On the Science of Finance in the Practice of Finance: Challenges and Opportunities from the Financial Crisis

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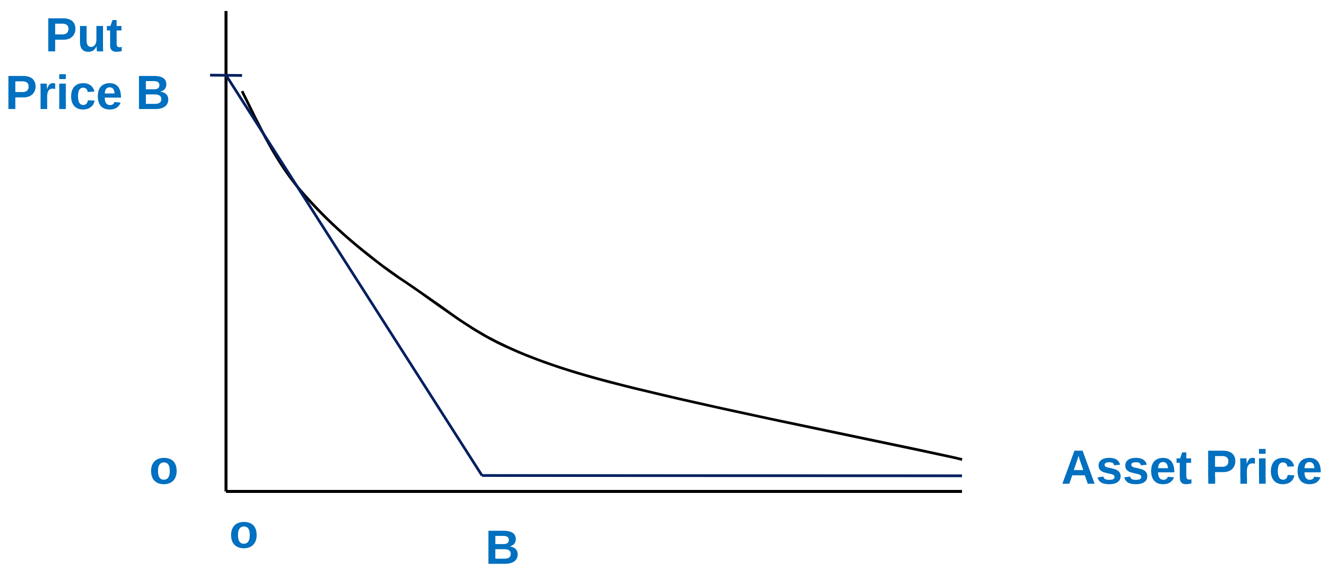
My remarks are divided into five parts

- Structure of credit-risk propagation. How can large macro risks build up without recognition and then appear to explode? Why do banks continue to report larger losses, even after booking no new risks?
- Government policy on the financial crisis: guarantees, takeover vs. bankruptcy, fair-value accounting, regulatory reforms.
- Financial innovation and risk of crisis.
- Structural implications of inevitable incompleteness of models.
- Financial innovation and science beyond the crisis.

Put Option: Asset-Value Insurance Contract

- **Put Option** gives its owner the right to sell an asset at a specified exercise price, B, on or before a specified expiration date
- On expiration date, Value of the Put is given by Max [0, B-A] where A = current price of asset



Functional Description of Being a Lender When There is Risk of Default and of Writing a Guarantee of Debt

RISKY DEBT + GUARANTEE OF DEBT = RISK-FREE DEBT

RISKY DEBT = RISK-FREE DEBT - GUARANTEE OF DEBT

Corporation	
Operating Assets, A	Debt (face value B), D
	Common Stock, E

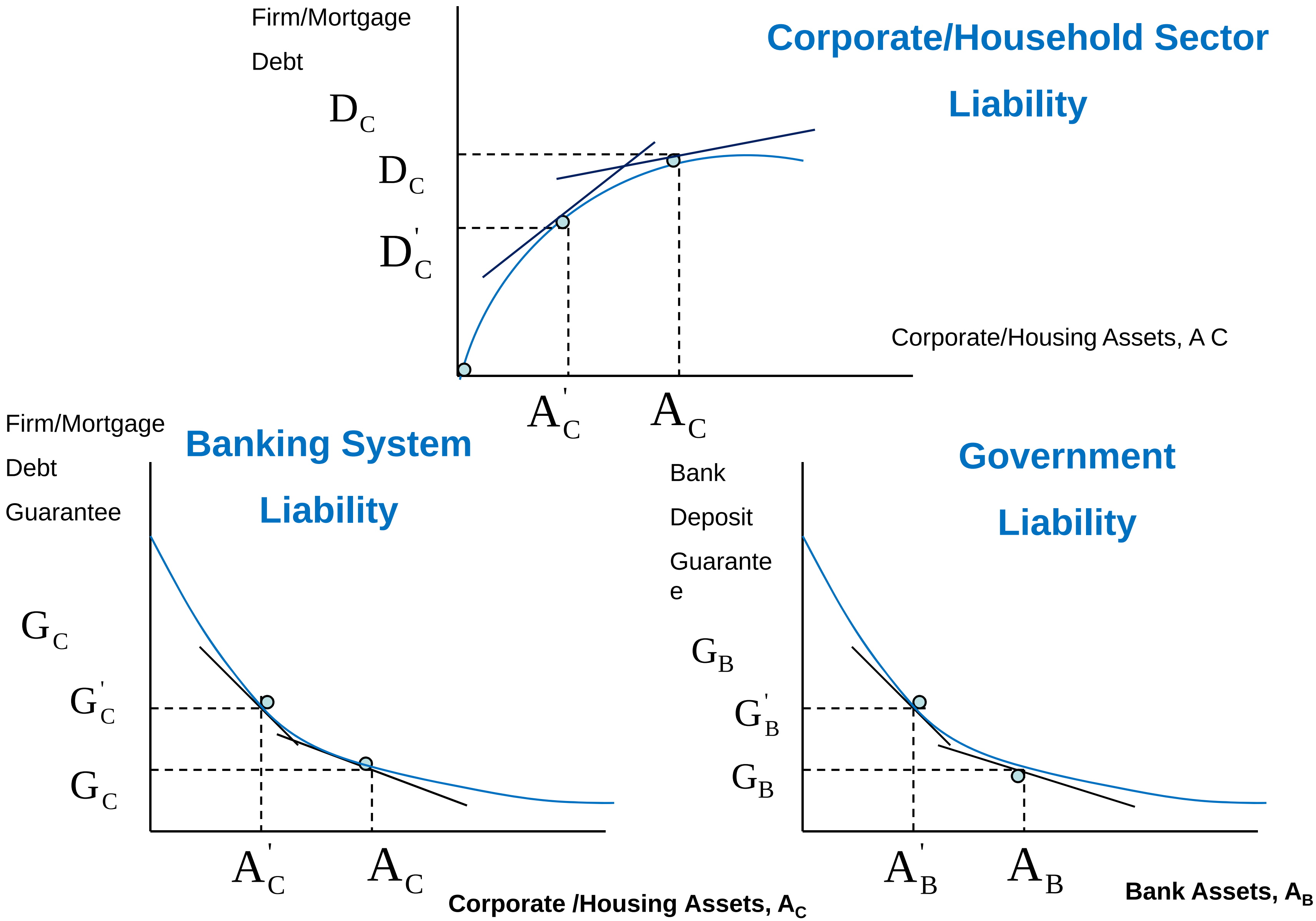
A = D + E

IN DEFAULT, THE HOLDER OF THE GUARANTEE RECEIVES PROMISED VALUE OF THE DEBT MINUS VALUE OF ASSETS RECOVERED FROM DEFAULTING ENTITY = MAX [0, B – A]

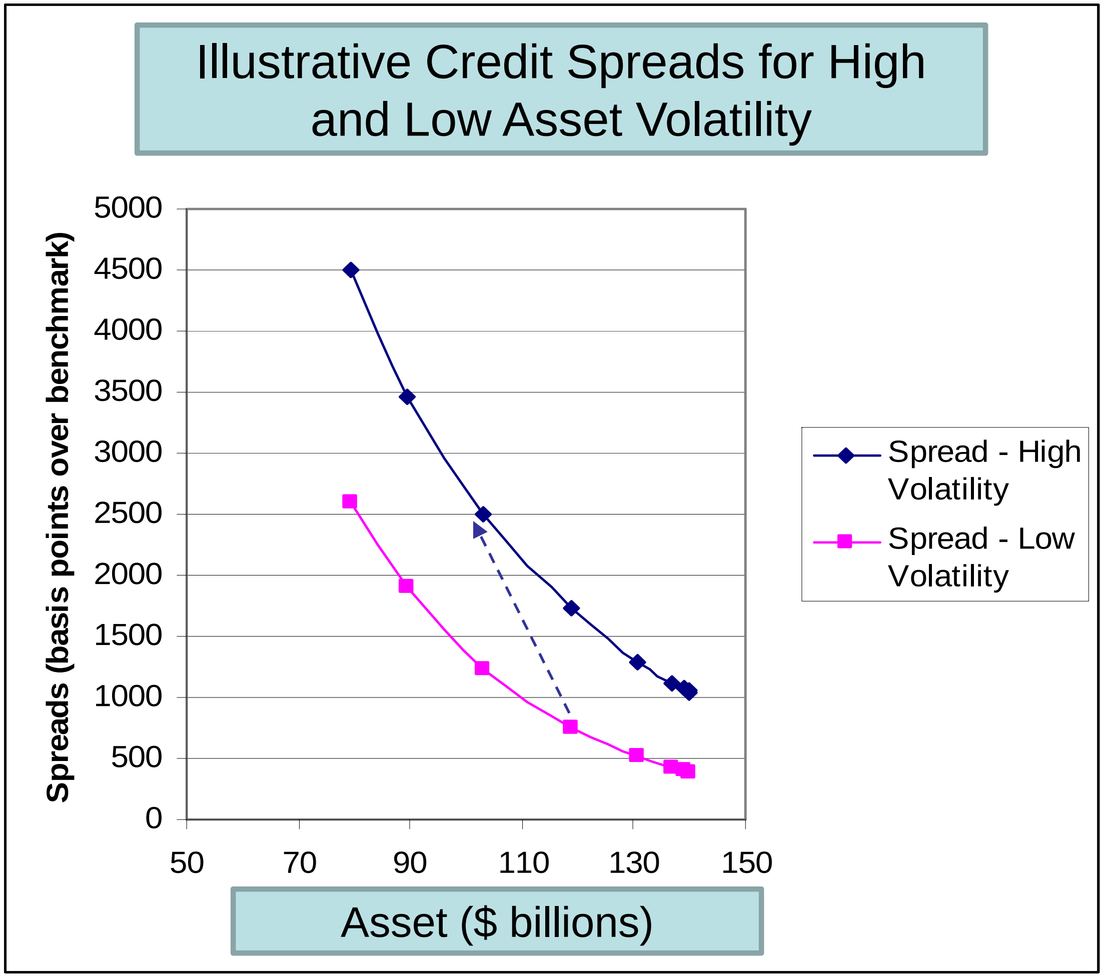
VALUE OF GUARANTEE = PUT OPTION ON THE ASSETS OF BORROWER

CREDIT DEFAULT SWAPS ARE GUARANTEES OF DEBT AND THEREFORE ARE PUT OPTIONS ON THE ASSETS OF THE BORROWER

Non-linear Macro Risk Buildup



Higher Credit Put Price when Asset Volatility Increases and Assets Decline



Effect of Non-linear Risk and Volatility Shift

5-Year Loan with $100 Principal

				% Change
Asset Value	$200	$160	$120	-40%
Asset Volatility	0.50	0.75	1.00	+100%
Guarantee Price	$14	$35	$53	+279%

- Value and Risk of Guarantees Large and Rapidly Changing
- Losses can continue and become larger in a static portfolio
- Overestimate frequency of “tail” events

U.S. Government Bank-Bailout Policy: PPIP and Guarantees

- Guarantees are asset-value insurance policies and have significant value. Their value is even greater in volatile and uncertain times. Their cost is not included in appropriations budget. They are "off balance sheet." Without transparency, their use distorts cost and risk exposure of taxpayer.
- Desired Constraints
  - Avoid government takeover of major banks
  - Minimize cost to taxpayers
  - Get private sector investing in financial institutions
- Do not see a feasible way to satisfy all three constraints. PPIP hides cost to taxpayer and is vulnerable to asset-selection-and-sale bias which could leave banks with concentration of most-toxic assets. Purpose seems to be to transfer value to the banks.
- Recognize that current asset prices may not be "firesale" distorted and that within U.S. alone, $15 trillion in wealth has been lost.

Systemic Risk Differences: Capital-Infusion-and-Takeover versus Bankruptcy

- LTCM (1998) versus Lehman (2008)
- Default triggers cross-default provisions in securities and contractual agreements
- Collateral seizures and sales or replacement of contractual agreements cause a worsening of original net position exposure
- Typically counterpart for long-side is not the same for short-side of position
- With capital infusion, risk exposure is to *net* positions
- With bankruptcy, risk exposure is to *gross* positions
- Depending on character of position, gross risk can be up to *40* times larger than net risk

New Derivatives Regulation and Financial Innovation Spiral

Dynamics of Financial Institutional Competition and Complementarity
Intermediaries versus Markets

	TIME 0	TIME 1	TIME 2	TIME 3	TIME 4
Product #1					
Producer	INT	MKT	MKT	MKT	MKT
Customer	HH/F	HH/F	INT	INT	INT
Product #2					
Producer			INT	MKT	MKT
Customer			HH/F	HH/F	INT
Product #3					
Producer					INT
Customer					HH/F
Producers Serving HH/F	INT	MKT	INT	MKT	INT

HH/F = Households and Non-Financial Firms / **INT** = Financial Intermediaries / **MKT** = Financial Markets

Destructive Feedback Loops: Guarantors writing Guarantees of their Own Guarantors

- *Guarantor writes a guarantee in which its assets will not be adequate to meet its obligations precisely in those states of the world in which it will be called on to pay*.
- Less-than-AAA government debt held by a bank whose deposits are guaranteed by that government.
- A corporation writing a CDS contract on its own debt
- Funding a corporate pension fund with the plan sponsor's own stock.
- The Pension Benefit Guarantee Corp investing in the equities of the companies whose pensions it guarantees.
- A company writing put options on its own stock.

Government Oversight of Risk: The Case of the PBGC

- New investment policy: 45% stocks and 10% alternatives
- Policy approved 2/2008 by PBGC board, Secretaries of Treasury, Labor, and Commerce
- 2000-2003 large losses from ALM mismatch, interest rate drop, and stock decline
- PBGC equity = - $14 billion 11/07 and = - $33.5 billion 5/09

PBGC

Stocks	Guarantee Corp. Pension Plans
Bonds	
Alternatives	
Contributions	Equity

Innovation and Crisis: Behavioral: Familiar Risk versus New Risk

Corporate Pension Plan: Immunized match-funded: No risk to Corporation

Nonfinancial Corporation	
Operating Assets Pension Assets [100 long-maturity fixed-rate bonds]	Senior Debt Pension Liabilities [100 long-maturity fixed payments]
	Common Stock

Corporate Pension Plan: Mismatch Funded: Risky to Corporation

Nonfinancial Corporation	
Operating Assets Pension Assets [75 Common Stock; 25 bonds]	Senior Debt Pension Liabilities [100 long-maturity fixed payments]
	Common Stock

Risk Comparison: Equities in Pension Fund VS. Swap

Incremental Pension risk is: receive: the total return on stocks on 75
Give up: the total return on bonds on 75

Derivative: Total-Return Equity Swap for Total-Return on Bonds on 75 notational amount

Incremental Swap risk is: Receive the total return on stocks on 75
Pay the total return on bonds on 75

Risk and Return on Equities in the pension fund is identical to Swap

On Mathematical Models in Finance Practice

"Any virtue can become a vice if taken to extreme, and just so with the application of mathematical models in finance practice. I therefore close with an added word of caution about their use. At times the mathematics of the models become too interesting and we lose sight of the models' ultimate purpose. The mathematics of the models are precise, but the models are not, being only approximations to the complex, real world. Their accuracy as a useful approximation to that world varies considerably across time and place. The practitioner should therefore apply the models only tentatively, assessing their limitations carefully in each application."

R.C. Merton, "Influence of Mathematical Models in Finance on Practice", *Phil. Trans. Royal Society of London*, 1994.

On Mathematical Models in Finance Practice (continued)

" Even this brief discourse on the application to finance practice of mathematical models in general and the options-pricing model in particular would be negligently incomplete without a strong word of caution about their use. At times we can lose sight of the ultimate purpose of the models when their mathematics become too interesting. The mathematics of financial models can be applied precisely, but the models are not at all precise in their application to the complex real world. Their accuracy as a useful approximation to that world varies significantly across time and place. The models should be applied in practice only tentatively, with careful assessment of their limitations in each application."

R.C. Merton, "Applications of Option-Pricing Theory: Twenty-Five Years Later", **N**obel Lecture, 1997.

Models are Always Abstractions from Complex Reality: Implications for Ratings Agencies and Regulators

Credit Evaluation: 1) Probability of Default

2) Expected Recovery Rate in Default

3) Degree of Procyclicality in Default

Ratings Agencies (S&P and Fitch)

1) Ratings based on Probability of Default only

Incomplete model for ratings induces bias in assets selected for structures

Behavior: Maximize value, subject to meeting ratings constraint

Minimize cost, subject to meeting ratings constraint

Prediction of bias in asset choices

- Low Expected Recovery Rate in Default
- High Procyclicality ("Beta") in Default

Recommendations: Risk Measurement

- Financial institutions provide prescribed risk data to central processing authority on confidential or coded basis. Aggregate risk parameters to regulators and public.
- Fair-value accounting always required and considered by regulator, whether or not capital-adequacy ratios and other specific regulatory rules are based on it.
- Encourage development and implementation of risk-accounting reporting measures for non-financial firms.
- Creation of national Capital Market Safety Board (A.Lo). International coordination is critical but single global body unrealistic.

Recommendations: Risk Management

- OTC derivative contract positions between financial institutions and above a threshold size must have two-way mark-to-market collateral at least equal to the contract liability value, independent of credit rating.
- Central clearing for OTC contracts (above threshold volume).
- No financial product can be offered with either a fixed redemption price/NAV or a fixed rate of return without an explicit guarantor. E.g., money-market fund; stable-value fund.
- Require financial engineering expertise among senior management, board members, and regulators of financial institutions, including central banks, BIS, and IMF.

Recommendations: Government Regulation and Macroeconomic Policy

- Establish U.S. Sovereign wealth fund to hold and manage assets acquired.
- Functional perspective on regulation to be more dynamic and take into account non-linear risk exposures, connectedness / network coupling and mismatch of innovations and infrastructures to support them.
- Do not use legislation to perform business management and governance functions.
- Government risk balance sheet with market-based estimates of the liability value and risk-exposures from guarantees.
- Integrated macrofinance framework for macroeconomic and monetary model analysis and incorporation into policy setting.

Selected Government Issues Involving Bailouts and Forbearance

- Establish policy on protection of equity-owners of financial institutions deemed "too big to fail," to avoid creating GSEs *defacto*. Potential moral hazard issue and perhaps more importantly, a potential destruction of competition in financial services. Could require "break-up" if too big to fail.
- Establish policy on protection of non-guaranteed creditors of financial institutions. Less of a moral hazard with respect to the risk-taking policy of the institution but lose the monitoring and price-signaling benefits from subordinated debt.
- If credible policy cannot be derived, then the affected institutions must have material restrictions on activities and pay fees for the guarantees and extra oversight costs.

Comparative Advantage vs. Efficient Risk Diversification Managing Country Risk

Before:

Taiwan Return = Return World Chip Industry + Return Taiwan-Specific Chip

Concentrated generic risk Comparative-advantage risk

Enter into a total-return Swap contract where Taiwan

Pays: Return World Chip Industry

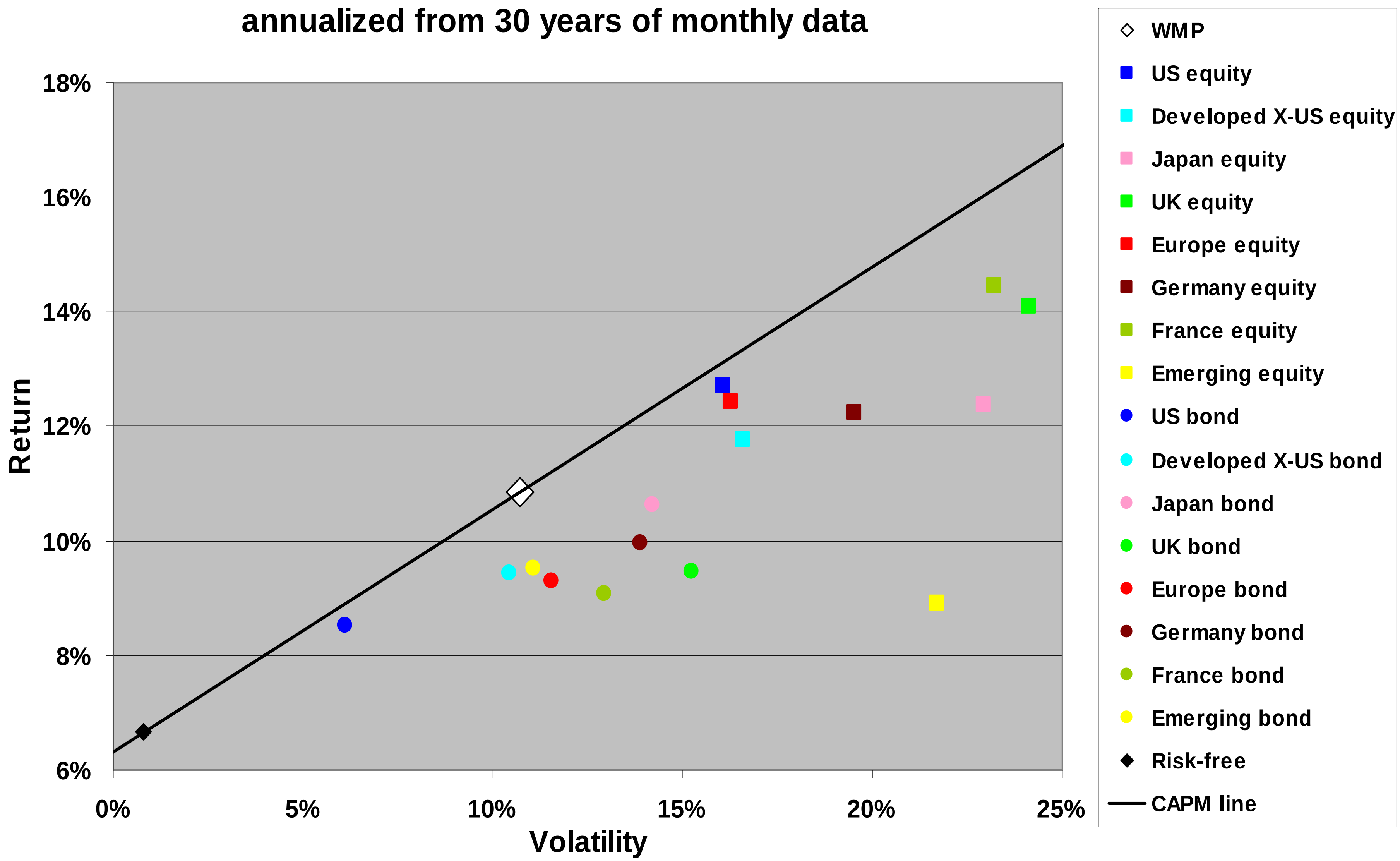
Receives: Return World all Industries

After:

Taiwan Return = Return World All Industries + Return Taiwan-Specific Chip

Diversified generic risk Comparative-advantage risk

Performance of world equity and bond markets, 1972- 2001, annualized from 30 years of monthly data



Source: André F. Perold, Joshua N. Musher (2002), “The World Market Portfolio”

Relative Advantage of Country Swaps for Diversifying Risk

- *Minimizes Moral Hazard* of Expropriation or Repudiation
- *Locals perform* industrial governance, trading in shares in local market, receive benefits/losses of local-country-specific component of industry returns, thus avoids political risk of "selling off the crown jewels of the country"
- *Credit Risk*: no principal amounts at risk; set frequency of payments (.25,0.5,1.0 years); "right-way" contract [pay when country is better able]; potential for credit guarantee and/or two-way-marked-to-market collateral
- *Policy is non-invasive*: doesn't require change in employment patterns and behavior, changes in industrial structure or changes in financial system design
- *Policy is reversible* by simply entering into an off-setting swap
- *Robust* with respect to local financial system design: works with capital controls, pay-as-you-go pension system, or no local stock market at all
- *How to measure country risk*: Patterned after BIS model for banks
- *Potential Gains*: From 1972-2001, a gain of 600+ b.p. in average return for same risk level by efficient diversification
- *Global political question*: In the future if all countries had economic risks that were (nearly) perfectly correlated with the World Market Portfolio, then how might that affect global political behavior?