# Enterprise Risk Management in Complex Systems

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- Today's complex global environment requires understanding, assessing and integrating multiple risk factors
- Traditional risk methods often fail to account for factors impacting low and/or high return values.
- We will address strategies for integrating risk factors providing new insight in understanding enterprise risk and quantifying its uncertainty.

### **Risk Intertwined**



# RICE UNIVERSITY What do we need?

- Understand the connections.
- Possibly different measures of Value at Risk
- Mean/variance based models won't necessarily suffice
- How to combine risk metrics across the investments(s), the long term goal. Hierarchical models are key.

# RICE UNIVERSITY Our pseudo world

- As academics we don't have global construction projects to study.
- We set up a psuedo world using
  - Market value of country
    - MSCI Morgan Stanley Capital International (basket of equities for each country)
  - Political risk measures
- Develop portfolios from our pseudo world designed to mimic project investments.
- Returns are important in their own right THIS IS WHAT SHAREHOLDERS PERCEIVE.



# Our categories

- Latin America emerging
  - Argentina, Brazil, Chile, Mexico, Columbia, Peru?
- Europe emerging
  - Greece, Portugal, Poland, Czech Republic, Hungary, Russia,
- Europe developed
- Asia emerging
  - Indonesia, Taiwan, India, Jordan, Thailand, Israel, Korea, Turkey, Pakistan, Malaysia, China, Egypt, Philippines, South Africa
- North America developed
  - Canada + US
- Oceania developed
  - Australia, New Zealand, Hong Kong, Singapore, Japan

Diversification

- Diversify by global economic segments.
- Is the project portfolio diversified globally?



Correlation of Percent Returns by Segment

Country

## Convergence?

Latin America -Changing correlation structure over time *January* 1996 *through December* 2007



**Correlation of Percent Returns over Time** 

## Convergence?

Europe Emerging -Changing correlation structure over time *January 1996 through December 2007* 



**Correlation of Percent Returns over Time** 

# Convergence?

Asian Emerging -Changing correlation structure over time January 1996 through December 2007



- The portfolios based in equally weighted country returns for each geopolitical segment behave very similarly on the market place today.
- The correlation between the emerging market sectors approaches 0.8.
- Global emerging market portfolios may possess little diversification.
- Locally in time, contagion issues can derail a project.



- What factors affect our global investment?
- Turn to the International Country Risk Guide
  - Yields 12 subcomponents of political risk
  - Purchased the data (thank you Global Forum!)
- Annual data (was within our budget)

# Data Summary

POLITICAL RISK COMPONENTS					
Sequence Component		Points			
	_	(max.)			
А	Government Stability	12			
В	Socioeconomic Conditions	12			
С	Investment Profile	12			
D	Internal Conflict	12			
Е	External Conflict	12			
F	Corruption	6			
G	Military in Politics	6			
Н	Religion in Politics	6			
Ι	Law and Order	6			
J	Ethnic Tensions	6			
К	Democratic Accountability	6			
L	Bureaucracy Quality	4			
Total		100			

Equity Returns obtained from MSCI. •Data Set spans: 1994-2006 Countries Includes: •21 Developed •26 Emerging

#### PRS: International Country Risk Guide

### RICE UNIVERSITY Impact of PR measures

- How do the political risk measures impact the country value at risk?
- We use novel advanced regression strategies to ascertain the true value at risk.
- Limit study period from 1996 through 2006 to have complete data.
- Since we have annual political risk information, we are examining the annual returns.

#### **Beyond Basic Regression**



#### VAR -5% Quantile

- OLS Regression estimates the conditional mean of a distribution.
- The Value at Risk (VAR) is then computed based on the number of standard deviations from this mean.
- Our strategy a mixture between historical and model based estimates of Value at Risk based on the explanatory variables.

# Explaining QR



#### Risk Attributes – Impact OLS

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	0.248711	0.140942	1.765	0.07823	
GovtSth	0 005508	0 008769	0 628	0.5302	
SoscCon	-0.02391	0.010435	-2.291	0.02235	
BQ	-0.01193	0.028298	-0.422	0.67347	
Corruption	0.021866	0.015875	1.377	0.169	
DemAcct	-0.00584	0.013252	-0.441	0.65957	
EthnicT	-0.00702	0.011461	-0.613	0.54024	
ExConflict	-0.01256	0.011634	-1.08	0.28086	
InConflict	-0.0078	0.012574	-0.62	0.53552	
LawOrder	-0.01586	0.017663	-0.898	0.36968	
MP	0.055019	0.01641	3.353	0.00086	
RP	0.000982	0.012379	0.079	0.93682	
InstPrf	-0.01111	0.008142	-1.365	Only signif	icant
(t) = c0 + c1A(t-1) + error(t)			factors are	military i	
			- 1	politics and	
				socioeconomic	
				conditions	– this

seems odd.

#### **Closer Examination - QR** RICE UNIVERSITY



score These factors impact the tails of the distribution differentially. OLS will lead to a different and incorrect decision. Bureaucracy Quality Corruption Military in Politics







### RICE UNIVERSITY PR – does matter



- The distribution of returns exhibits more variability for low values of:
  - Investment profile
  - Socio Economic Conditions
  - Bureaucracy
  - Corruption
  - Military in Politics
- More variability yields a LOWER value at risk.
- Government stability warrants further investigation on its relationship to country returns.

- Enterprise Portfolio returns are mixtures of developed and emerging country returns.
- Emerging markets display more extreme returns and warrant further study.
- Our definition of enterprise risk incorporates only those markets for which we have data.
- Closely held companies and/or family enterprises may behave quite differently in these markets.

#### Focus on Emerging Markets

- Generate Portfolios
  - For Emerging/Developed:
    - Select 5 countries from set and calculate annual returns for horizon.
  - Enterprise:
    - Described on next slide
- Can we see an impact of our political risk factors and/or regional factors?

– Tools: OLS and our new methodology

#### Design of Enterprise Portfolios

#### Building our Enterprise Portfolio(s)



- Simulate for each year of our study
  - 5000 enterprise portfolios
  - 5000 "developed" portfolios
  - 5000 "emerging" portfolios
- Total simulation
  - 60,000 of each (12 years)
  - 180,000 total

#### **Distribution of Simulated Returns**

**Distribution of** simulated portfolio percent returns for each year. Emerging exhibits **HIGH** volatility. Enterprise volatility more closely follows the low volatility of portfolios of developed countries.







2001













Legend: Developed (Black) Emerging (Red) Enterprise (Green)











1 2 3

#### **INVESTMENT PROFILE 12 POINTS**

- Assessment of factors affecting the risk to investment not covered by other risk components.
- 3 subcomponents (4 points each)
  - Contract Viability/Expropriation
  - Profits Repatriation
  - Payment Delays





Investment Profile

Less secure contracting environments, e.g. Korea, Pakistan, Russia result in more volatility.

## Value at Risk

Comparison of VaR for Investment Profile Scores:								
1	' Millio	on \$ In\	vestment:	Corre	ect VaR	Tradition VaR	nal	
			$\frown$			projectio	ons	
Score			VaR95	VaRN95	VaR05	VaRN05		
Poor investment profile		4	-\$417,011	-\$271,602	\$474,418	\$323,904		
		5	-\$382,795	-\$278,293	\$424,256	\$317,213		
		6	-\$348,580	-\$284,985	\$374,094	\$310,522		
		7	-\$314,364	-\$291,676	\$323,932	\$303,830		
		8	-\$280,149	-\$298,367	\$273,770	\$297,139		
		9	-\$245,933	-\$305,059	\$223,608	\$290,448		
		10	-\$211,718	-\$311,750	\$173,447	\$283,756		
Chrone	11	-\$177,502	-\$318,441	\$123,285	\$277,065			
inves	tment	12	-\$143,287	-\$325,132	\$73,123	\$270,374		
profile			Ĺ	DSS	GA	IN		

- With a \$1million dollar investment in a country with a low investment profile of 4, you have a 5% chance of losing \$417K.
- Using traditional normal based VaR techniques you would estimate this loss to be \$271K (a 154% undervaluation of the risk)
- Furthermore, with a \$1million dollar investment in a country with high investment profile (12), you have a only a 5% chance of making **\$73K** or more in profit.
- Using traditional normal based VaR techniques you would estimate this gain to be \$270K (a 370% overvaluation of the potential potential profit)

- The volatility and mean of a portfolio is dependent on the investment profile of the country.
- Without adjusting for this changing volatility and mean structure, *value at risk measures computed on normal based theory are incorrect*.
- Our regression techniques automatically adjust for changing volatility as well as other potential changes by estimating the quantile or VaR directly.
- Our regression strategies are a mix between model based VaR estimates and historical VaR estimates.

- Other political risk measures matter as well.
- It is important to disaggregate the components.
- For foreign direct investors you must understand which variables are key.
- The value at risk of your investment will differ based on the political risk factors.
- OLS and normal based calculations will not adequately quantify the risk in many cases.

- Country interactions change as market structures change. Global markets are converging. Enterprise portfolios should account for complex associations between investments.
- Correctly quantifying political risk is important.
  - Important to disaggregate its components.
  - Decision is based on what components will most affect your project.
  - Investment value and risk measures are affected by political risks differently. Incorrectly accounting for these difference can result in a *dramatic* understatement of the potential loss and overstatement of the potential gain.
- Our technologies are designed to integrate different risk factors to better understand the global risk landscape.