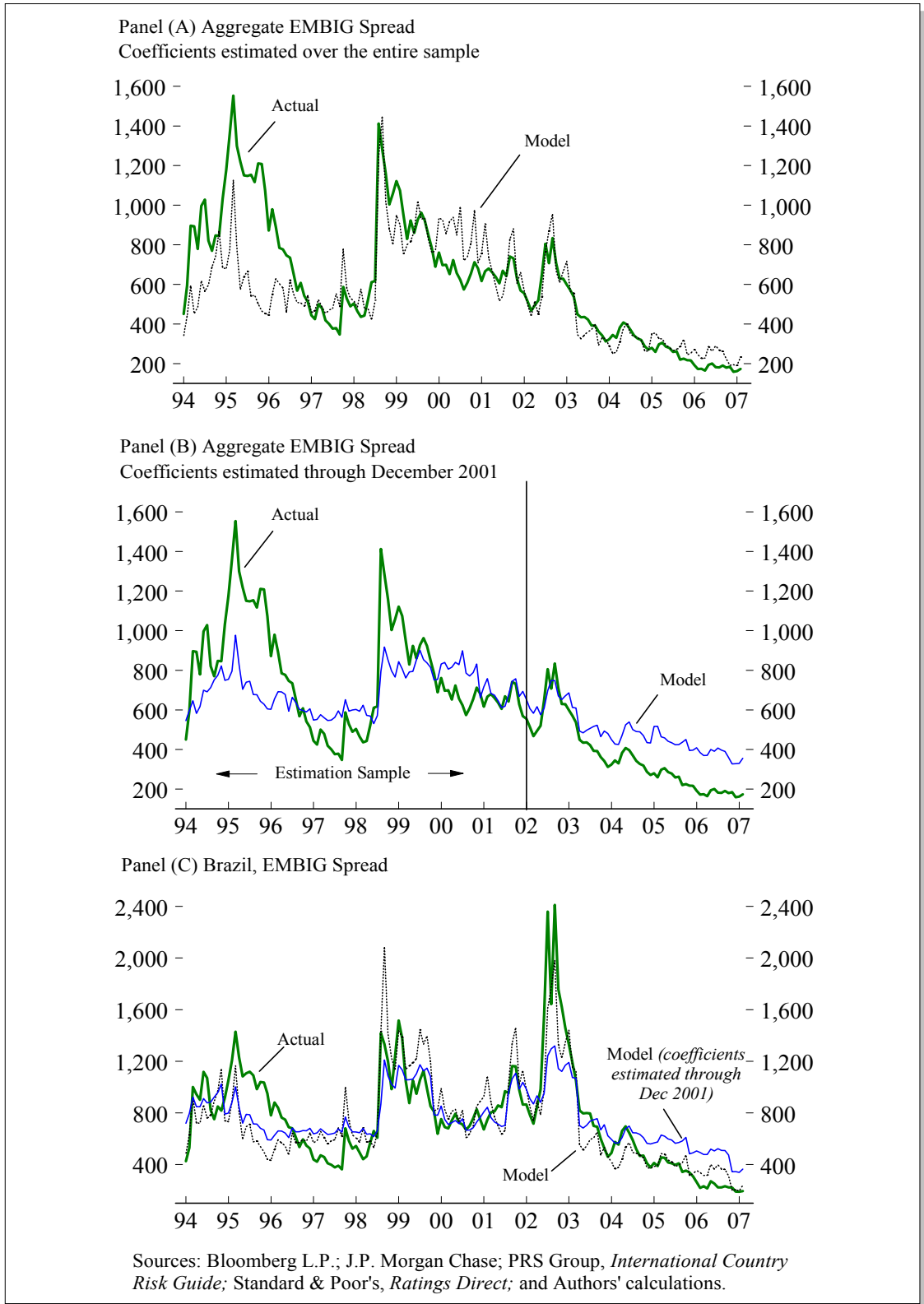
C. Graphical Interpretation of the Models

To evaluate how well the model is able to perform, we aggregate the estimated EMBI global spreads, weighted by market capitalizations of the countries in the sample, and compare them against the actual spread. The aggregation is based on 30 countries, and the actual spread is based on splicing EMBI and EMBI Global.[22]

Panel (A) in Figure 6 shows that the in-sample fit of the extended model with CROI mirrors the data fairly well. The model does less well in the early part of the sample in part because the sample is sparse and the volatility of actual spreads is quite high. Panel (B) shows that the out-of-sample forecasting ability of the model has increasingly deviated from actual spreads—with the estimated spreads at the end of our sample some 180 basis points above actual spreads. This may reflect an additional "search for yield" that is not captured by the VIX index and the low level of interest rate volatility. Deviations could also be explained by structural shifts in the parameters or a faster decline in issuance of external debt than the previous period, which we do not control for. Panel (C) shows how the model performs for a specific country, Brazil. The panel coefficients are used to produce in-sample and out-of-sample forecasts of Brazilian EMBIG spreads. The model captures the dramatic events surrounding 2002 quite well. The current level of the spread is well-approximated (in-sample) by the model, whereas the out-of-sample forecast suggests somewhat higher spreads.

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[22] Aggregate EMBI series through November 1997, and aggregate EMBI Global series from January 1998 through February 2005 are spliced as to create the combined series.

Figure 6. Actual vs. Estimated Spreads

Extended Model with CROI as Fundamentals

(scale in basis points)

Panel (A) Aggregate EMBIG Spread
Coefficients estimated over the entire sample

Panel (B) Aggregate EMBIG Spread
Coefficients estimated through December 2001

Panel (C) Brazil, EMBIG Spread

Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide;* Standard & Poor's, *Ratings Direct;* and Authors' calculations.

D. Contributions to EMBI Spreads

By decomposing the model dynamics over a certain time period, we can get an insight into how important changes in fundamentals have been, relative to changes in external financial variables, for the dynamics of the EMBI spread over that period.[23]

Table 5 shows that from December 2002 to the end of our sample, the variable that represented the country-specific fundamentals, the CROI, explained 197 basis points (46 percent) of the model-predicted 431 basis point decline in spreads. The other variables, representing the external factors, VIX, the fed funds futures rates, and the volatility of fed funds futures, explained a total of 234 basis points of decline (54 percent). Of the actual decline in spreads, some 455 basis points, the CROI accounts for 43 percent and the other three external variables for 51 percent of the decline. Just examining the two variables representing U.S. monetary policy (the Fed Funds futures rate and its volatility), the explanatory power amounts to less—around 10 percent—while the rise in risk appetite, proxied by the VIX, is an important external factor—accounting for nearly 44 percent—of the recent movement in the EMBIG. Overall, then the recent decline spreads is more related to risk appetite and uncertainty regarding U.S. monetary policy than it is due to country fundamentals as these variables account for over half of the decline in spreads. Rising forecasted U.S. interest rates, by contrast, have taken a back seat.

Table 5. Determinants of Change in the EMBIG Spread,
December 2002–February 2007

VIX	- 189	
FF4	+ 52	54%
Vol(FF)	- 97	
CROI	- 197	46%
Model	- 431 bps	
Actual	- 455 bps	

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[23] The decomposition is done for each country by calculating the share of the change in the *log* of the EMBIG spread that the model attributes to each variable for the chosen time period. These shares are then multiplied by the change in the model spread over the same period.

IV. CONCLUSIONS

While it is difficult to parse out a pure "liquidity effect" from the model, the estimations show that US interest rate variables clearly have an effect on emerging market debt spreads. This implies that the Fed can play a role in reducing the risk of any disruptions in the emerging bonds market. A clear communication strategy by the Fed that helps guide market expectations can promote financial stability by keeping the volatility of the expected U.S. monetary policy low, thus contributing to a more modest widening in emerging market spreads when fundamentals start to worsen.

While the Fed plays an important role, emerging market economies also have a role. To avoid abrupt increases in spreads they must put policies in place during "good times" to help insure that their overall fundamentals will not deteriorate. Even when the U.S. interest rate increases, the model shows that they can still offset any negative impact by continuing to improve good economic policies that contribute to better credit ratings.

The model attempts to gauge the role of U.S. interest rate effects, risk appetite, and emerging market fundamentals by using a more refined variable for fundamentals. The new variable utilizes not only rating changes (a variable used in previous studies to proxy for country economic fundamentals) but incorporates the outlooks for ratings as well. This adds some, but not a great deal, of explanatory power. The model is explicitly designed as a descriptive model for the determinants of emerging market bond spreads and does not account for the supply-side of the sovereign emerging market bond market. Future research could attempt to model both the demand and supply side of the market to better hone the effects of U.S. interest rates on emerging market bond spreads.

Appendix 1.A: A Procedure of Constructing the CROI

There are four steps required to construct the Total Credit Rating-Outlook Index (CROI). The CROI, by its construction, includes a factor that differentiates prices of bonds by investment/noninvestment grade categories as well as by the negative, stable, and positive outlooks. Since the CROI integrates these unique properties, the first step is to explain how we embed such features in the index.

Step 1: Instead of applying a unified log-linear relationship between the spreads and the ratings (R_i)[24] across the entire rating spectrum, we conducted regression analyses and assessed if there are more than one log-linear relationship across the rating spectrum. We divided the spectrum into three categories: (i) investment grades, denoted G_1; (ii) first tier of noninvestment grades, denoted G_2; and (iii) second tier of noninvestment grades, denoted G_3. By creating a set of intercept and slope dummy variables including ones for outlooks, we ran a variance-constrained OLS regression based on a pooled sample to evaluate levels of statistical significance for these three grade categories as well as for the rating and outlook variables.[25]

$$SPRD = b_1 + b_2(R) + b_3(G_1 * POS) + b_4(R * G_1 * POS) + b_5(G_1 * NEG) + b_6(R * G_1 * NEG)$$
$$+ b_7(G_2 * STB) + b_8(R * G_2 * STB) + b_9(G_2 * POS) + b_{10}(R * G_2 * POS) + b_{11}(G_2 * NEG) + b_{12}(R * G_2 * NEG)$$
$$+ b_{13}(G_3 * STB) + b_{14}(R * G_3 * STB) + b_{15}(G_3 * POS) + b_{16}(R * G_3 * POS) + b_{17}(G_3 * NEG) + b_{18}(R * G_3 * NEG)$$

When defining investment grades as ratings of AAA through BBB−, first tier of noninvestment grades as BB+ through CCC+, and the second tier as CCC through SD, F-statistics of joint hypothesis suggest that separately distinguishing both the investment and the first tier of noninvestment grade categories is important as both are statistically significant at the 1 percent level (Appendix Table 1.A.1).[26] However, the second tier of noninvestment grade category was not. The adjusted R^2 reported by this regression was 0.715, compared to 0.676 reported under the univariate regression.[27] There are varying levels of individual and joint significance for the intercept and slope dummies for "negative and "positive" outlooks across the various grade categories.

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[24] The rating variable (R_i) takes a cardinal number in log such that AAA=1, AA+=2, … , and SD=22.

[25] Where *STB* is a dummy variable for a "stable" outlook, *POS* for a "positive" outlook, *NEG* for a "negative" outlook, *R* is for log-term credit ratings in log, and *SPRD* is log of spreads in basis points. We suppressed (n) for indicating the n-th observation of the sample.

[26] We divided the rating spectrum in a number of ways to see what combinations of rating groups provide the best fit and plausible significance levels for estimated coefficients.

[27] This univariate regression is based on the long-term credit ratings (R) only, without the three categories.

Appendix Table 1.A.1: Selecting an Underlying Model for the Total Credit Rating-Outlook Index (CROI)

	Variance-Constrained OLS based on the pooling sample						Feasible GLS With U.S. Policy Rate (Heteroskedasticity corrected)		
(1) Break between G_1 and G_2:	(1) BBB-/BB+								
(2) Break between G_2 and G_3:	(2) CCC+/CCC								
	Without U.S. Policy Rate			With U.S. Policy Rate					
	Coef.	Std. Err.	*p-value*	Coef.	Std. Err.	*p-value*	Coef.	Std. Err.	*p-value*
FFTR				0.082	0.005	*0.000*	0.083	0.004	*0.000*
(1) Investment grades: AAA ~ BBB (G_1)									
Constant	2.794	0.109	*0.000*	2.532	0.105	*0.000*	2.783	0.081	*0.000*
R	0.256	0.013	*0.000*	0.256	0.012	*0.000*	0.233	0.009	*0.000*
G_1*POS	0.716	0.225	*0.001*	0.692	0.214	*0.001*	0.439	0.164	*0.007*
R* G_1* POS	-0.103	0.026	*0.000*	-0.107	0.025	*0.000*	-0.079	0.019	*0.000*
G_1*NEG	0.135	0.271	*0.618*	0.072	0.258	*0.781*	0.090	0.192	*0.639*
R* G_1* NEG	0.043	0.031	*0.168*	0.039	0.029	*0.189*	0.035	0.023	*0.117*
(2) 1st tier of noninvestment grades: BB+ ~ CCC+ (G_2)									
G_2*STB	1.740	0.161	*0.000*	1.499	0.154	*0.000*	1.017	0.119	*0.000*
R* G_2* STB	-0.128	0.015	*0.000*	-0.111	0.015	*0.000*	-0.068	0.012	*0.000*
G_2*POS	0.499	0.251	*0.047*	0.058	0.240	*0.810*	-0.297	0.207	*0.152*
R* G_2* POS	-0.041	0.021	*0.051*	-0.015	0.020	*0.475*	0.021	0.017	*0.230*
G_2*NEG	0.703	0.233	*0.003*	0.561	0.222	*0.011*	0.423	0.188	*0.024*
R* G_2* NEG	-0.029	0.020	*0.146*	-0.020	0.019	*0.295*	0.003	0.016	*0.839*
(3) 2nd tier of noninvestment grades: CCC ~ SD (G_3)									
G_3*STB		*n.a. 2/*			*n.a. 2/*			*n.a. 2/*	
R* G_3* STB	-0.070	0.024	*0.004*	-0.062	0.023	*0.007*	-0.051	0.014	*0.000*
G_3*POS		*n.a. 2/*			*n.a. 2/*			*n.a. 2/*	
R* G_3* POS		*n.a. 2/*			*n.a. 2/*			*n.a. 2/*	
G_3*NEG	0.417	0.944	*0.658*	0.786	0.898	*0.382*	0.465	0.830	*0.575*
R* G_3* NEG	-0.035	0.046	*0.448*	-0.050	0.043	*0.246*	-0.022	0.040	*0.589*
R2(Adj.) / Log likelihood	0.715			0.742			-1601.2		
RMSE	0.504			0.480			*n.a. 2/*		
F-stat / Chi^2-stat 1/									
Overall									
"Positive"	11.0(***)			15.5(***)			83.9(***)		
"Negative"	38.4(***)			32.8(***)			295.0(***)		
Group 1 (G1)									
"Positive" and "Negative"	39.4(***)			40.2(***)			179.7(***)		
"Positive"	18.1(***)			30.5(***)			71.7(***)		
"Negative"	46.7(***)			33.1(***)			70.5(***)		
Group 2 & Group 3	38.1(***)			36.7(***)			468.7(***)		
Group 2 (G2)									
"Stable", "Positive", and "Negative"	53.8(***)			52.3(***)			454.5(***)		
"Stable"	91.8(***)			73.1(***)			157.9(***)		
"Positive"	1.98			2.2(*)			2.83		
"Negative"	24.1(***)			20.9(***)			119.4(***)		
Group 3 (G3)									
"Stable", "Positive", and "Negative"	3.1(**)			2.9(**)			0.32		
"Stable"	8.3(***)			7.3(***)			*n.a. 2/*		
"Positive"	*n.a. 2/*			*n.a. 2/*			*n.a. 2/*		
"Negative"	1.81			1.8			0.32		
Chi^2-stat (H0: constant variance) 3/	1.06			25.1(***)			*n.a. 2/*		

1/ The number of asterisks indicates the level of significance: *** at 1% level; ** at 5% level, and * at 10% level.

2/ Estimated coefficient is not available.

3/ Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. The null hypothesis is based on a constant variance for the fitted value of
the spreads. The level of significance is expressed by the number of asterisks where (***) indicates 1%, (**) 5%, and (*) 10%.

Source: Authors' calculations.

Examining heteroskedasticity indicated that acceptance of the null hypothesis of no heteroskedasticity.[28]

Under the hypothesis that liquidity influences the spreads, to avoid any omitted variable biases on the estimated coefficients, we re-ran the regression while controlling for Federal Funds target rate (*FFTR*). The result from Table 1.A.1 indicates that the regression with *FFTR* gives a better fit with an adjusted R^2 of 0.75. In addition, *FFTR* is statistically significant at 1 percent level. Some of the individual intercept and the slope dummies for "positive" and "negative" outlooks altered somewhat with the inclusion of the FFTR and now the test of no heteroskedasticity is rejected.

By running a Feasible Generalized Least Squares (FGLS), we correct for heteroskedasticity. Table 1.A.1 indicates that some further changes in the statistical significance of various parameters. After excluding the variables that are not statistically significant to explain the spreads, we ran another FGLS and obtained the following estimated result for the next step.

$SPRD = 2.78 + 0.08(FFTR) + 0.23(R) + 0.46(G1*POS) - 0.08(R*G1*POS) +$

$0.11(G1*NEG) + 0.03(R*G1*NEG) + 1.00(G2*STB) - 0.06(R*G2*STB) + 0.44(G2*NEG)$

Step 2: Given the coefficients from the regression result in Step 1, we estimated the spreads $(\widehat{SPRD})$ in log based on the combination of all possible credit ratings (*R*) and outlook (*O*) on average. Based on the estimated spreads, we calculated unweighted difference of the spreads ($DSPRD^U$) between "positive" (*POS*) and "stable" (*STB*) outlook and that between "negative" (*NEG*) and "stable" (*STB*) outlook for each credit rating as follow.

$$DSPRD^U_{R_i,O} = \widehat{SPRD}_{R_i,O} - \widehat{SPRD}_{R_i,STB}$$

where O takes either "positive" or "negative" outlook, and
$$R_i \in [AAA, AA+, AA, ..., SD], \text{ and}$$
$$R_1 = AAA; R_2 = AA+; ..., R_{22} = SD$$

Step3: We then calculated weighted differences of the spreads $(DSPRD^W_{G_s,O})$ for each grade category (G_s), where G_1 is an investment grade category, G_2 is the first tier, and G_3 is the second tier of noninvestment grade categories. Our weight $(WGT^{G_s}_{R_i,O})$ is based on the number of observations (*OBS*) sorted by credit ratings (R_i) and outlook (*O*) under the category of G_s. For example, for the investment grade category,

---

[28] Based on Breusch-Pagan / Cook-Weisberg test for heteroskedasticity, the null hypothesis is defined as a constant variance for the fitted value of *SPRD*.

$$WGT^{G_1}_{R_i,O} = \frac{OBS^{G_1}_{R_i,O} + OBS^{G_1}_{R_i,STB}}{\sum\limits_{i=1}^{10} OBS^{G_1}_{R_i,O} + \sum\limits_{i=1}^{10} OBS^{G_1}_{R_i,STB}} =$$

Weight of R_i when the rating (R_i) is in G_1 of the investment grade category

where

$$R_1, R_2, \ldots, R_{10} \in G_1 = investment\ grade$$
$$R_{11}, R_{12}, \ldots, R_{17} \in G_2 = noninvestment\ grade, tier\ 1$$
$$R_{18}, R_{19}, \ldots, R_{22} \in G_3 = noninvestment\ grade, tier\ 2$$

The weighted differences of the spreads $(DSPRD^W_{G_s,O})$ are calculated as:

$$DSPRD^W_{G_1,O} = \sum\limits_{i=1}^{10} DSPRD^U_{R_i,O} * WGT^{G_1}_{R_i,O} =$$

Weighted difference of the s spreads for the investment grade category (G_1)

$$R_1, R_2, \ldots, R_{10} \in G_1 = investment\ grade$$
$$R_{11}, R_{12}, \ldots, R_{17} \in G_2 = noninvestment\ grade, tier\ 1$$
$$R_{18}, R_{19}, \ldots, R_{22} \in G_3 = noninvestment\ grade, tier\ 2$$

For the investment grade (G_1) category, we obtained the following estimates in log.

$$DSPRD^W_{G_1,POS} = -0.226$$
$$DSPRD^W_{G_1,NEG} = 0.398$$

For the first tier of noninvestment grade (G_2) category, the estimates are:

$$DSPRD^W_{G_2,POS} = -0.150$$
$$DSPRD^W_{G_2,NEG} = 0.346$$

For the second tier of noninvestment grade (G_3) category, the estimates are:

$$DSPRD^W_{G_3,POS} = 0$$
$$DSPRD^W_{G_3,NEG} = 0$$

These estimates signify discount/penalty factors based on a given outlook under the three grade categories. A discount of 0.226 given to countries with a "positive" outlook in the investment grade (G_1) category implies that their spreads are lower by 20.6 percent relative to other countries with a "stable" outlook in the same grade category. Similarly, a penalty of 0.346 given to countries with a "negative" outlook in the first tier of noninvestment grade (G_2) category implies that their spreads are higher by 34.6 percent relative to other countries with a "stable" outlook in the same grade category. In contrast, a "positive" outlook in the second tier of noninvestment grade category does not bear a discount factor, and neither does a "negative" outlook a penalty factor. In addition, the discount/penalty factors account for

asymmetric responses by the investors. The widening of the spreads in response to a "negative" outlook is larger in an absolute magnitude than the spread tightening in response to a "positive" outlook. Investors, instead of handsomely rewarding countries with "positive" outlook, penalize them harshly with a "negative" outlook.

Step 4: These discount/penalty factors feed into a calculation of adjusted spreads for each rating (R_i) with outlooks (O) of both "positive" and "negative". While we use the estimated spreads ($\widehat{SPRD}_{R_i, STB}$) for a "stable" outlook from Step 1, the adjusted spreads ($SPRD_{R_i, O}^{Adj}$) are defined as follow.

$$SPRD_{R_i, O}^{Adj} = \widehat{SPRD}_{R_i, STB} + DSPRD_{G_s, O}^W$$

$$where$$

$$R_1, R_2, \ldots, R_{10} \in G_1 = investment\ grade$$

$$R_{11}, R_{12}, \ldots, R_{17} \in G_2 = noninvestment\ grade, tier\ 1$$

$$R_{18}, R_{19}, \ldots, R_{22} \in G_3 = noninvestment\ grade, tier\ 2$$

Using these adjusted spreads and the estimated coefficients of the regression from Step 1, we calculate the values of ratings (R_i). These values are, in essence, the index values of the Total Credit Rating-Outlook Index (CROI). Thus, the CROI takes the following form when an outlook is "stable."

$$CROI_{R_i, STB} = i$$

$$(i = 1, 2, \ldots, 22)$$

When an outlook (O) is either "positive" or "negative," the CROI takes the following form.

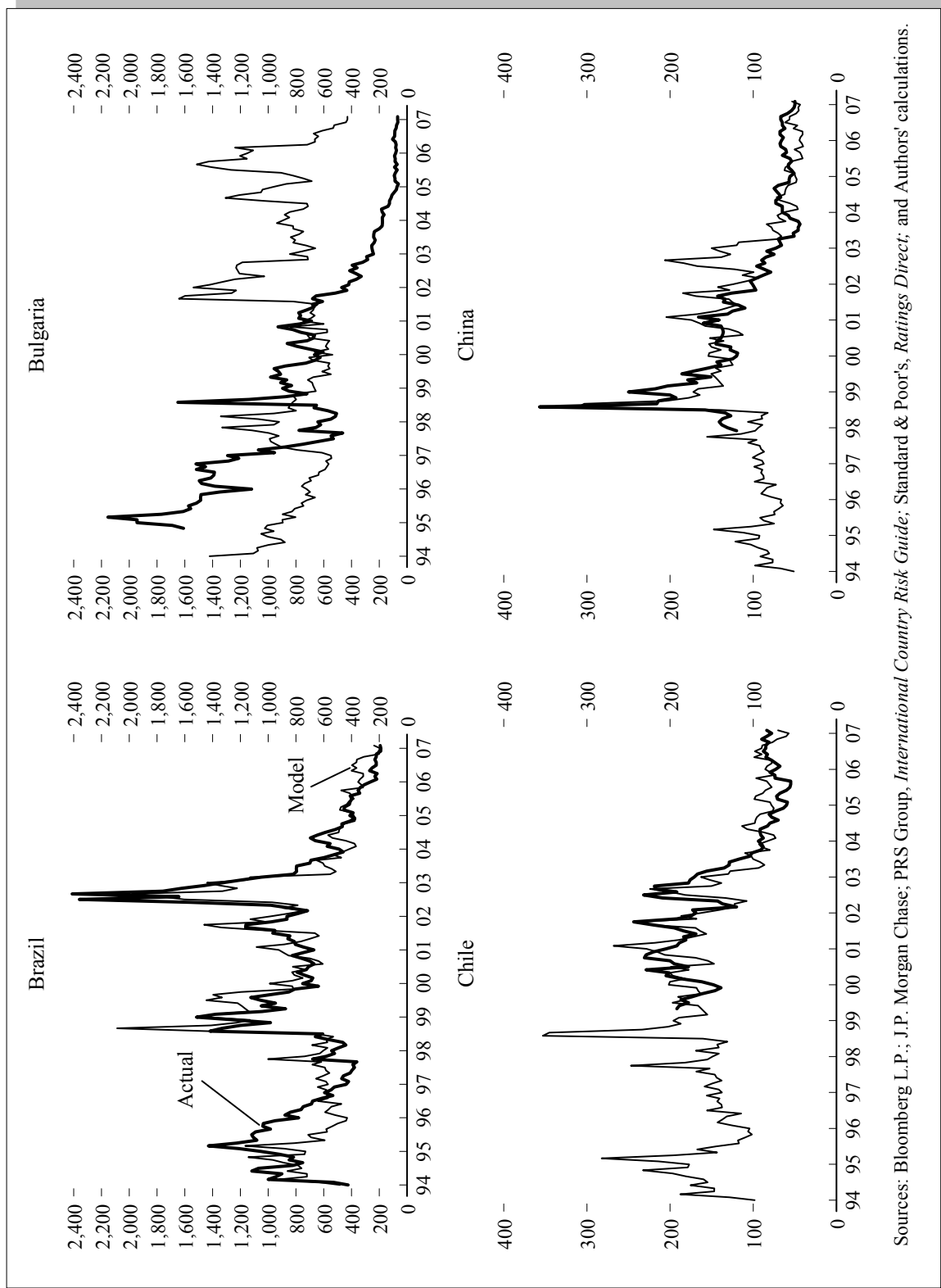$$CROI_{R_i, O} = i + F_{G_s, O}$$

$$where$$

$$F_{G_1, POS} = -0.97,\ F_{G_1, NEG} = 1.72$$

$$F_{G_2, POS} = -0.90,\ F_{G_2, NEG} = 2.08$$

$$F_{G_3, POS} = 0,\ F_{G_3, NEG} = 0$$

Table 2 shows values of the CROI based on the formulae above. The initial CROI is altered to incorporate the four unique properties that are attributed to the discount/penalty factors calculated earlier. These properties are discussed in the section B.1.

Appendix Figure 1. Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals
(log scale; basis points)

Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide*; Standard & Poor's, *Ratings Direct*; and Authors' calculations.
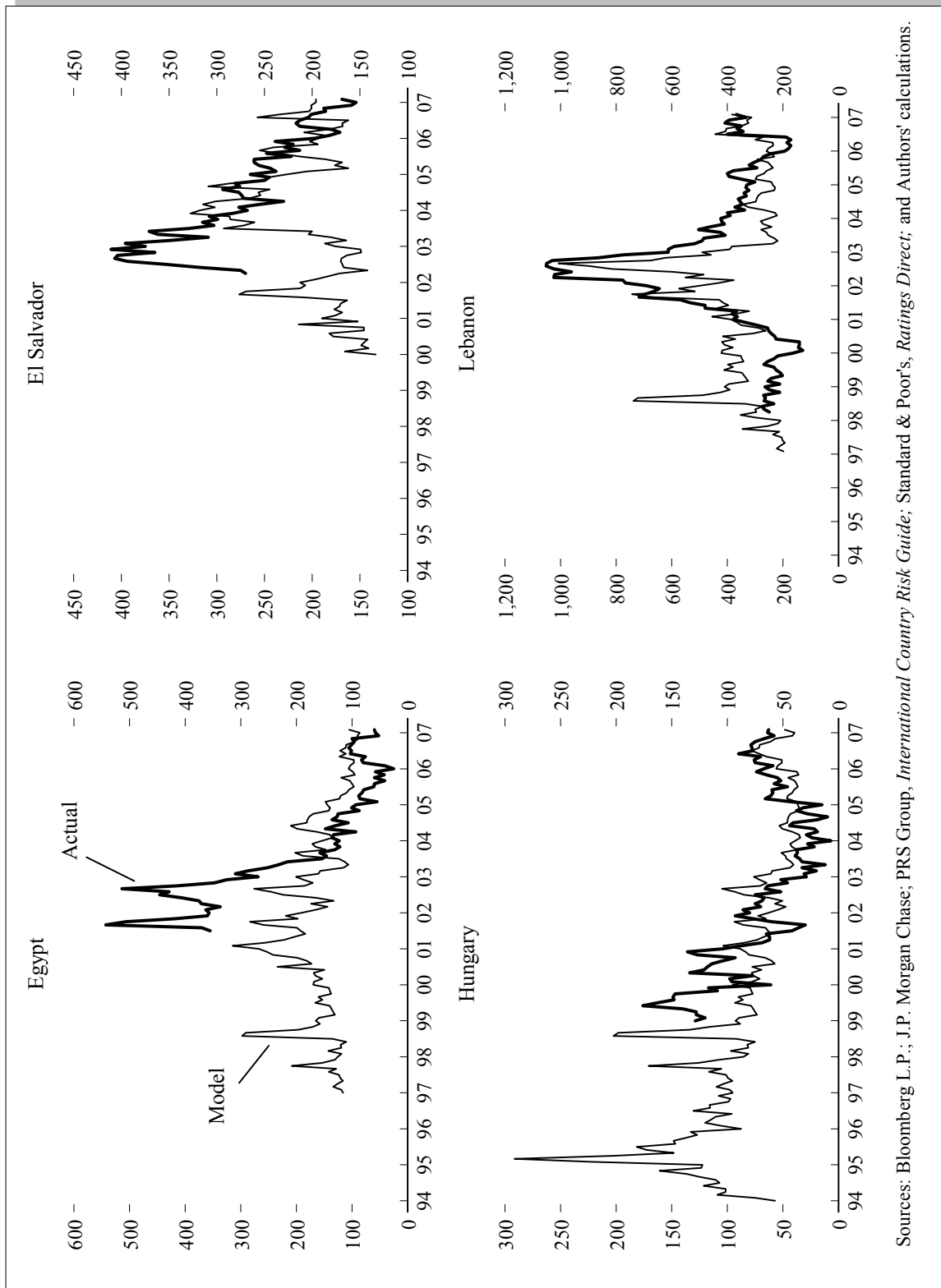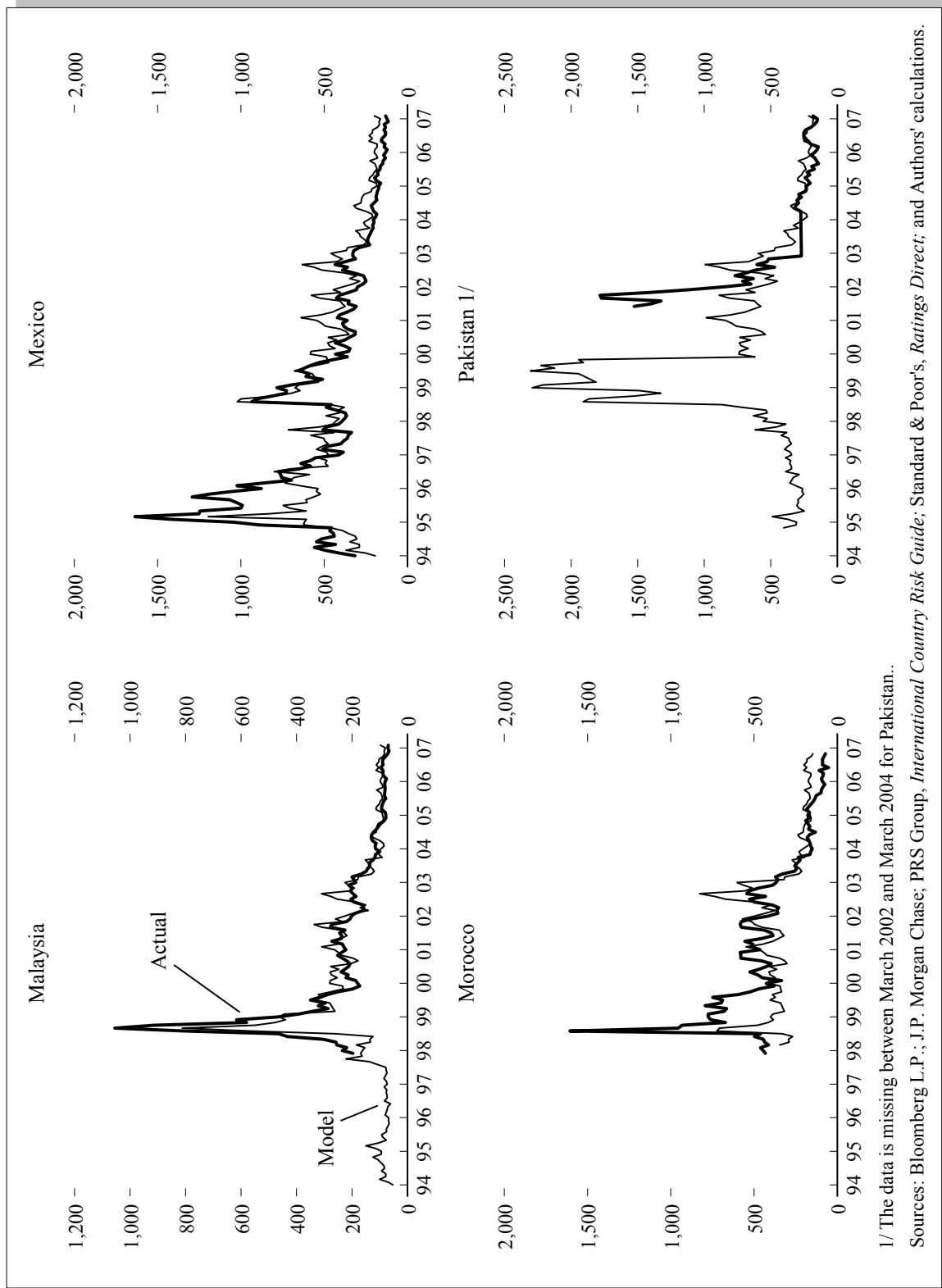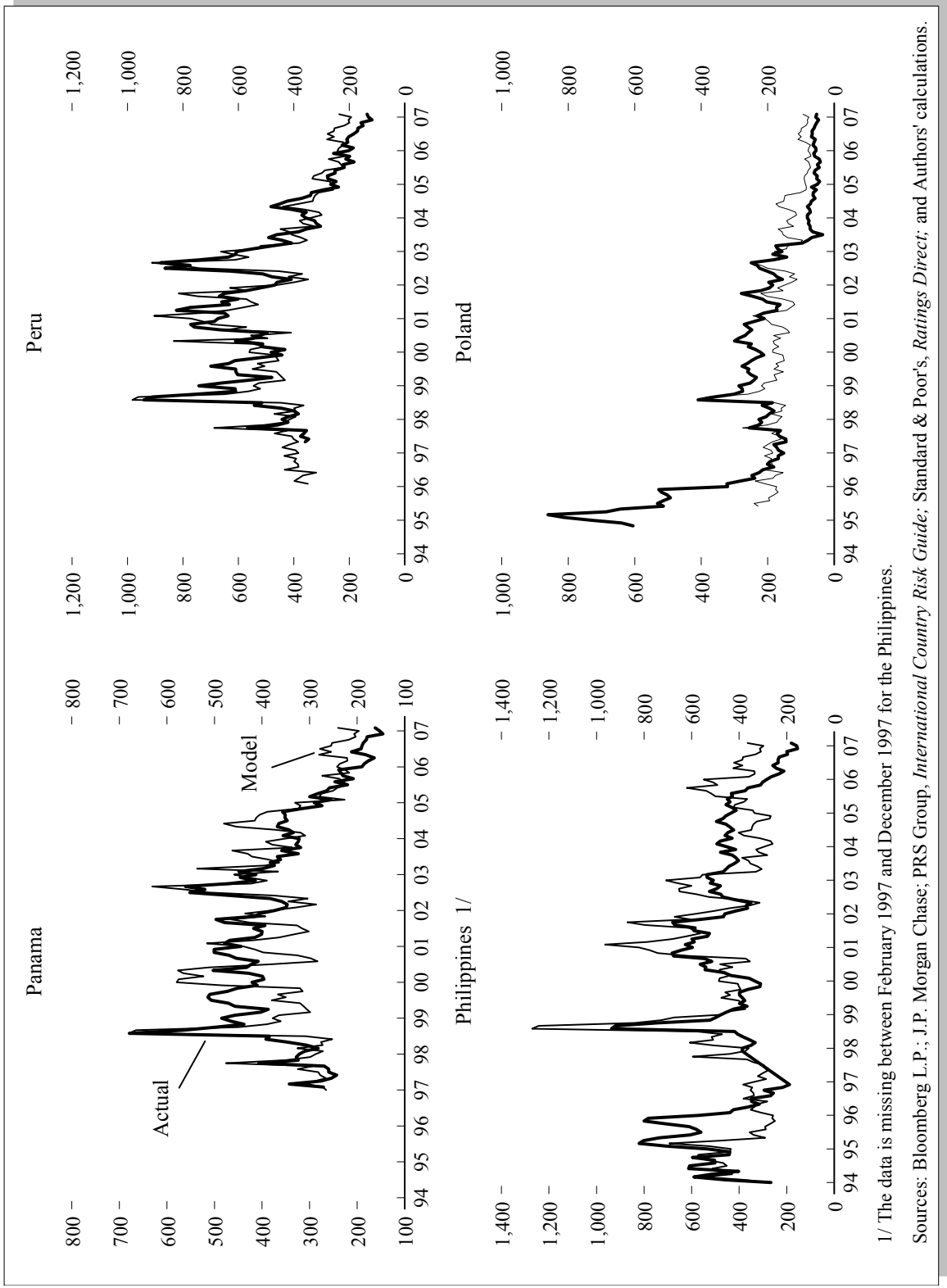
Appendix Figure 1 (continued). Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals
(log scale; basis points)

Colombia

Croatia 1/

Dominican Republic

Equador

Model
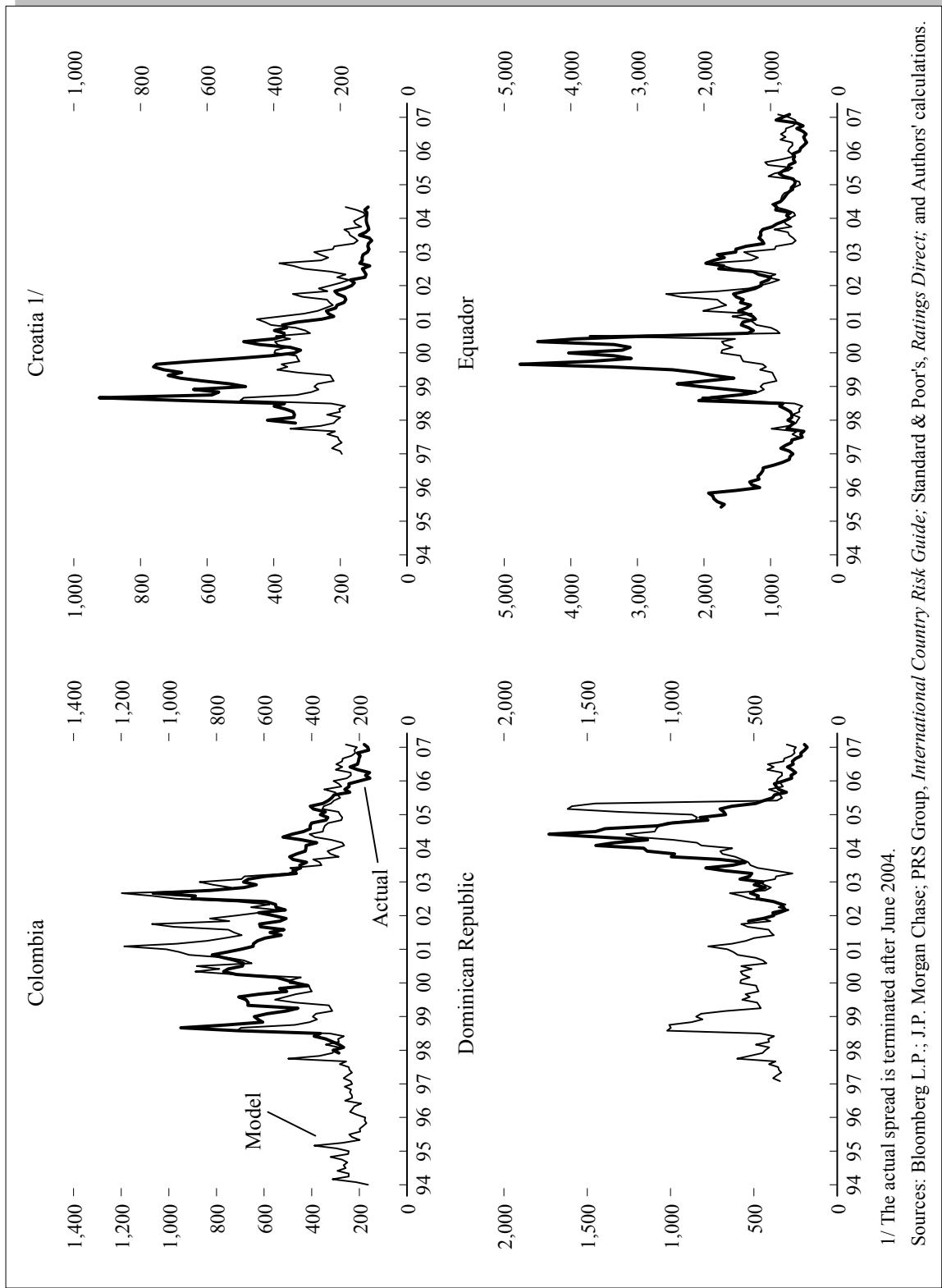
Actual

1/ The actual spread is terminated after June 2004.

Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide*; Standard & Poor's, *Ratings Direct*; and Authors' calculations.

Appendix Figure 1 (continued). Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals
(log scale; basis points)

Appendix Figure 1 (continued). Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals

(log scale; basis points)

Malaysia

Mexico

Morocco

Pakistan 1/

1/ The data is missing between March 2002 and March 2004 for Pakistan..

Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide*; Standard & Poor's, *Ratings Direct*; and Authors' calculations.

Appendix Figure 1 (continued). Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals

(log scale; basis points)

1/ The data is missing between February 1997 and December 1997 for the Philippines.

Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide*; Standard & Poor's, *Ratings Direct*; and Authors' calculations.
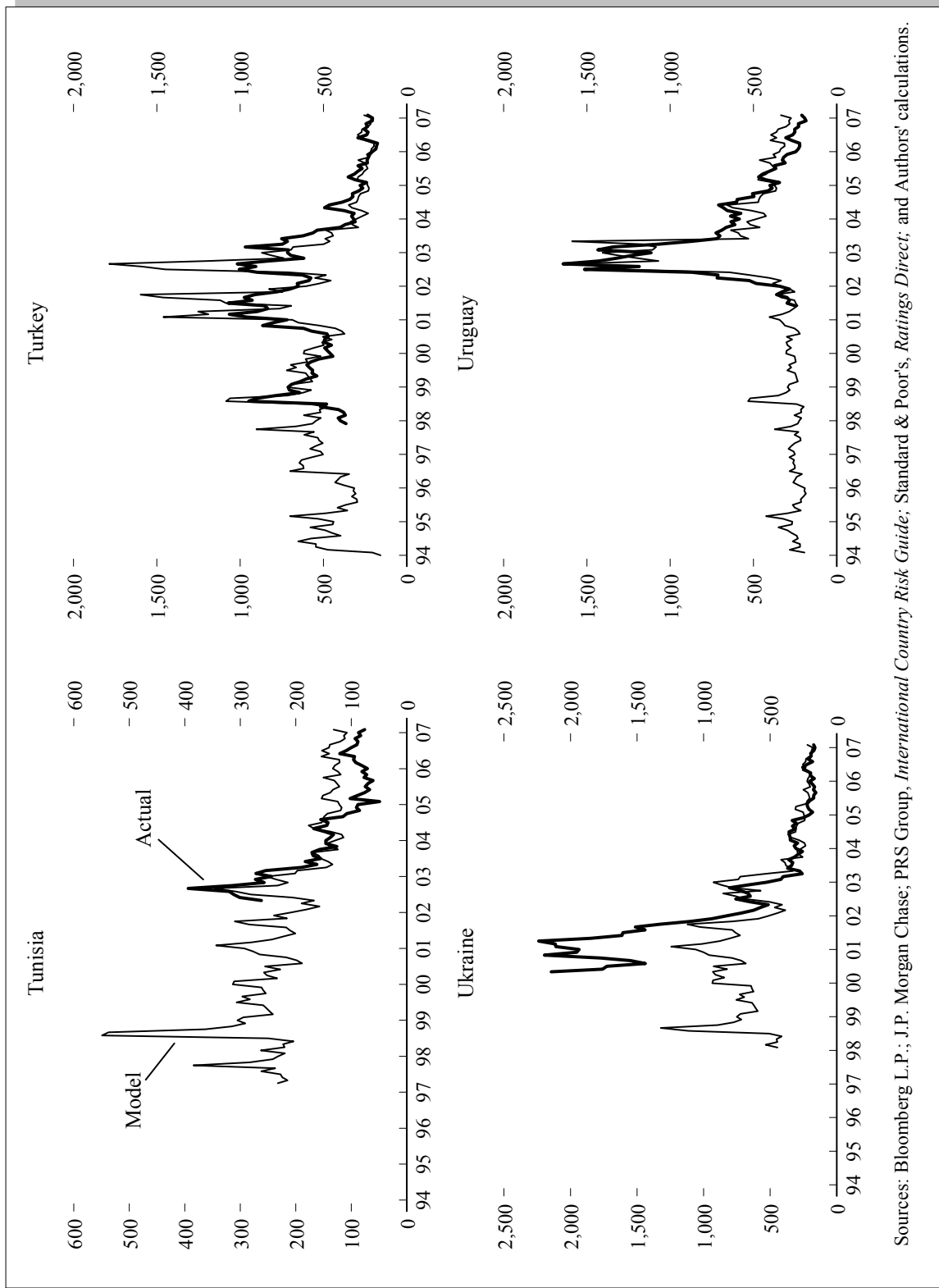
Appendix Figure 1 (continued). Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals

(log scale; basis points)
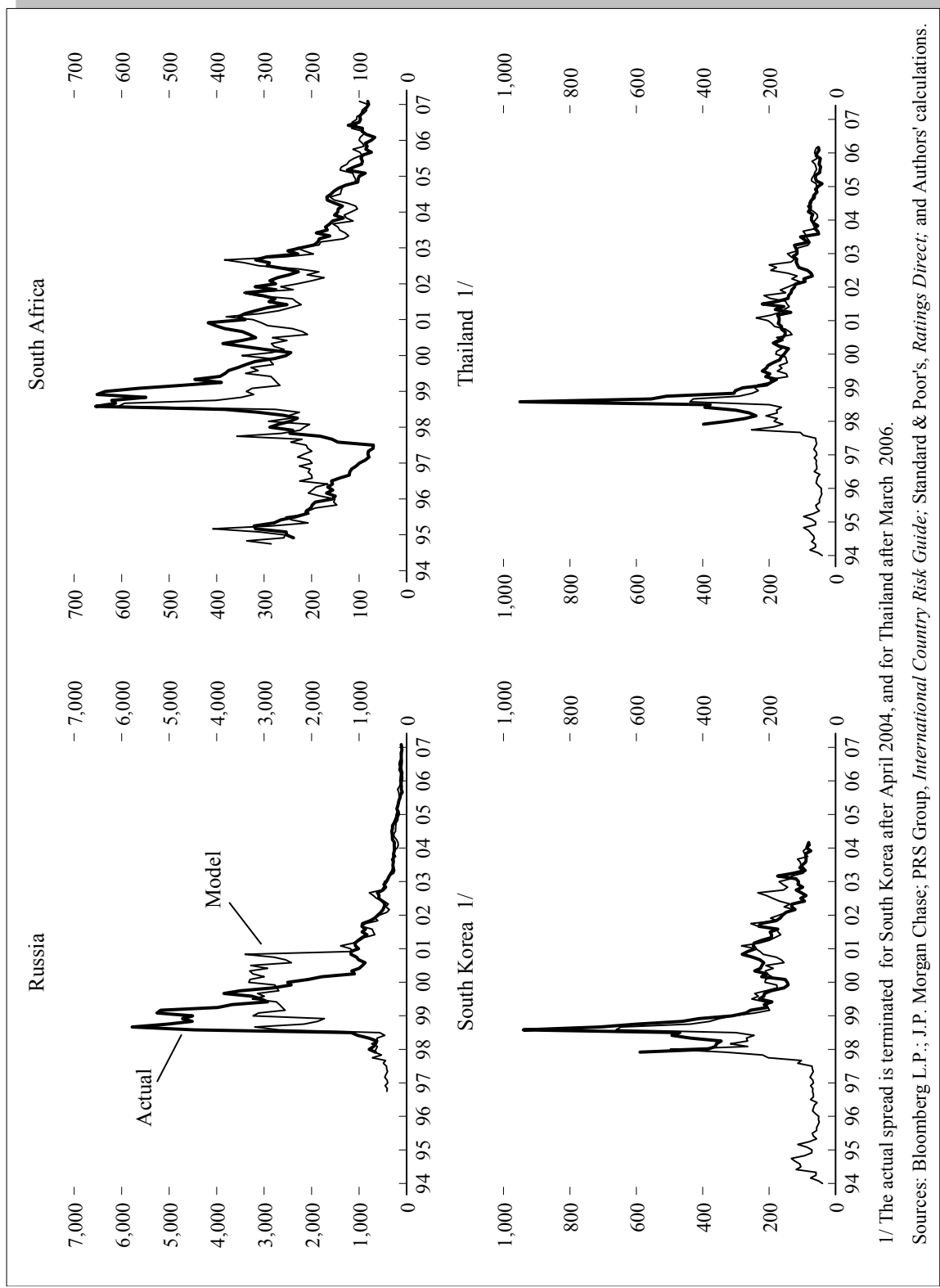
1/ The actual spread is terminated for South Korea after April 2004, and for Thailand after March 2006.
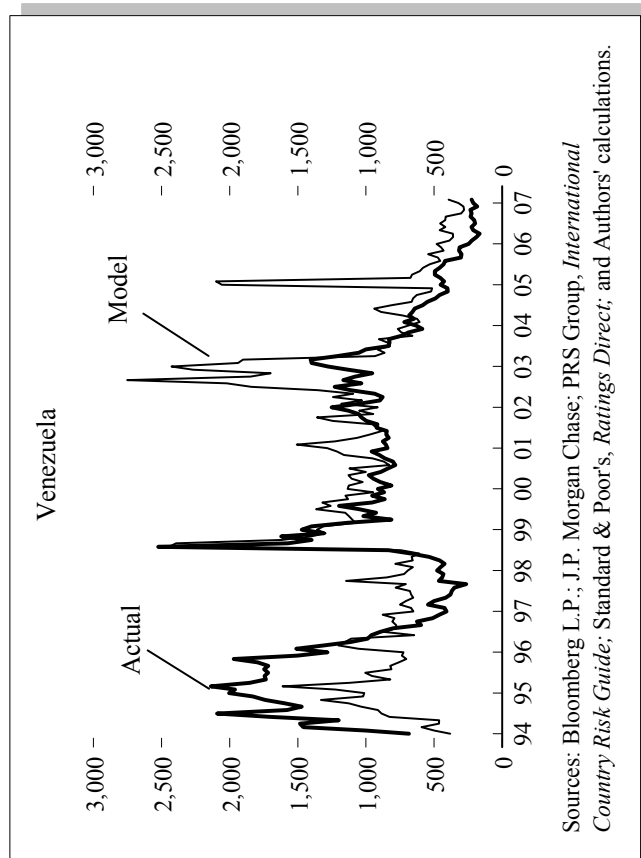
Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide*; Standard & Poor's, *Ratings Direct*; and Authors' calculations.

Appendix Figure 1 (continued). Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals
(log scale; basis points)

Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide*; Standard & Poor's, *Ratings Direct*; and Authors' calculations.

Appendix Figure 1 (continued). Actual and Estimated Spreads:
Extended Model with CROI as Fundamentals

(log scale; basis points)

Sources: Bloomberg L.P.; J.P. Morgan Chase; PRS Group, *International Country Risk Guide*; Standard & Poor's, *Ratings Direct*; and Authors' calculations.

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