What Drives Credit Risk in Emerging Markets? The Role of Country Fundamentals and Market Co-movements

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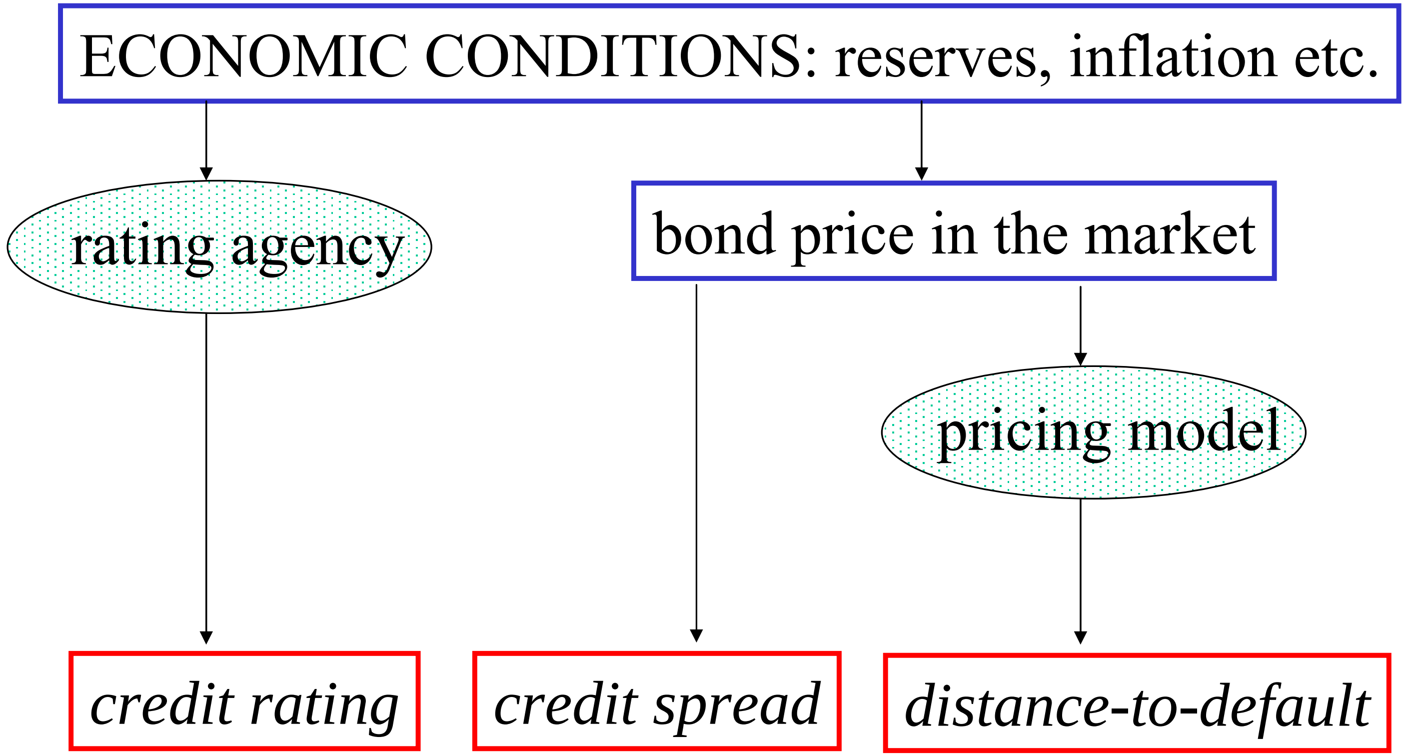
Aims of the Paper

1) Use an extended structural model to estimate a measure of creditworthiness, the ***distance-to-default,*** for Argentina, Brazil, Mexico and Venezuela over 1994 to 2001

2) To discover ***which factors affect the distance-to-default***

    - global factors (e.g. US stockmarket, oil prices)
    - regional factors (e.g. sentiment, contagion)
    - local factors (e.g. reserves, inflation)

Alternative Measures of Creditworthiness for Countries



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Pricing Corporate Risky Bonds

- **Structural Approach:**

  Default is triggered when a solvency or latent variable crosses a specific threshold.

  ✓ Merton(1974)
  ✓ Longstaff and Schwartz (1995)

- **Reduced Form Approach:**

  Default is an unpredictable event that occurs as a jump.

  ✓Jarrow, Lando and Turnbull (1994)
  ✓Lando(1995)
  ✓Duffie and Singleton (1997)

Main Story

- **Major problem with Structural Models is:**
  - Defining a solvency variable and the barrier

- **Our Approach:**
  - Extract latent variable: ***distance-to-default***
  - Explain it with economic fundamentals

- **Use Brady Bonds.**
  - Liquid bonds
  - Some cashflows are guaranteed by US Treasuries

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What is the “Distance-to-Default”?

- for a **company** it is (firm value – debt)/sigma
  - ✓ risk-neutral estimation (like Merton’s model)
  - ✓ used by Moodys/KMV
  - ✓ related empirically to probability of default
- for a **country** we define it as:

$$Y_t = \ln (X_t/X_l)$$

signalling variable

implicit barrier

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Why focus on the "Distance-to-Default"?

1) like a credit-rating, but in continuous time

2) market-determined

3) unlike credit-spread, does not depend on maturity, coupons, amortization

4) correlation across issuers is informative (contagion)

What do we know about Credit Spreads?

➢corporate bond spreads

- expected default explains only small proportion
- risk premium, tax, liquidity...
- there is an unexplained common factor

(Elton et al, 2001; Huang&Huang, 2003; Collin-Dufresne et al, 2002; Driessen, 2003)

➢sovereign bond spreads

- expected default
- local, regional, and global fundamentals
- market sentiment

(Kamin and von Kleist, 1999; Eighengreen and Mody, 1998; Westphalen, 2001)

Previous Modelling of Sovereign Bonds

➢ **Claessens and Pennacchi (1996), Cumby and Evans (1997)**

- Diffusion models for solvency variable
- Kalman filter estimation

→ implied default probability varies over time

➢ **Gibson and Sundaresan (1999)**

- Sovereign spreads depend on potential retaliation

→ larger than corporate spreads

➢ **Keswani(2000)**

- Longstaff and Schwartz(1995) model
- Implicit distance-to-default variable using a Kalman Filter
- Brady bonds for short period

→ compares structural and reduced-form models

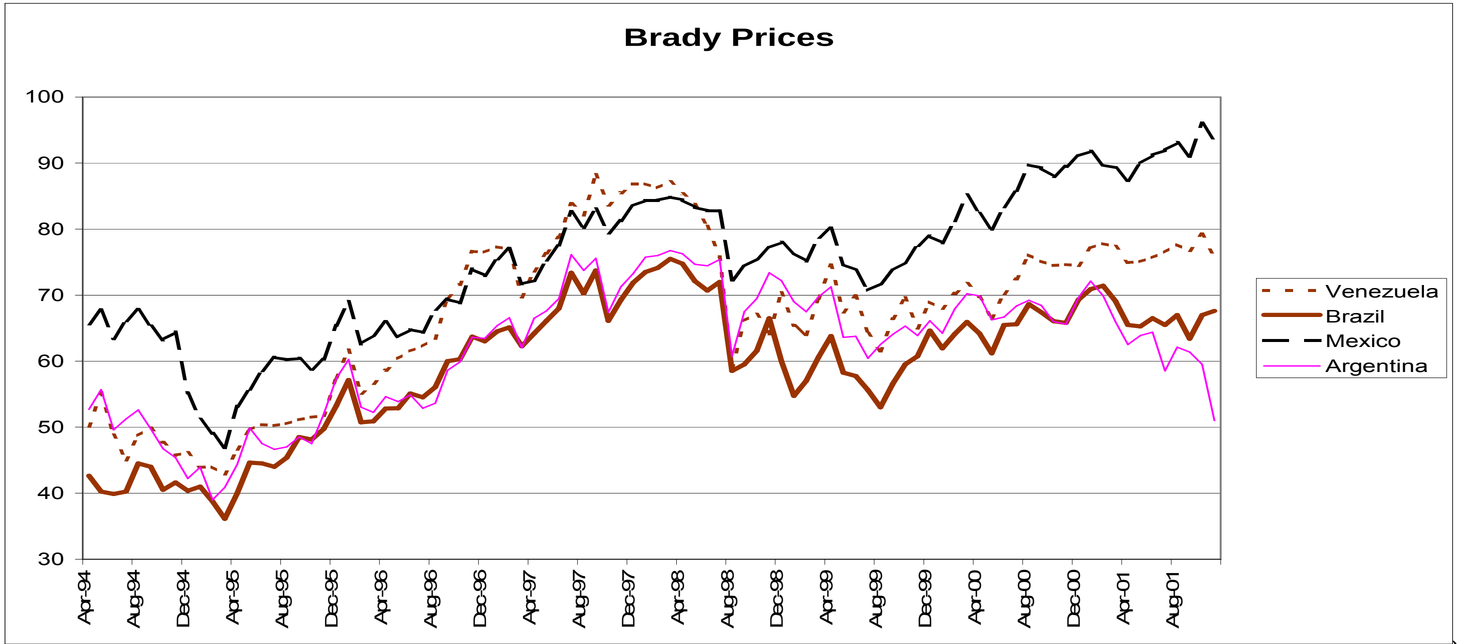
➢ **Duffie, Pederson and Singleton (2003)**

- Reduced Form Model
- Russian debt

Data

➢Brady Bonds

- Monthly observations (April 1994 – Oct 2001) from Datastream
- Argentina, Brazil, Mexico and Venezuela
- Bonds are partially collateralised with US Treasuries



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The model for Bond Pricing

(Cathcart and El- Jahel, 2003)

➢ **Structural Model plus a Reduced-Form Jump-to-Default**

- **Risk free interest rate** ~ CIR (1985)

$$dr_t = \kappa_r (\mu_r - r_t) dt + \sigma_r \sqrt{r_t}\, dZ_r$$

- **Signalling variable**

$$dX_t = \alpha_x X_t dt + \sigma_x X_t dZ_x$$

- **Jump event**

$$h_t = a_r + b_r r_t$$

- **Default occurs if X_t hits the Barrier X_l**

- **Recovery Rate:** δ

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Cathcart and El- Jahel then show that:

Risky Bond = Risk Free Bond - {PV(Loss on Default)}

$$H(x_t, x_\ell, r_t, \tau) = P_t(r_t,\tau) - \left\{P_t(r_t,\tau)\left(1 - f(x_t,\tau)g(r_t,\tau)\right)(1-\delta)\right\}$$

$$f(x_t,\tau) = \Phi\left(\frac{y + \left(\alpha_x - \frac{1}{2}\sigma_x^2\right)\tau}{\sigma_x\sqrt{\tau}}\right) - \exp\left(\frac{-2\left(\alpha_x - \frac{1}{2}\sigma_x^2\right)y}{\sigma_x^{2}}\right)\Phi\left(\frac{-y + \left(\alpha_x - \frac{1}{2}\sigma_x^2\right)\tau}{\sigma_x\sqrt{\tau}}\right)$$

Probability of not hitting a barrier

$$g(r_t,\tau) = \exp\left(C(\tau) + D(\tau)r_t\right)$$

Probability of no jump to default

Let $y_t = \ln(X_t/X_l)$ denote the Distance-to-Default process.

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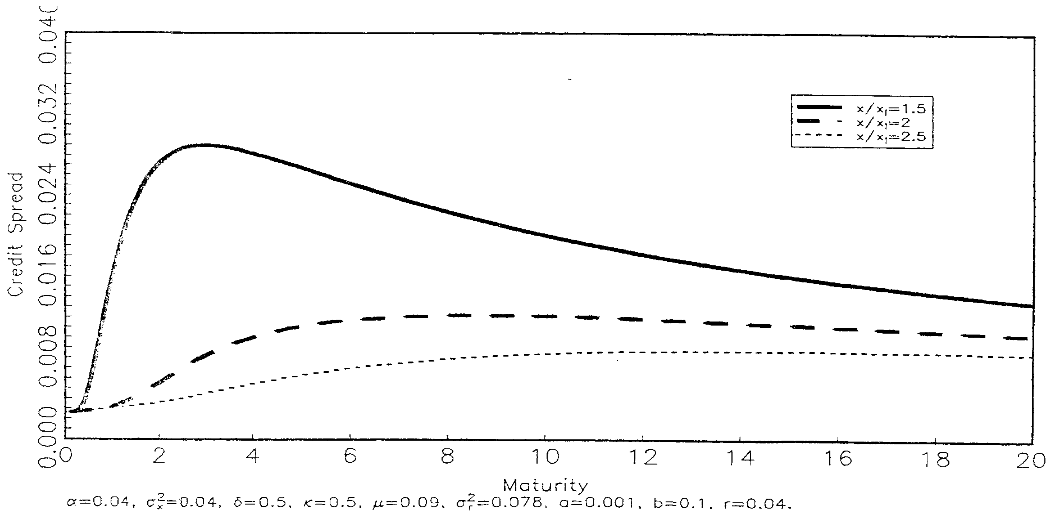
Why Use the CEJ and not the L&S Model?

1. CIR process for interest rates rather than Vasicek
2. Includes a hazard rate, so spread exceeds zero near to maturity
3. Can generate various credit-spread term-structures (like L&S)



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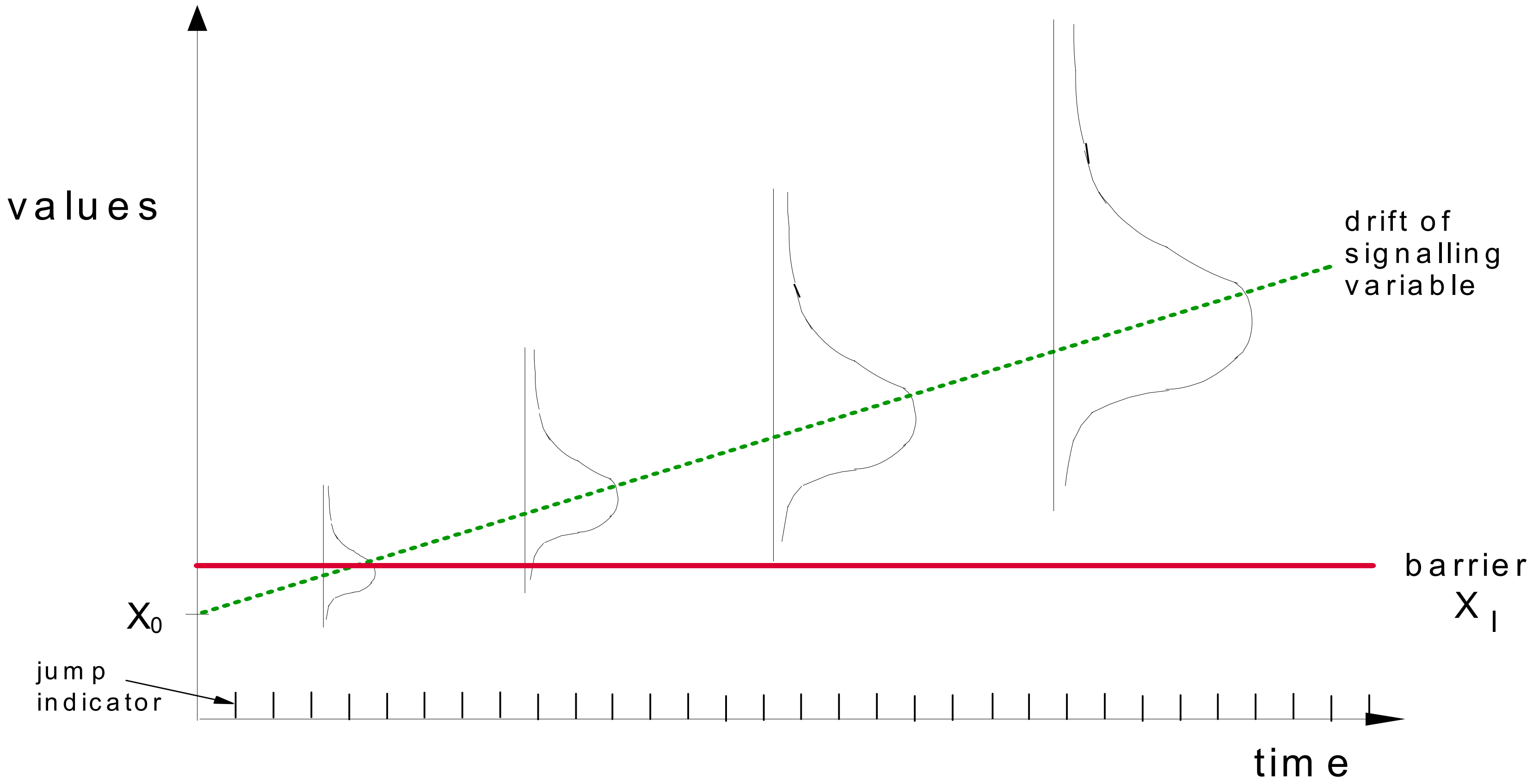
The Intuition of the Pricing Model



We do not observe either X_t or X_l

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Estimation of the Model: the Kalman Filter

- Solvency variable [$Y_t = \ln(X_t/X_l)$] cannot be observed.
- Use data and model to impute it, with a Kalman Filter
  - Measurement Equation

$$\mathcal{B}_t = B(t, r, Y_t; \Psi, \Gamma) + \varepsilon_t$$

where:

Γ set of the risk-free parameters (CIR)

Ψ vector of risky parameters

  - Transition Equation: discretisation of the latent variable

$$Y_{t|t-1} = Y_{t-1} + \left(\alpha_X - \frac{\sigma_X^{\,2}}{2} \right) \Delta t + \sigma_X \sqrt{\Delta t}\, \eta_t$$

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Estimation of the Model (continued)

- CEJ model is estimated in two stages:
  - Estimate parameters of the risk-free process (one- factor CIR model)
  - Use a Kalman Filter to obtain estimates of the distance-to-default and risky parameters.
- Quasi-Maximum-Likelihood estimates of parameters
- Recovery rate (δ) = 0, as no collateral for risky part of bond
- Hazard rate (jump) is <u>not</u> significant

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Results from Estimation

Country	Hazard Rate		Latent Signalling Variable	Standardised Long-Term Drift of Distance-to-Default	Log Likelihood function
	$a_r\,(x10^3)$	$b_r\,(x10^3)$	α_x	α_y	*QML*
Argentina	0.00000	0.00114	0.18709* (4.136)	-0.31291	176.42
Brazil	0.00010	0.00172	0.23020** (8.815)	-0.26980	182.73
México	0.00087	0.00413	0.35632** (20.900)	-0.14368	186.88
Venezuela	0.00000	0.00003	0.27274** (14.135)	-0.22726	169.18

a_r and b_r are the parameters of the hazard rate defined as $\lambda = a_r + b_r \cdot r_t$.

α_x is the drift of the latent variable X_t and has been estimated using the specification of the following transition equation in the Kalman Filter:

$$Y_{t|t-1} = Y_{t-1} + \left(\alpha_x - \frac{\sigma_x^{\ 2}}{2}\right)\frac{1}{12} + \sigma_x\sqrt{1/12}\,\eta_t\,, \qquad \text{where } Y_t = \ln(X_t / X_\ell)\,,$$

α_y is the drift of the distance-to-default, where $\alpha_y = \alpha_x - (\sigma^2_x / 2)$

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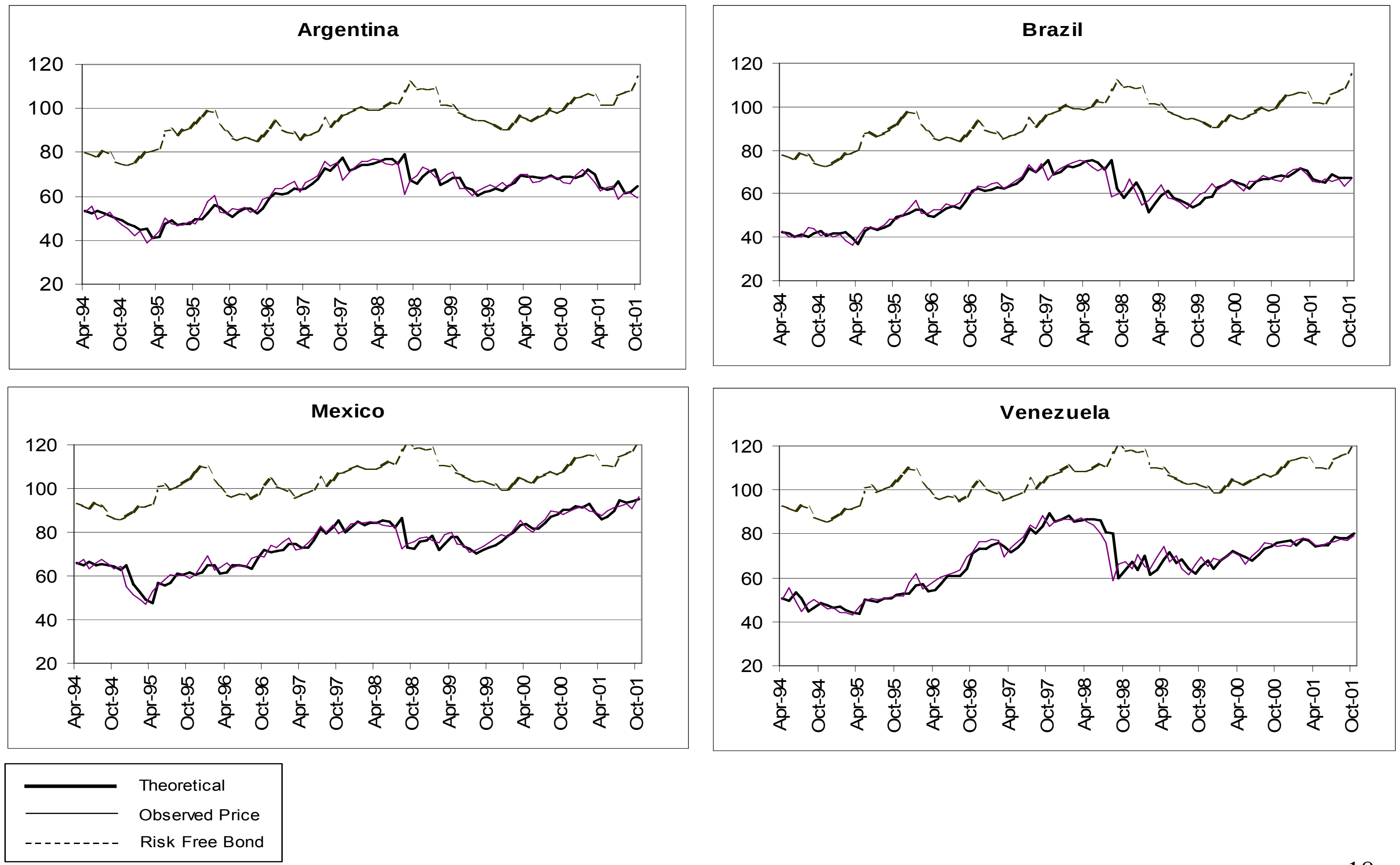
Results from Estimation: Prices



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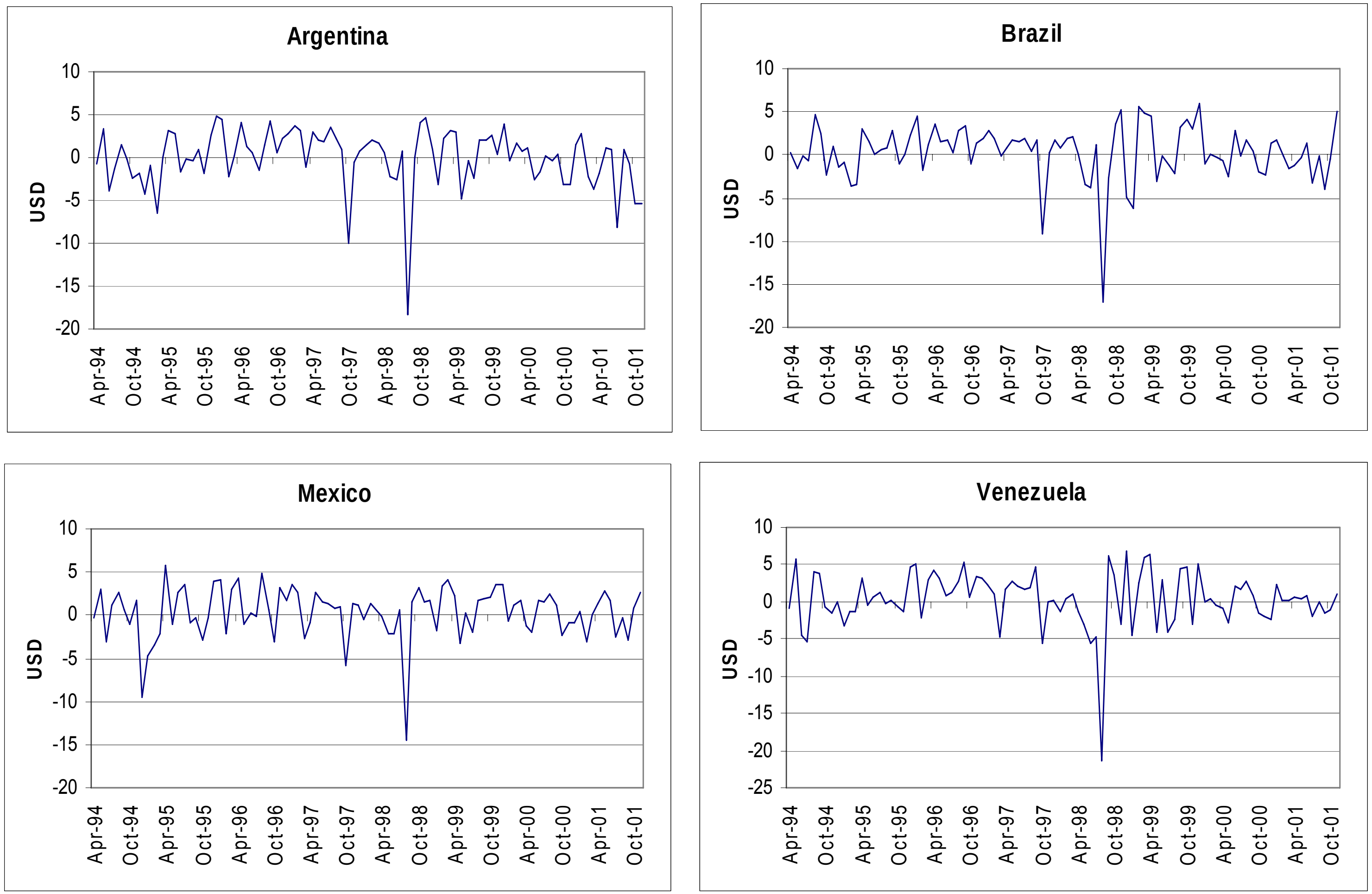
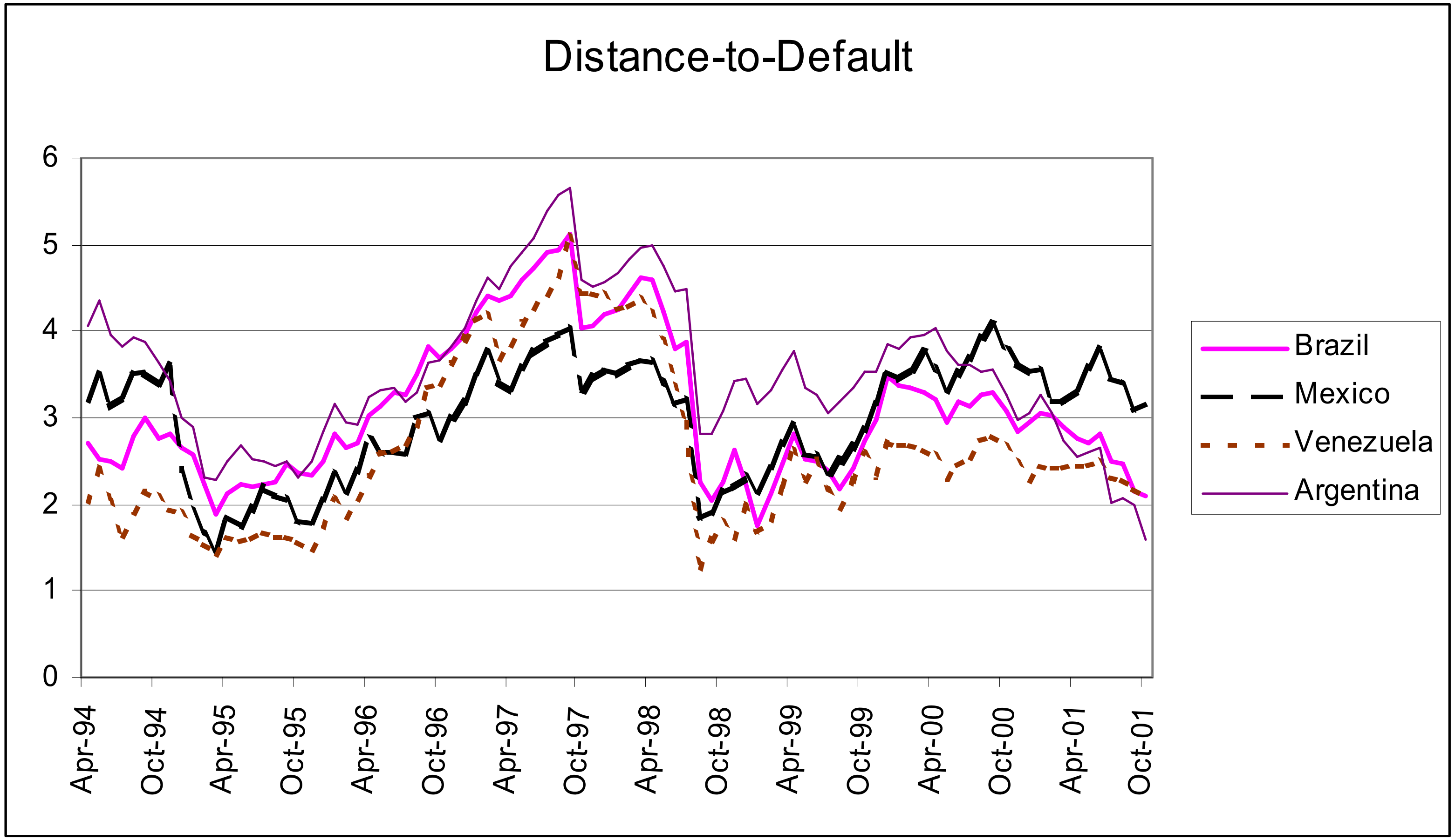
One-Step-Ahead Residuals of Forecast Bond Prices



Results from Estimation: Distance-to Default



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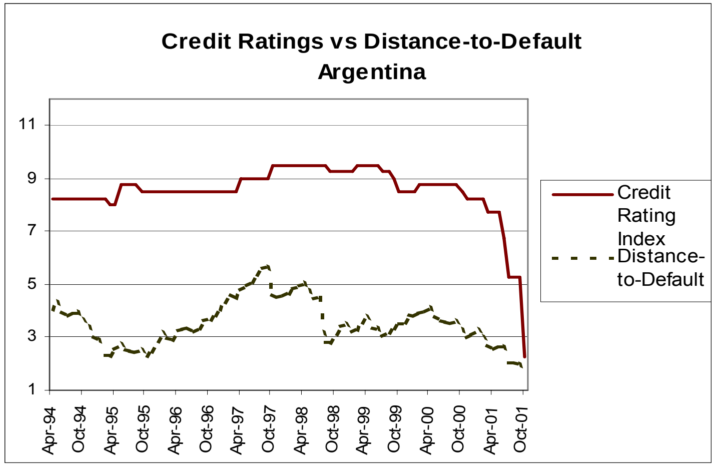
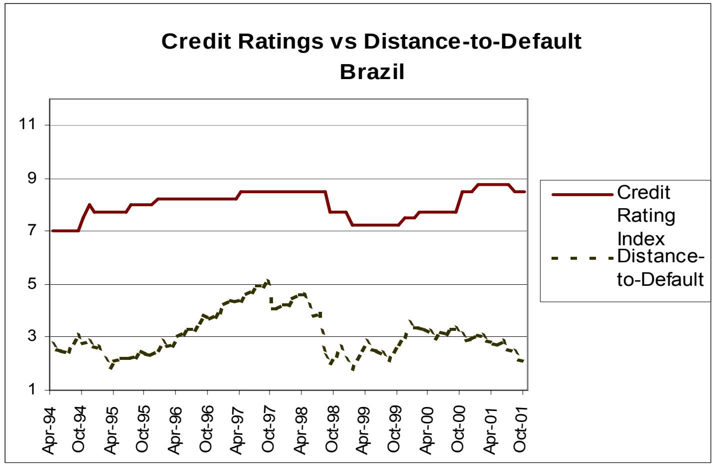
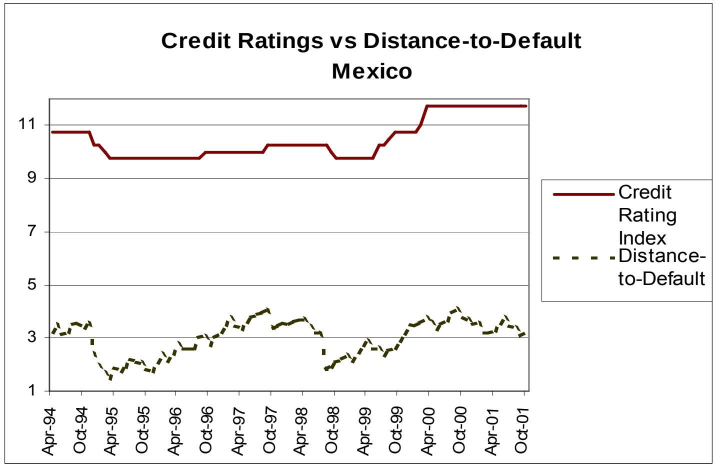
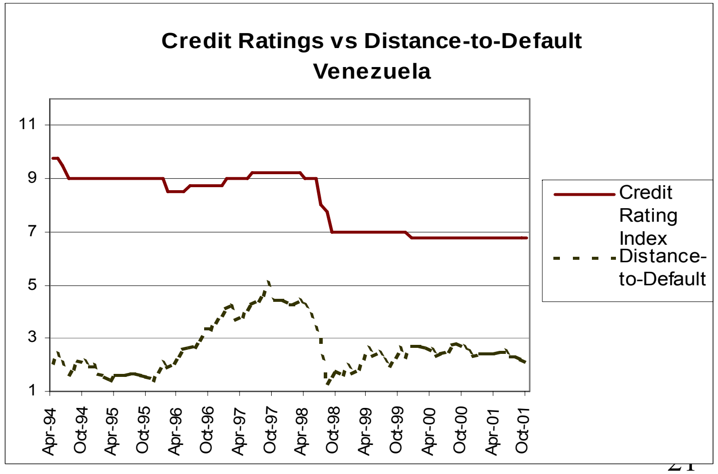
Credit Ratings versus Distance-to Default









Co-movements of the Distance-to-Default

Correlations

	Argentina	Brazil	Mexico	Venezuela
Argentina	1			
Brazil	0.845	1		
Mexico	0.766	0.747	1	
Venezuela	0.768	0.744	0.704	1

Principal Components of the variations of the Distance-to-Default

Loadings

	Comp 1	Comp 2	Comp 3	Comp 4
Eigenvalue	3.289	0.296	0.263	0.152
Variance Prop.	0.822	0.074	0.066	0.038
Cumulative Prop.	0.822	0.896	0.962	1.000

Eigenvectors

Variable	Vector 1	Vector 2	Vector 3	Vector 4
Argentina	0.515	0.007	-0.382	0.768
Brazil	0.508	-0.027	-0.585	-0.632
Mexico	0.488	-0.696	0.523	-0.061
Venezuela	0.488	0.717	0.489	-0.091

Theoretical Determinants of the DD

➢ **Global Factors**

- **Interest Rates**.

→ An increase in rates may signal a recovery in the world economy (G&S,2001)
→ A greater slope may predict and increase in rates.

❖ Use the first two PC of the term structure.

- **World economic growth**.

→ World economic conditions are likely to affect the creditworthiness of countries.
→ Positive impact on the DD.

❖ Use the S&P500.

- **Oil Prices**.

→ Venezuela and Mexico are important oil producers.
→ The higher the price, the higher the revenues and the DD.

❖ Brent Crude prices.

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Theoretical Determinants of the DD

➢ **Common (Regional) Factors**

- **Regional Stock Market Returns**.

→ Countries stock markets move together
→ First PC explains 64% of total variance

❖ Use the first PC purged of US influences (S&P500, interest rates).

- **Regional Stock Market Volatility**.

❖ PC explains 52% of total variance.

- **Regional Investor Sentiment**.

→ Some investors in the bond market do not discriminate in an informed way among borrowers.
→ Herding behaviour.

❖ Built index using data on UK closed-end country funds that invest in LA.

Theoretical Determinants of the DD

- **Country-Specific Factors**

  - **Country-Specific Stock Market Returns**.

    - Residuals of the returns not explained by the 4-nation regional returns

  - **Country-Specific Stockmarket Volatility**.

  - **International Reserves**.
    → Measure of liquidity.
    → Ability of the country to pay its foreign debt.

  - **Inflation rate**.
    → Indicator of how well a country manages its monetary policy.
    → High inflation rates may indicate imprudent policies.

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Factors Affecting Distance-to-Default (changes)

	% variance		Arg	Bra	Mex	Ven
GLOBAL	25%	US interest rates -- level				
		US interest rates -- slope	+	+	+	+
		US stockmarket returns	+	+	+	+
		Oil prices			+	+
REGIONAL	45%	4-nation stockmarket returns	+	+	+	+
		4-nation volatility	-	-	-	-
		Sentiment (regional closed-end fund discount	-	-	-	
NATIONAL	10%	Reserves	+		+	
		Inflation				
		Country-specific stockmarket returns	+	+	+	+
		Country-specific volatility				

OLS regression on changes in distance-to-default
Hendry method for selection of variables
# indicates at least 5% significance level and sign as expected

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Conclusions

- Distance-to-default can be imputed for emerging-market bonds

- Factors affecting the distance-to-default can mainly be identified:
  - 80% (approx.) of variance explained by economic factors
  - regional and global factors are more important than country-specific factors
  - Credit risk of these countries are non-diversifiable

- A common, systematic factor across the bonds of the four nations is still present and unexplained
  - accounts for 60% of residual variance

- Contagion arises from regional variables and the unexplained bond factor

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