

A Structural Model for Sovereign Credit Risk

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INTRODUCTION

Introduction

Outline

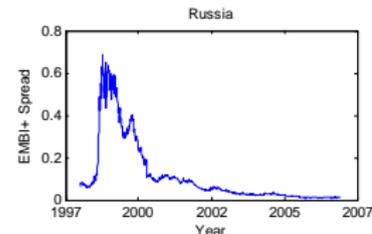
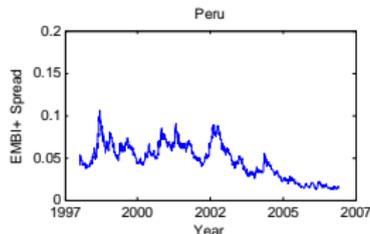
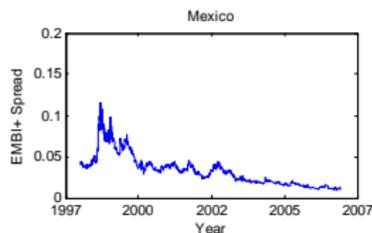
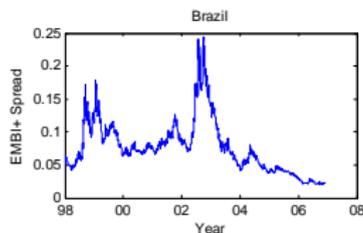
- Motivation and goal of this research
- A brief overview of the literature
- The main results at a glance
- A snapshot of the model
- Main results
 - ▶ Theoretical predictions of the relationship between credit risk and macro-variables
 - ▶ Explanation of the time variation in credit risk
- Conclusion

Introduction

Motivation

Stylized facts

- Sovereign debt constitutes the largest asset class in emerging markets
 - ▶ \$5,500bn of principal in 2007
- Sovereign debt has been at the center of several international lending crises
- We need to evaluate how developing country creditworthiness varies over time
 - ▶ Country risk rating agencies, financial institutions, and the financial market in general



Introduction

Motivation and main results

Goal of this paper

- Explain the variation across time in credit risk
- Analyze the relationship between default risk and macroeconomic variables

Results to take away

- The paper provides a new structural model to price credit risk: it is simple and intuitive
- Theoretical relationships between the macro-variables provided by the model and predicted credit spreads are in line with the empirical literature
- The model generates credit spreads that explain the dynamics of EMBI+ spreads
 - ▶ Explain 92% of the time variation
- The structural model can be used to explore new debt contracts to lower the risk of defaulting and its repercussions on more general financial crises

LITERATURE ON SOVEREIGN CREDIT RISK

Introduction

Theoretical literature

Literature on sovereign lending: *Explain the presence of sovereign debt*

- Eaton & Gersovitz (1981), Bulow & Rogoff (1989)
 - ▶ Does not provide a clear understanding of why a sovereign defaults, or of when it defaults

Literature on sovereign default: *Structural models to explain default*

- Gibson & Sundaresan (2001), Westphalen (2002), François (2006)
 - ▶ No formal international bankruptcy court
 - ▶ Debt renegotiation upon default
 - ▶ Exogenous foreign debt level

These studies do not explain the time variation of sovereign credit spreads

Introduction

Empirical literature

Literature on sovereign spreads: *Credit spread fitting*

- Reduced-form affine structure models
 - ▶ Duffie and Singleton (1999), Duffie, Pederson, and Singleton (2003), Longstaff, Pan, Pedersen, and Singleton (2007), and Pan and Singleton (2008)
- Reduced-form contingent-claims analysis
 - ▶ Weigel and Gemmill (2006), and Bodie, Gray, and Merton (2007)
- Panel-based approach
 - ▶ Hilscher and Nosbusch (2007) and the references therein

Predictions are based on historical data only: no structural decisions

Contribution of the paper

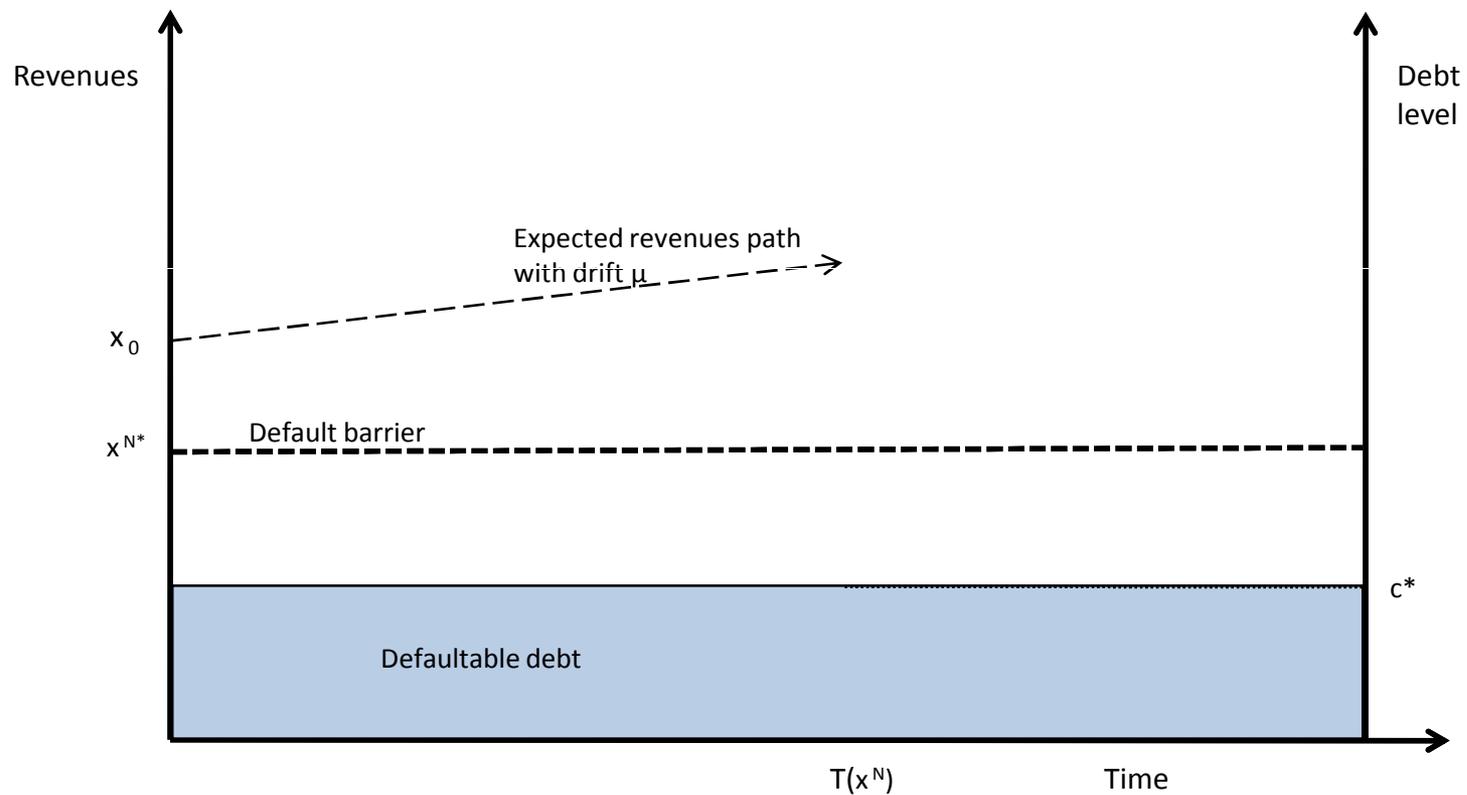
- Offer a structural model that explains the time variation in sovereign credit spreads

THE MODEL

The model

Default and renegotiation in a snapshot

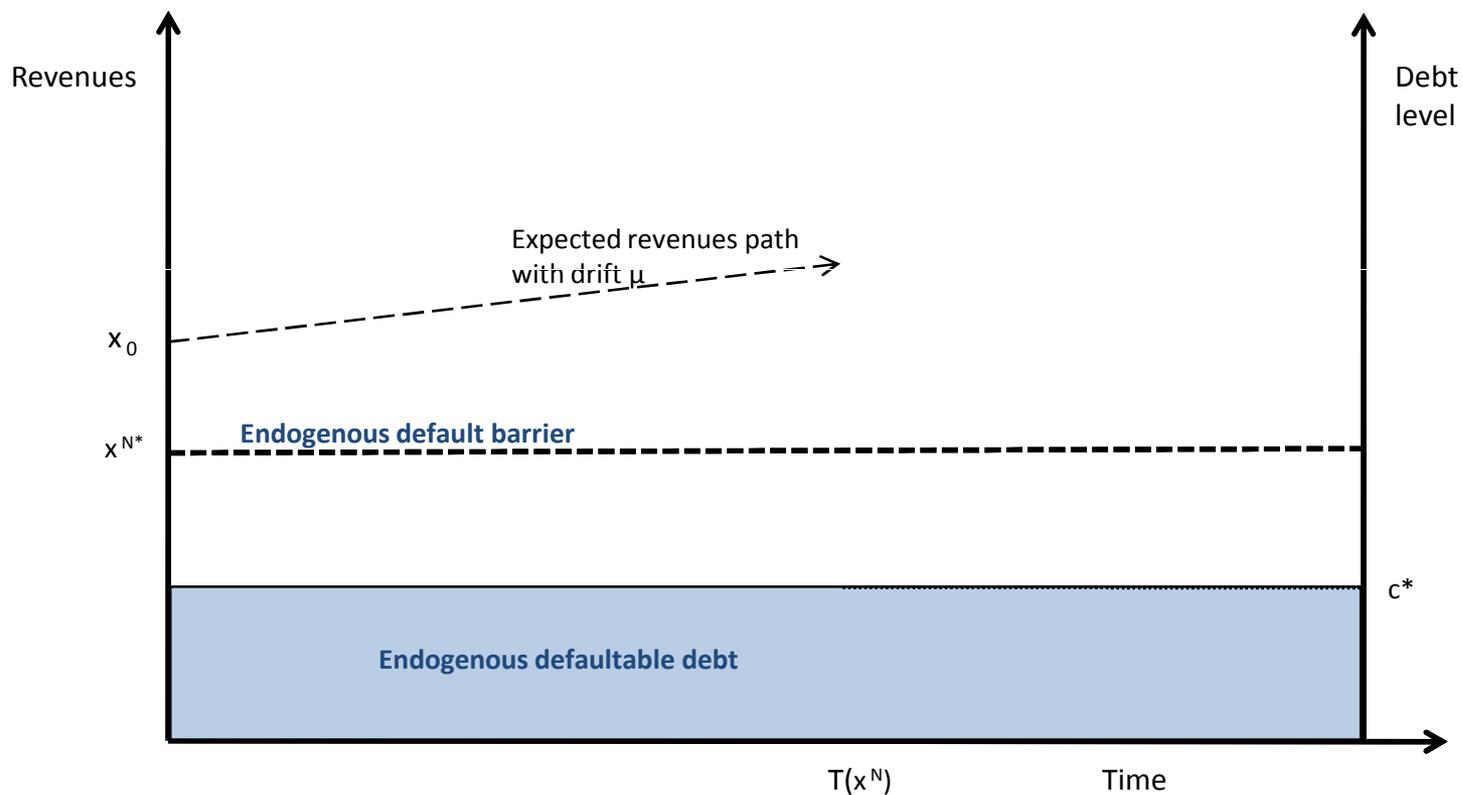
A classical first passage of time model à la Merton (1974)...



The model

Default and renegotiation in a snapshot

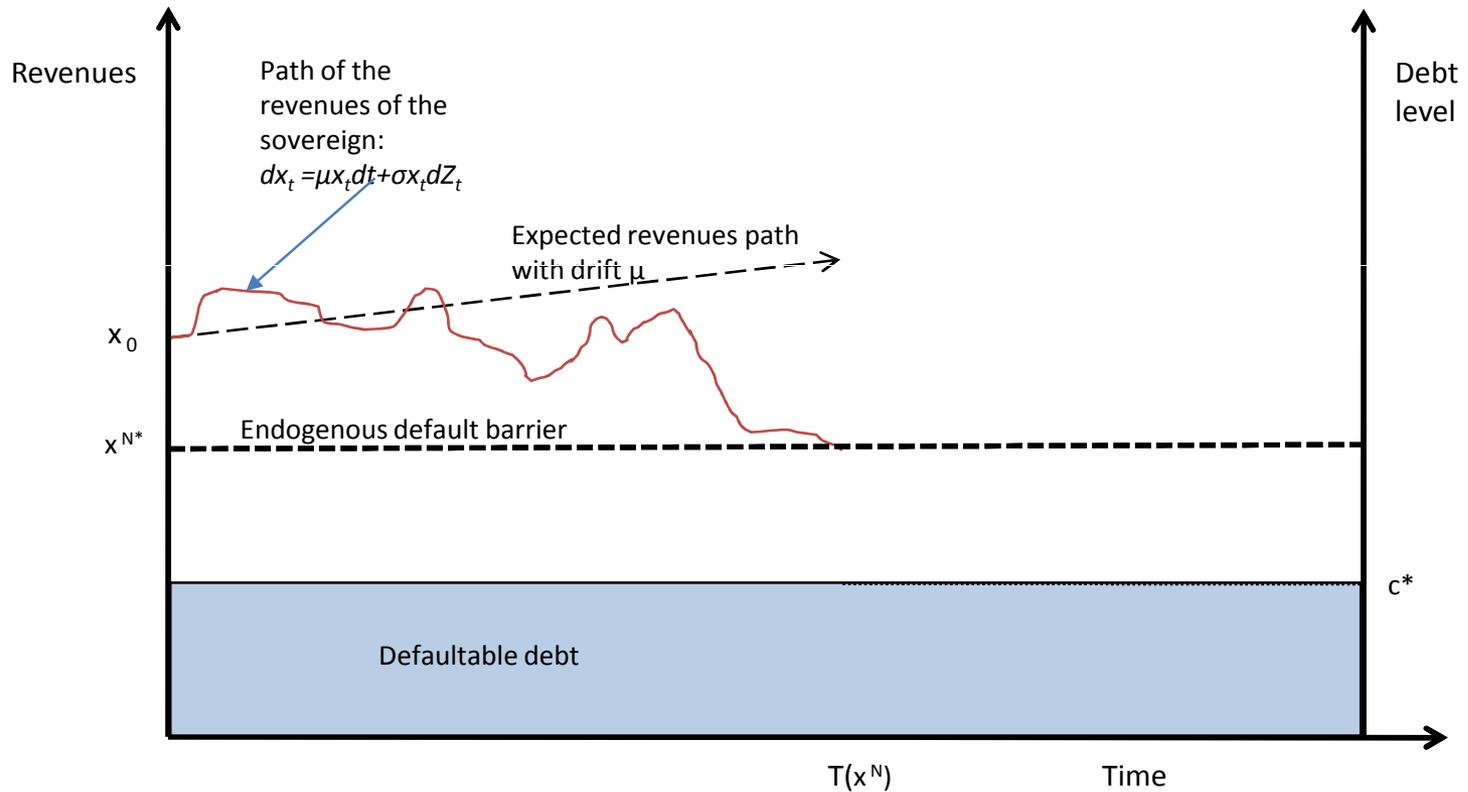
... except that the sovereign chooses a default policy and a level of debt to maximize the value of the economy



The model

Default and renegotiation in a snapshot

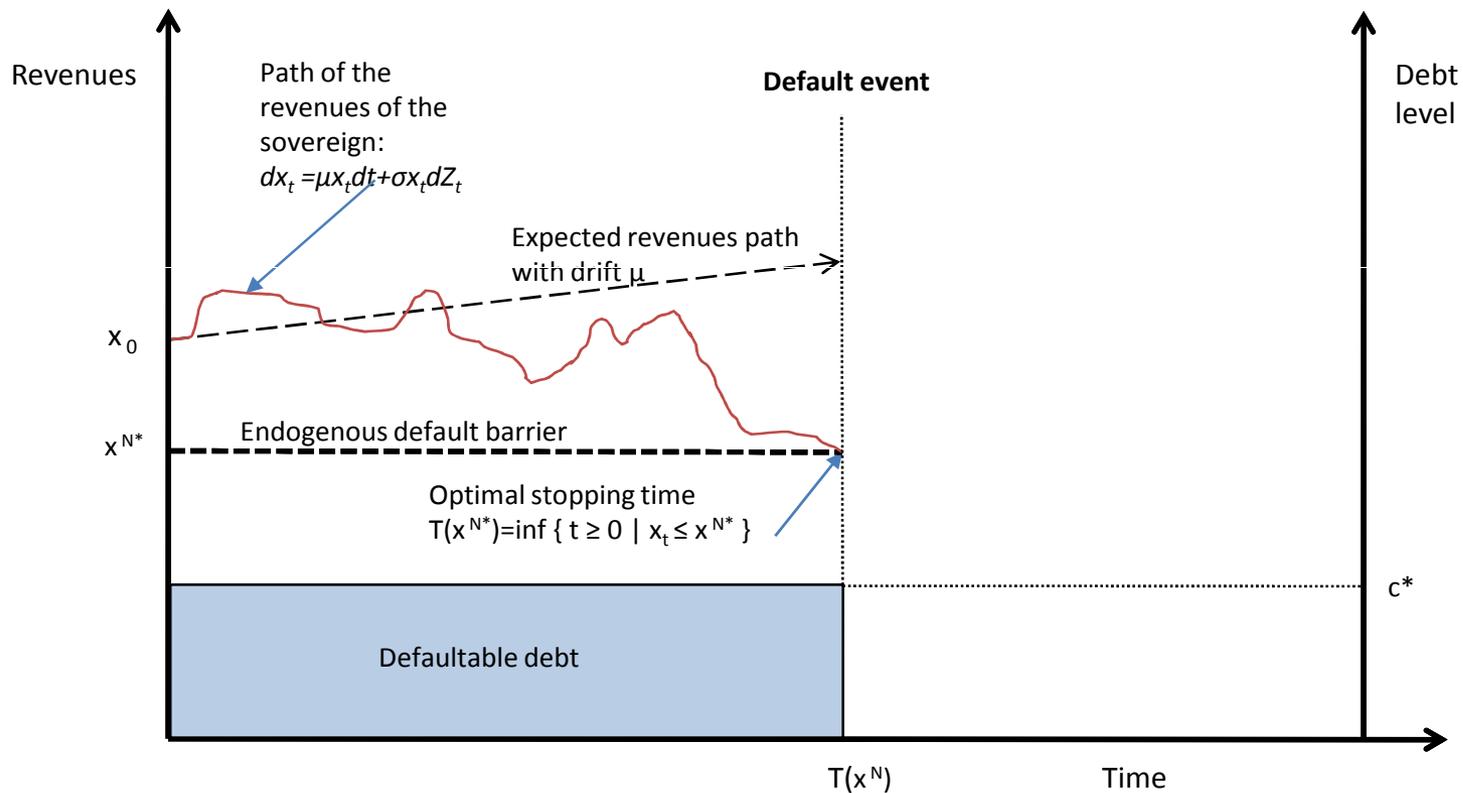
The revenues of the economy follow a stochastic process



The model

Default and renegotiation in a snapshot

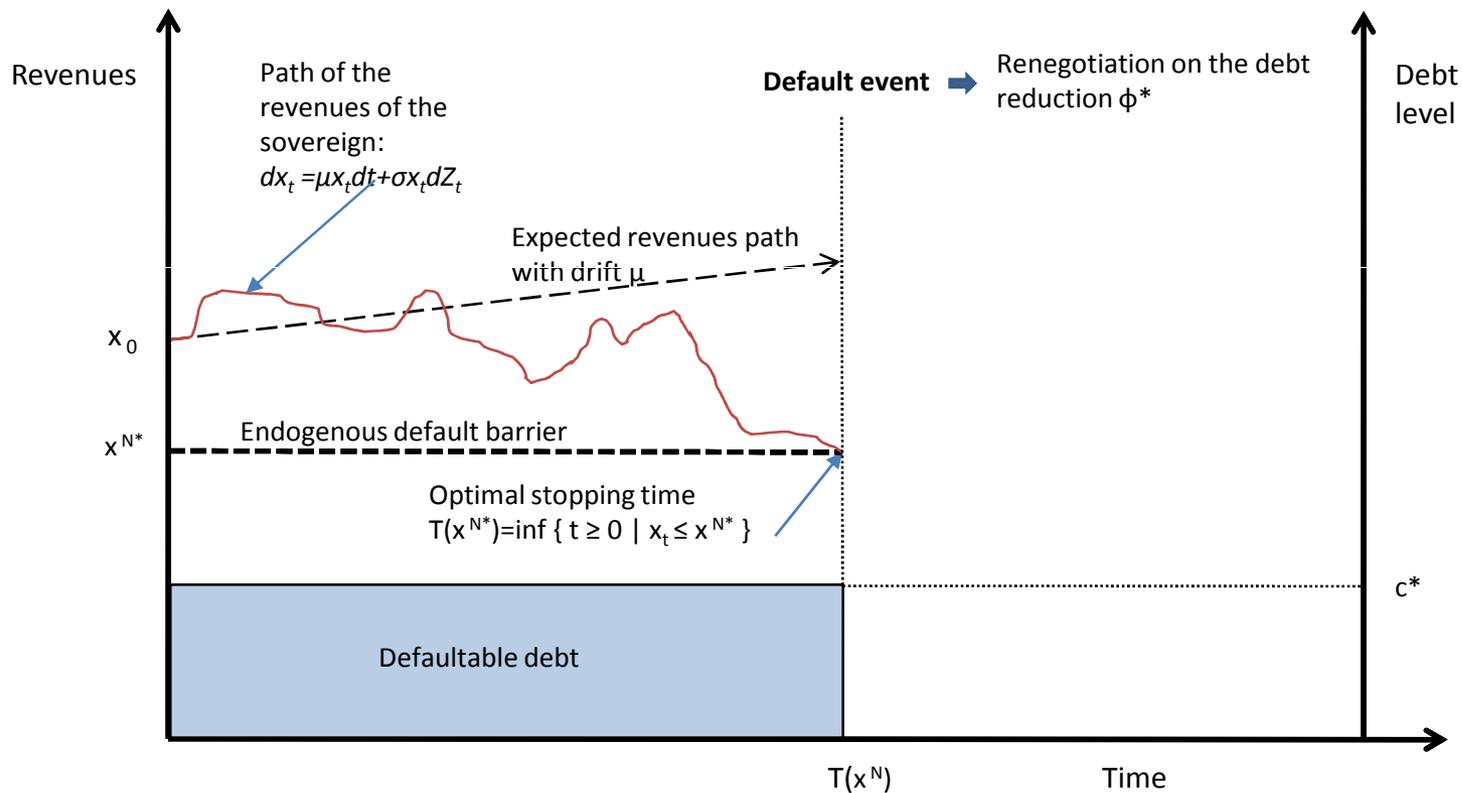
Default occurs when the revenues of the economy hit the default boundary



The model

Default and renegotiation in a snapshot

Upon default, the sovereign and its lenders renegotiate the terms of the debt contract

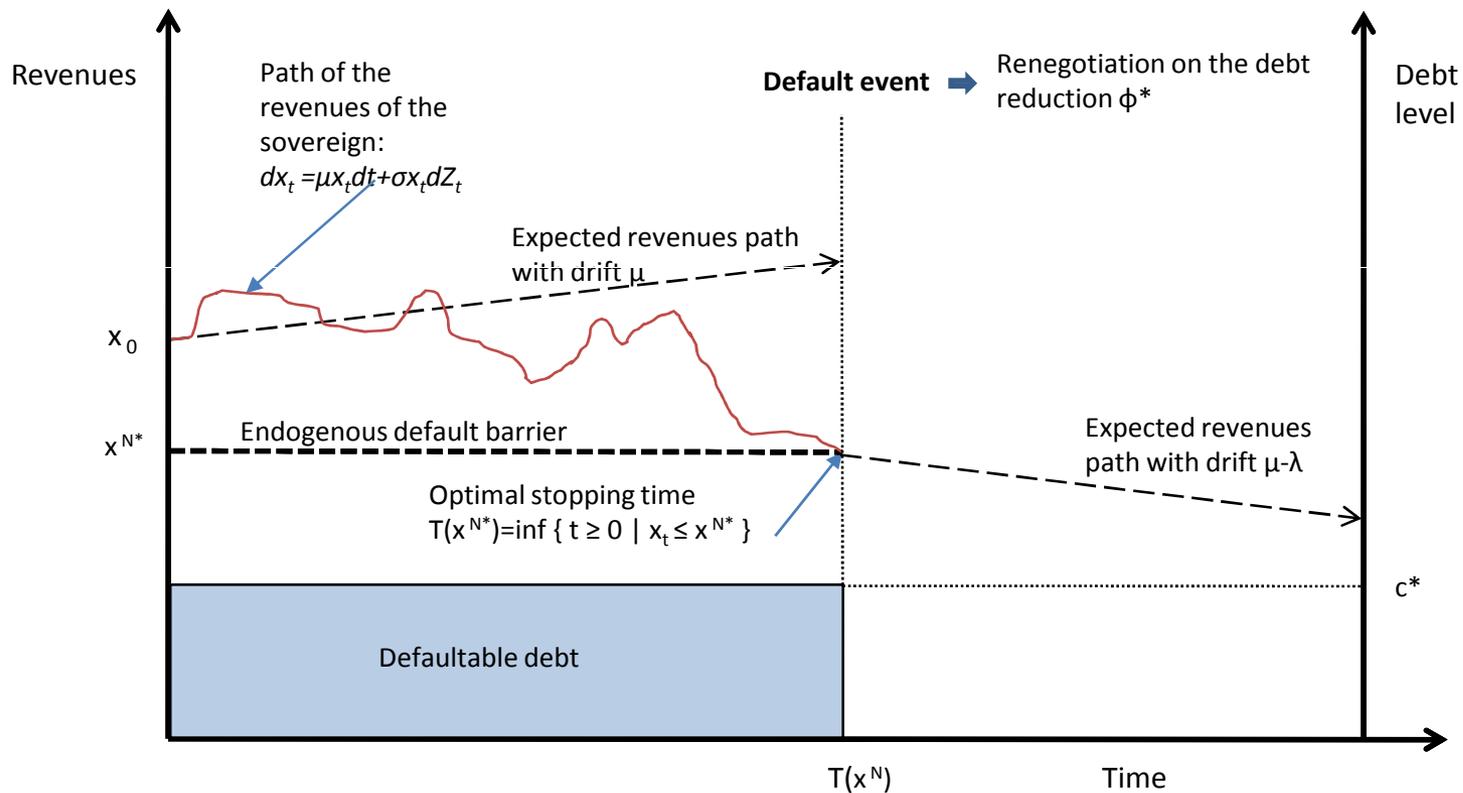


The model

Default and renegotiation in a snapshot

Each side benefits from the renegotiation round:

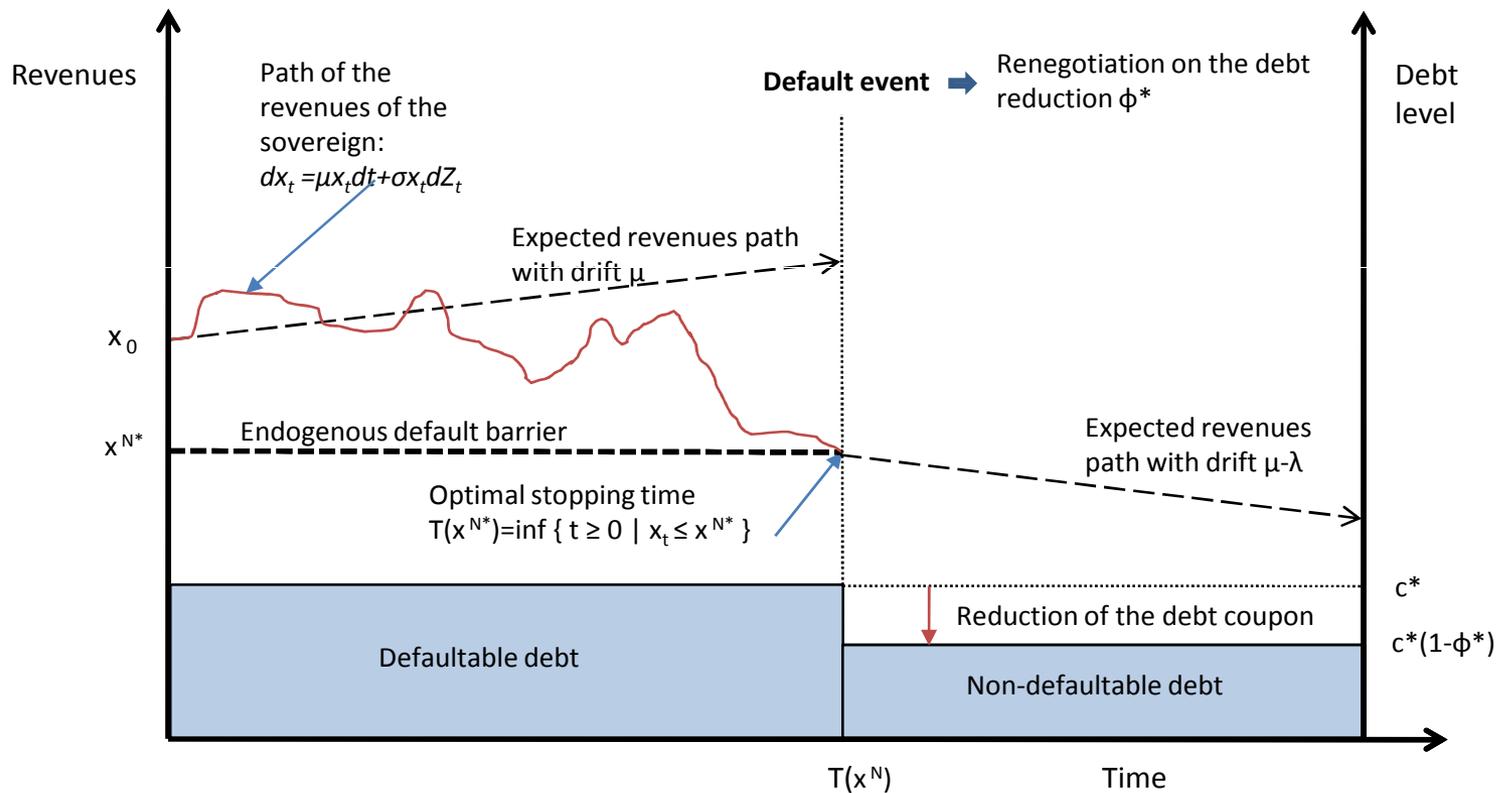
- Gain of the sovereign: avoid trade sanctions but must continue to partially service the debt
- Gain of the lenders: partially recover some value



The model

Default and renegotiation in a snapshot

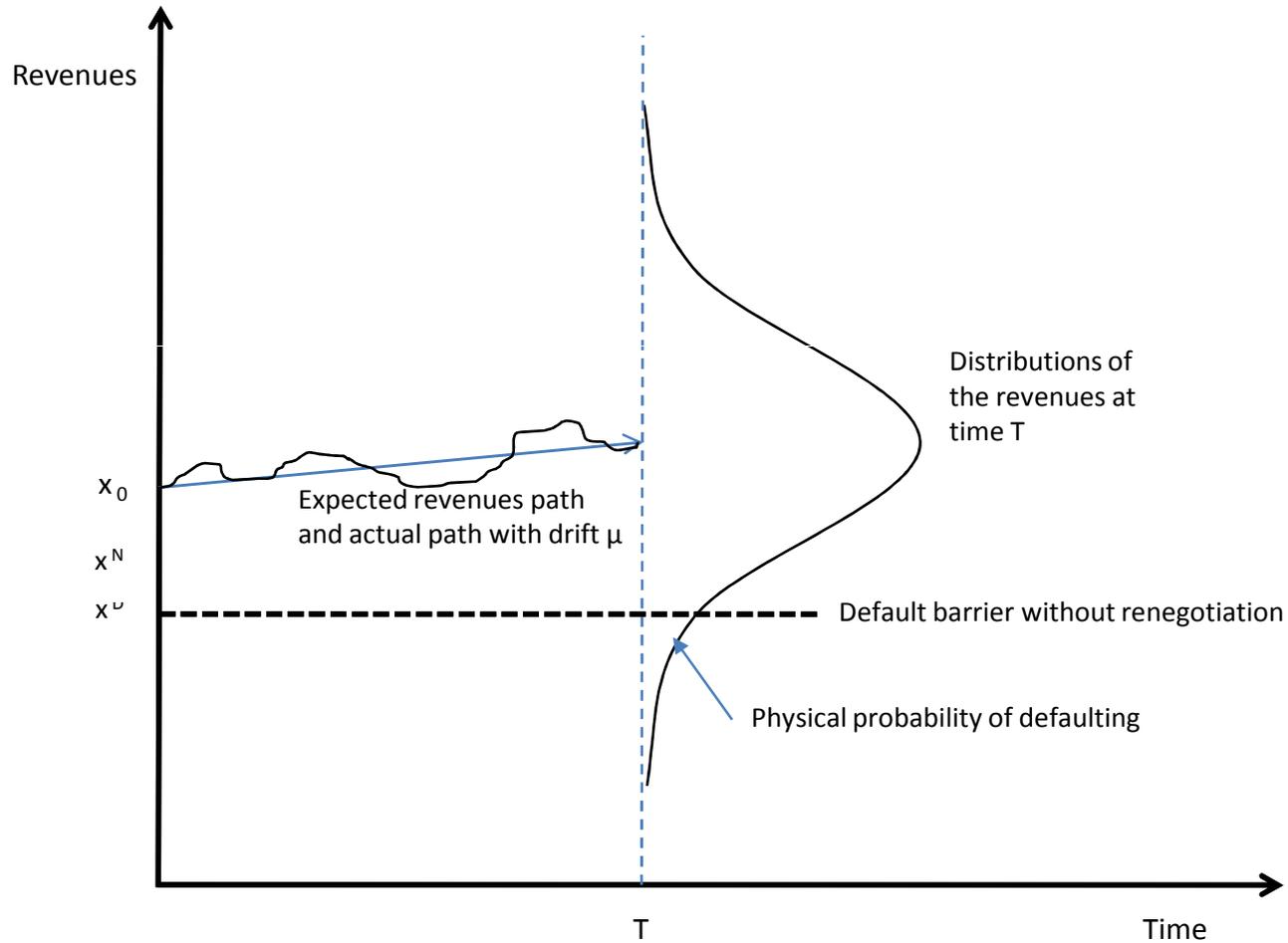
A Nash Bargaining game determines the debt reduction



The model

Credit risk in a snapshot

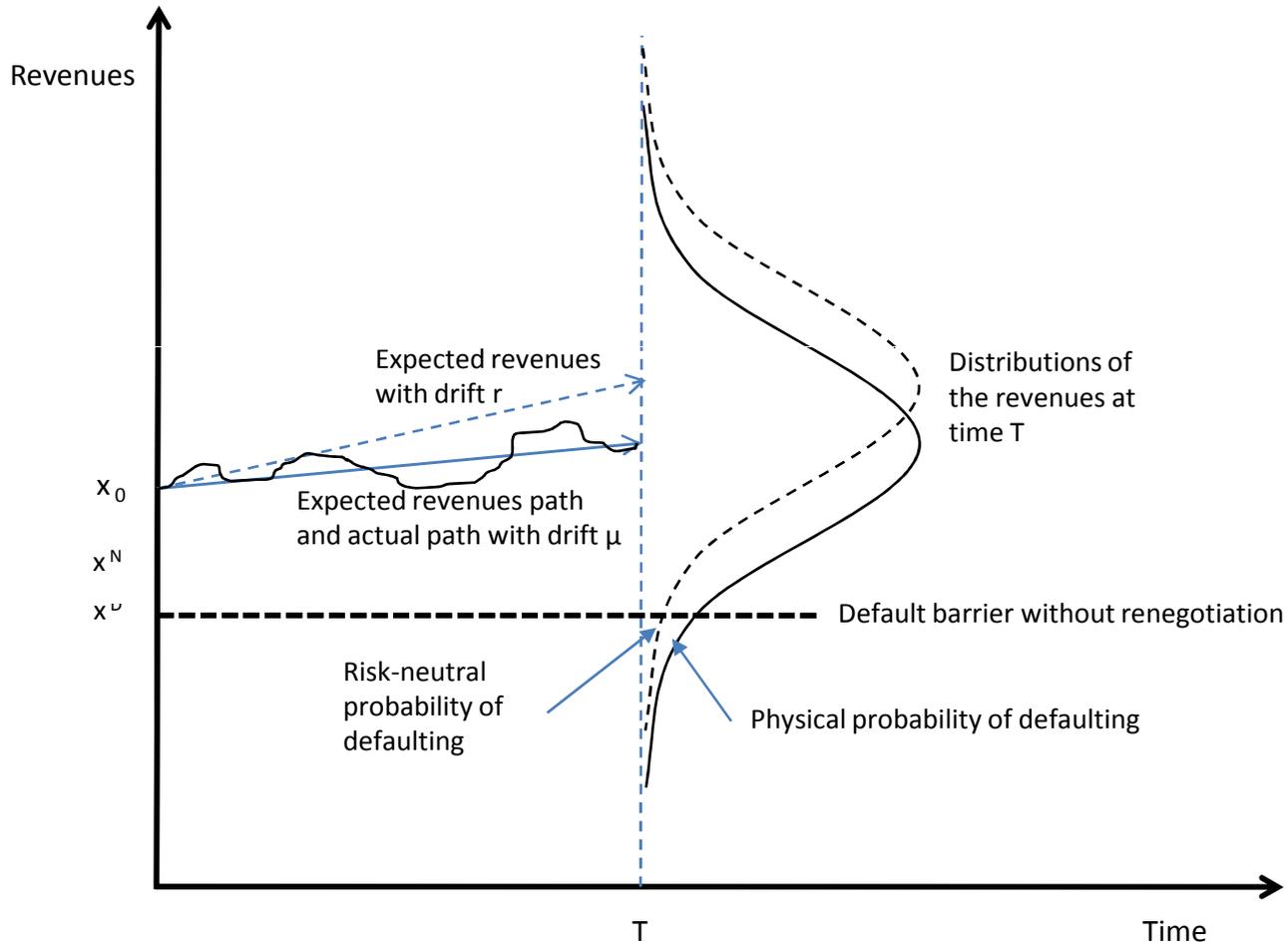
The probability of defaulting determines the credit spread...



The model

Credit risk in a snapshot

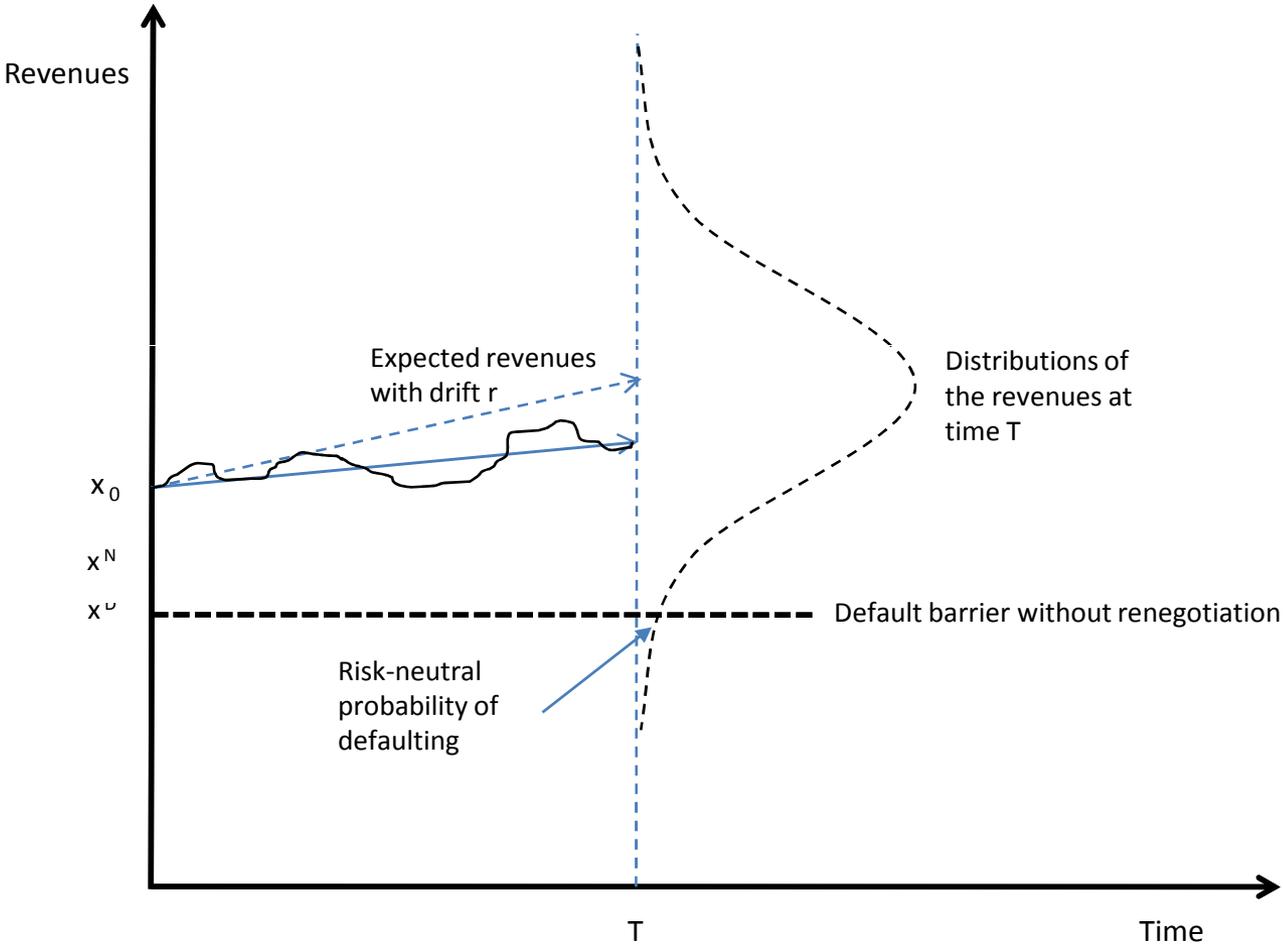
... which needs to be computed under the risk-neutral probability measure



The model

Credit risk in a snapshot

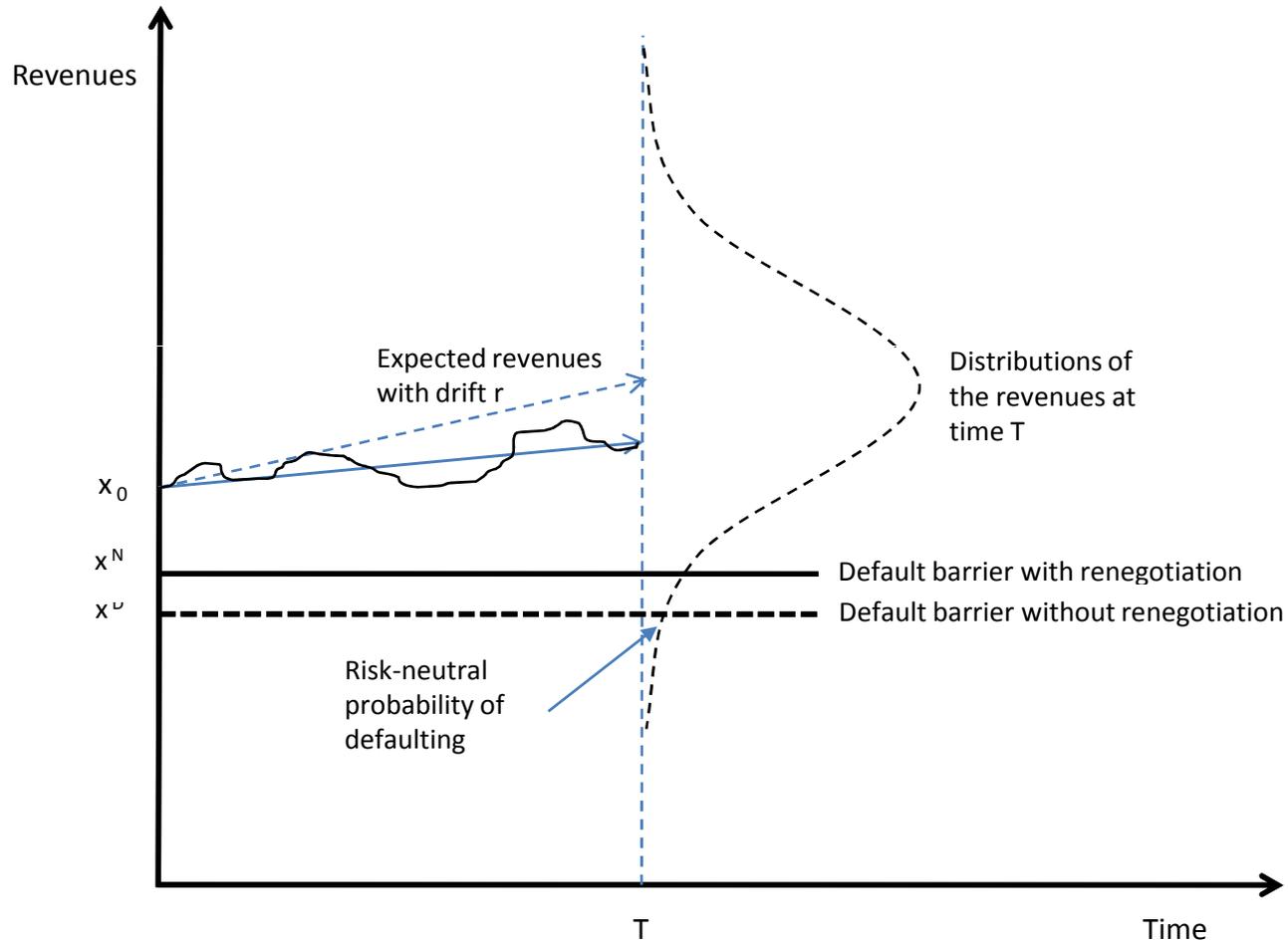
... which needs to be computed under the risk-neutral probability measure



The model

Credit risk in a snapshot

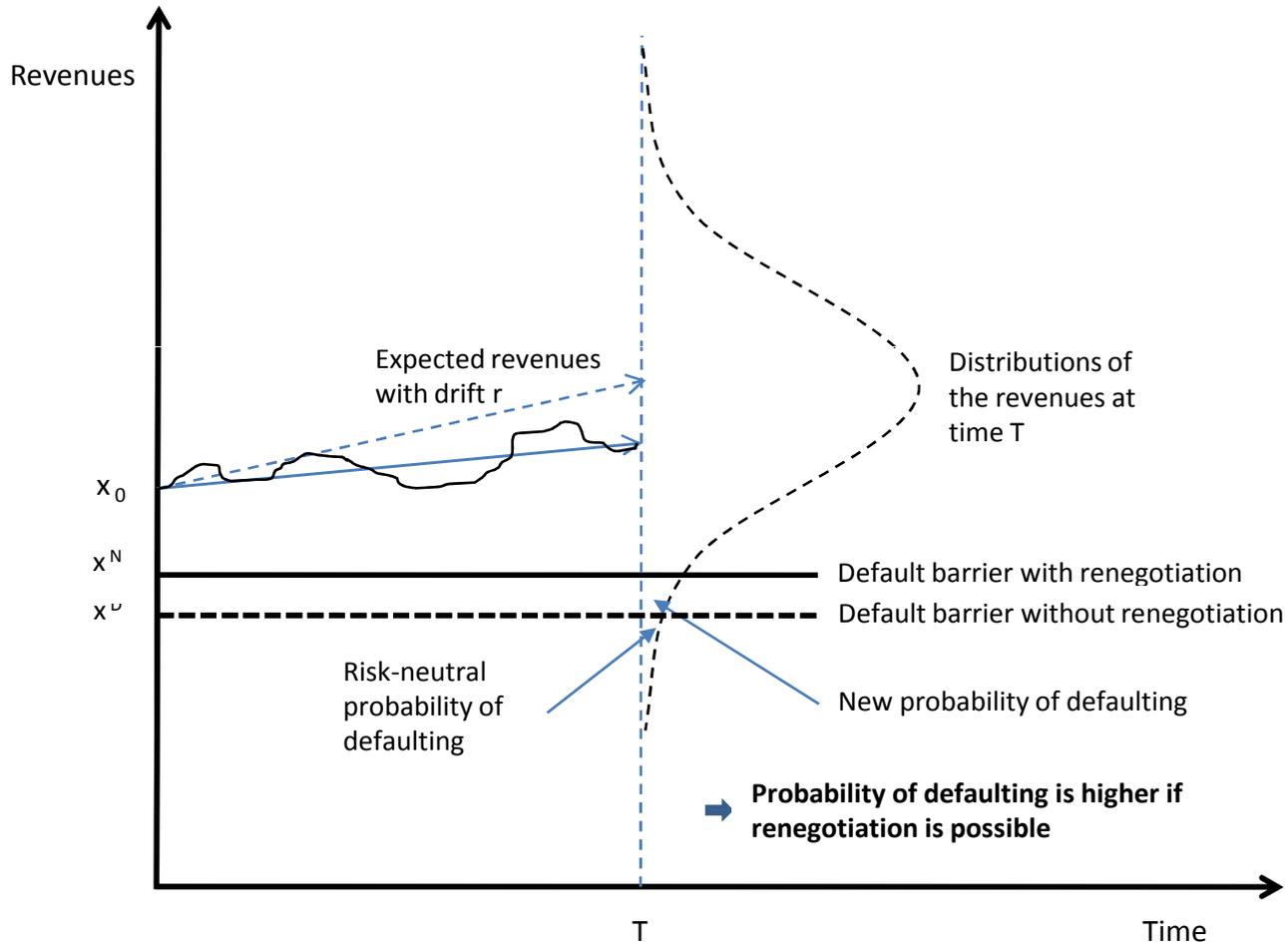
The potential for renegotiating the terms of the debt contract increases the incentive to default



The model

Credit risk in a snapshot

... which raises credit risk



THEORETICAL PREDICTIONS OF THE MODEL

Results of the paper

Theoretical predictions

Sovereign credit risk is high when

- The economy grows slowly
 - ▶ Cantor and Packer (1996), Haque, Kumar, Mark, and Mathieson (1998), Monfort and Mulder (2000), Hu, Kiesel, and Perraudin (2002), Catao and Sutton (2002), Alexe, Hammer, Kogan, and Lejeune (2003), and Harms and Rauber (2004)
- Macro-economic volatility is high
 - ▶ Westphalen (2001), Catao and Sutton (2002), and Catao and Kapur (2004)
- Risk-free interest rates are high
 - ▶ Haque et al. (1998), Monfort and Mulder (2000), Catao and Sutton (2002), and Catao and Kapur (2004)
- The sovereign is a large trading partner
 - ▶ Ades, Kaune, Leme, Masih, and Tenengauzer (2000), Reinhart, Rogoff, and Savastano (2003), and Rowland and Torres (2004)
- Domestic investment generates high returns
 - ▶ Edwards (1984) and Cosset and Roy (1991)

EMPIRICAL RESULTS

Results of the paper

Daily predicted credit spreads versus EMBI+ spreads

- Use daily stock market indices to infer the best prediction on the state of the economy
 - ▶ Other parameters are constant (volatility, risk-free rate, ...)
- Generate spreads predicted by the model for Brazil, Mexico, Peru, and Russia over 1998-2006
 - ▶ FE Panel analysis in levels and in differences

$$\ln(CS_{EMBI,i,t}) = \gamma_1 + \gamma_{2,i} \ln(CS_{Model,i,t-1}) + \omega_i + \tau_t + v_{i,t}$$

- ▶ Explain 92% of the time variation in EMBI+ spreads with a *single time-varying explanatory variable*

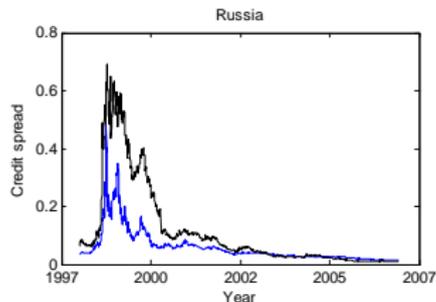
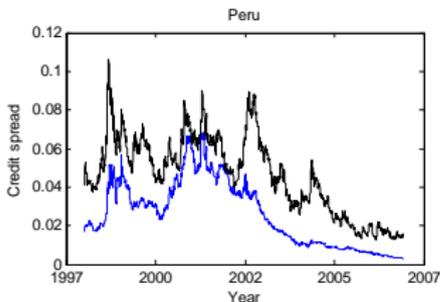
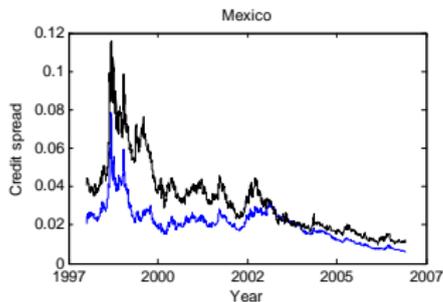
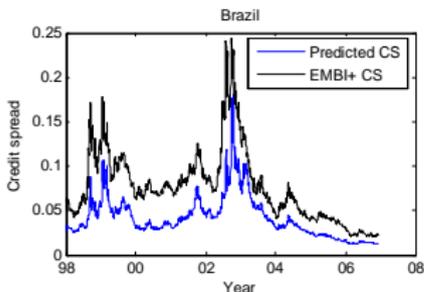
Comparison

- Correlation between stock market indices and EMBI+ spreads: 40%
- Weigel & Gemmill (2006): $R^2 = 8\%$ with only stock market indices
- Hilscher & Nosbusch (2007): $R^2 = 48\%$ with 7 variables
- Bodie et al. (2007): $R^2 = 80\%$ using market prices

Results of the paper

Daily predicted credit spreads versus EMBI+ spreads

- Explain 92% of the time variation in daily EMBI+ spreads
 - ▶ Brazil, Mexico, Peru, and Russia, 1998-2006



[Note: EMBI+ spreads data and debt prices are not used as input!]

Empirics

Other explanatory factors: what about the VIX implied volatility index?

New regression:

$$\ln(CS_{EMBI,i,t}) = \gamma_1 + \gamma_{2,i} \ln(CS_{Model,i,t-1}) + \gamma_3 VIX_t + \gamma_4 UST_t + \omega_i + \tau_t + v_{i,t}$$

- The explanatory power rises only slightly, to 94%, when accounting for additional time-varying factors such as
 - ▶ 5-year U.S. Treasury rates
 - ▶ The VIX option-implied volatility index
- This finding may change one's interpretation of the results of Longstaff, Pan, Pedersen, and Singleton (2007) and Pan and Singleton (2008)
- These authors show that the VIX index is a key factor in explaining credit risk movements
 - ▶ They do not include the factors that I show to almost eliminate VIX as an additional explanatory variable

CONCLUSIONS

Conclusions

- Theoretical credit spread predictions of the model are in line with the empirical literature
- The model generates credit spreads that explain the dynamics of EMBI+ spreads
- A structural model can be used to explore new debt contracts to lower the risk of defaulting and its repercussions on more general financial crises
- The model can also be applied to investigate the
 - ▶ Link with exchange rate crises as most crises in emerging markets simultaneously involve an exchange rate and a default component
 - ▶ Link between default and banking crises
 - ▶ Optimal amount of reserves to hold in the balance sheet
 - ▶ Difference in credit risk between domestic and external debt