Solving Challenges and Creating Opportunities in the Global Economy Using Finance Science Past and Future

Robert C. Merton

MIT Sloan School of Management

Iseo Institute

June 25, 2018

Iseo

Role of Financial Innovation and Finance Science in Economic Growth and Development

- Well-functioning financial system is essential for sustainable economic growth and development –financial innovation drives improvement of the financial system, and finance science, technology, and economic need drive financial innovation

  Robert M. Solow "Nobel Perspectives"
  ,https://www.ubs.com/microsites/nobel-perspectives/en/robert-solow.html
- Crisis can slow or even reverse financial innovation as in 2008-9. But crisis can also induce implementation of financial innovation which leads to a permanently improved financial system, as in the 1970s-1980s
- When did Finance become a science? 1950s-1960s
- When and why did finance science and finance practice become inexorably connected? 1970s-1980s

Finance Becomes a Science 1950s-1960s

- 1952 Diversification– Markowitz Mean-Variance Portfolio Theory
- 1953 Role of securities in optimal risk allocation- Arrow
- 1958 Hedging – Tobin risk-free asset in portfolio theory
- 1958 Corporate finance capital structure and payout policy – Miller and Modigliani
- 1960-3 First comprehensive individual stock return data base, Chicago Center for Research in Security Prices
- 1963-5 Efficient Market Hypothesis – Fama; Samuelson
- 1965 Risk-based differences in expected returns - Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM)
- 1965-70 Testing of various institutional investor performance using CAPM – Jensen, Roll

Major Financial and Economic Crisis 1970s: Risk Explosion and Stagflation in USA

- Multi-dimensional explosion of volatilities in the western economies reflected in financial systems
- Fall of Bretton Woods currency system
- First oil crisis in 1973-4 and a second one in 1979
- Double-digit inflation in the US highest since Civil War
- Double-digit interest rates , highest since Civil War
- No mortgage money: Regulation Q -5% deposit interest cap
- High unemployment ~9%:
- “Stagflation” unknown, and still unsolved, economic disease
- Stock market fell 50% in real terms mid 1973 – 1974
- 1973-1975 recession was really a 1970s recession because its effects extended into the 1980s

Risk Explosion 1970s Drives an Explosion of Financial Innovation in USA--Later Adopted Throughout the World--Finance Science and Practice Become Inexorably Linked

- Option exchange: financial value insurance
- Financial futures for currencies, interest rates, stocks
- NASDAQ , first electronic stock market
- Money market funds, high-yield and floating rate bonds
- Index funds Stage Coach Fund 1970 & Vanguard 1975
- TIAA-CREF international diversification in stocks 1972
- ERISA 1974 modern employer-funded pension system in US
- May Day 1975 permitted negotiated commissions on stock trading
- Debt securitization and creation of a national mortgage market
- Eliminate destructive regulations: deposit rate ceilings
- Foundation set for globalization of capital markets: derivative markets adopted throughout the world and global diversification
- Finance science: existing and breakthrough quantitative models and data bases were essential for implementing these innovations

How Intangible Innovation from Wall Street Can Solve Very Tangible Challenges to Economic Growth, Stabilization and Funding Retirement on Main Street

Derivative contracts can redistribute risks to those who are better equipped to bear them, in a non-invasive and reversible fashion

- Eliminating the largest risk in banks (1980s)
  - How the largest risk in banks was eliminated forever without disturbing how they serve their customers or increasing the costs of the services
- Lowering cost with a greener solution (1990s)
  - Leipzig Example: Creating a "synthetic pipeline" for a lower-cost and greener solution for a city to expand electric power capacity to grow
  - TVA Example: Creating synthetic power plants for more efficient energy resource use and a greener world in expanding electric power capacity for growth and development
- Addressing multiple policy objectives with a single financial innovation (2018)

  Global Example: Retirement income, funding infrastructure, and hedging tax revenues

  SeLFIES = standard-of-living indexed, forward-starting, income-only securities
- Implementing more-efficient financial stabilization and growth policies (2018)
  - China Example: Capital controls, governance and local investment government stabilization policies and comparative-advantage strategy for growth, each executed without bearing the costly "side-effects" from inefficient diversification

How the Largest Risk in Banks was Eliminated Forever

Interest Rate Swap 1980s

Before Swap: Bank lends money to customers at a fixed interest rate and provides deposits and pays interest to customers at a floating rate

Bank Earnings = fixed-rate paid by borrowers – floating-rate paid to its depositors

Bank enters into an interest-rate swap contract where it

Pays: a fixed-rate rate of interest

Receives: a floating rate of interest

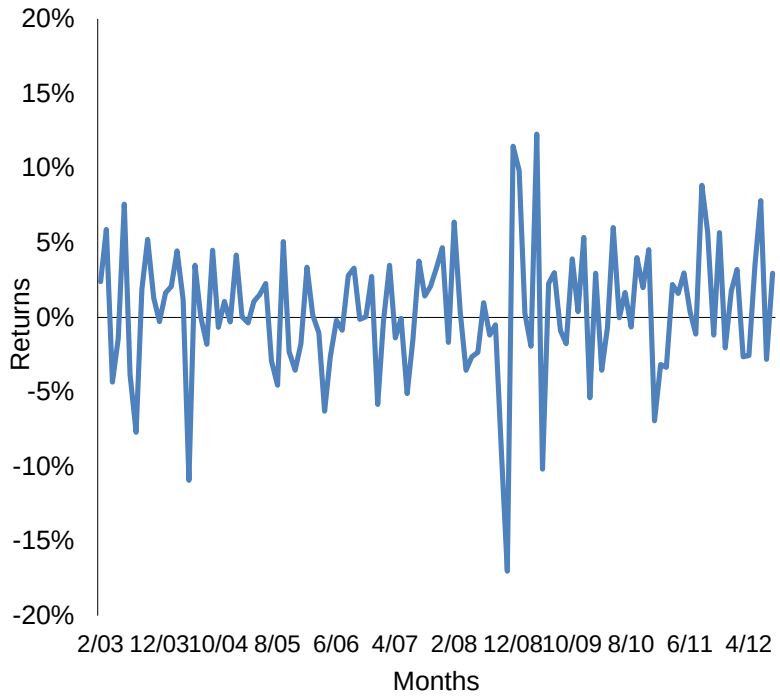
After: Still satisfies needs of both customers + swap contract which eliminates interest rate risk

Bank Earnings = [fixed-rate paid by borrowers – fixed-rate swap] + [floating-rate swap – floating-rate to depositors] = payment for banking services

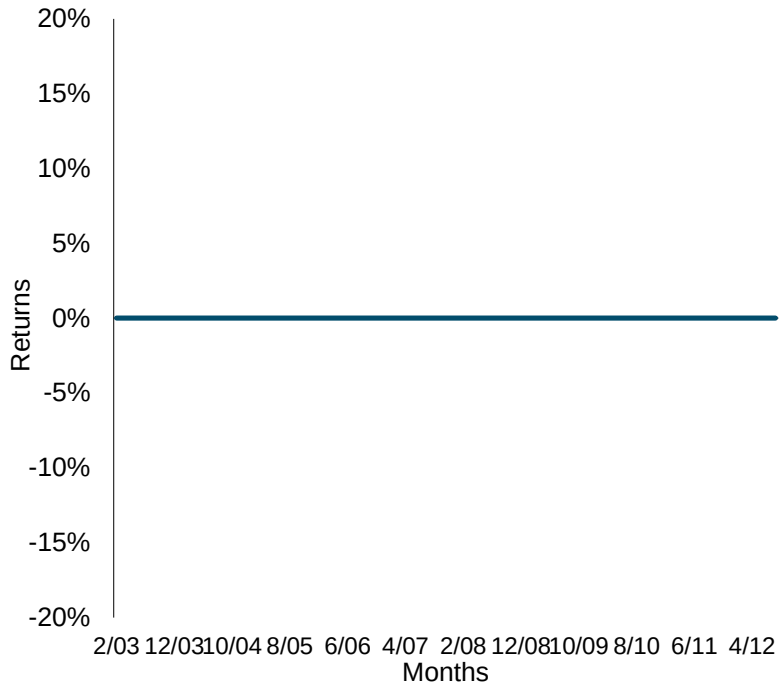
Interest Rate Risk is No Longer a “Banking-Service” Risk

Interest Rate Swap Derivative Contract Removes Interest Rate Risk for Banks in order to Service their Customers Needs:

FIXED-RATE LOANS FINANCED BY FLOATING-RATE DEPOSITS



FIXED-RATE LOANS FINANCED BY FLOATING-RATE DEPOSITS PLUS AN INTEREST-RATE SWAP



Substituting Contracts for Physical Assets to Create Greater Efficiency and a Greener World: Leipzig Gas Pipeline 1990s

German reunification in 1990 created rapid economic development and an increased power demand. To meet this demand required greater natural gas supply. Leipzig had two options:

Option 1

Spend **$50M** for a pipeline to the European gas grid and buy UK, Norwegian and Dutch gas at spot prices indexed off the USD price of heating oil at the Upper Rhine delivery point

Option 2

Spend **$300M** for a new pipeline to connect to the Russian gas grid and enter a 15 year fixed price contract in Deutsche Marks

Source: Peter Hancock, AIG, 2014

Contractual Synthesis of Assets: Leipzig Gas Pipeline

	Option 1	Option 2
Capital Investment	$50M	$300M
Advantages	Reduced political risk by avoiding dependence on Russians Lower capital investment	Stable prices of power potentially useful to population accustomed to price controls
Disadvantages	Gas price volatility	High capital investment

Option 1 could be made attractive with hedging, but had two significant problems:

1. **Limited hedge instruments available:**
   2. Crude oil call up to 5 years in USD
   3. Crude/heating oil basis swaps up to 2 years
   4. FX Options up to 5 years
   5. Currency swaps up to 10 years

2. **Limited sophistication of the city administration**

Efficient and Green Solution

A bank provided a 15 year cap on European gas prices at a strike price equal to the Russian fixed price contract in exchange for a premium of $125 MM. The cap is effectively a "synthetic pipeline".

The price is half of the incremental cost of a physical pipeline to Russia and compensates the bank for hedge mismatches and the need to dynamically adjust hedges over 15 years.

Source: Peter Hancock, AIG, 2014

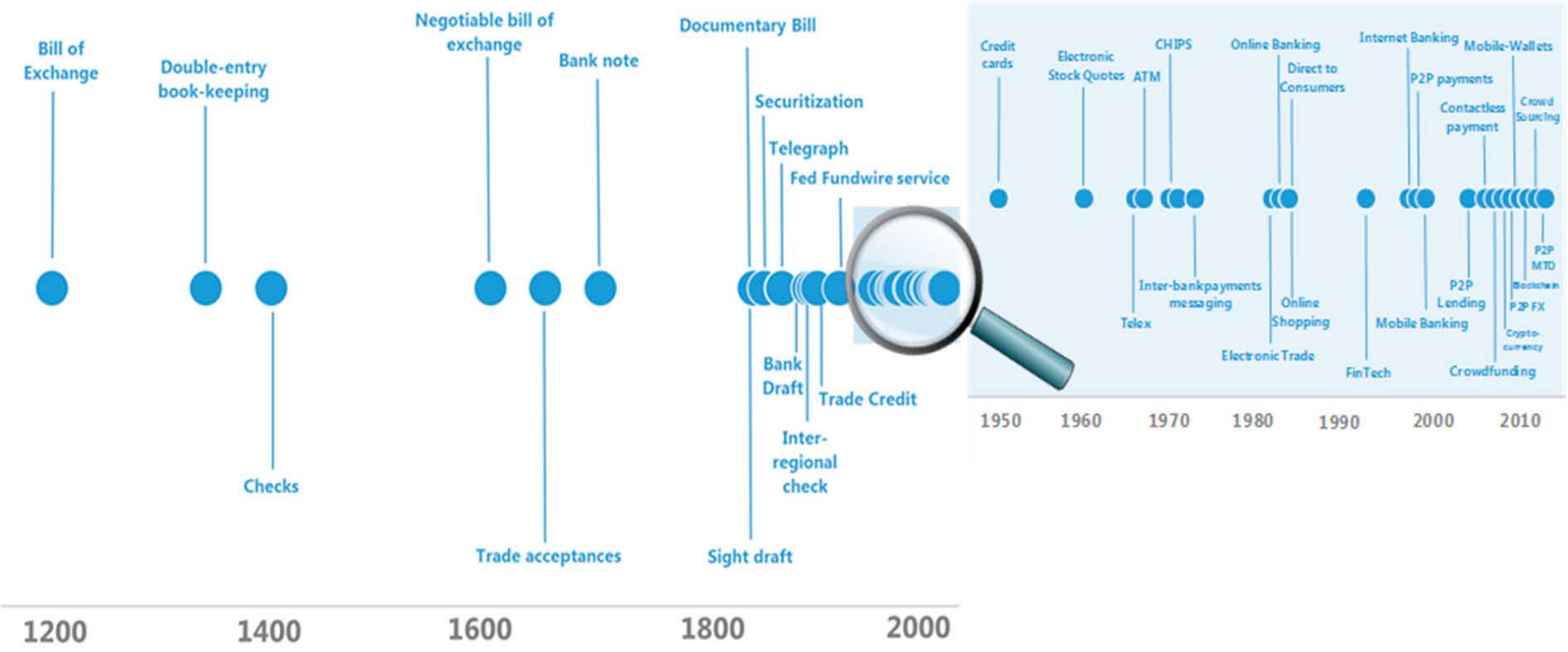
Financial Contracts as a Synthetic Power Plant to Create More Efficient Energy Resource Use and a Greener World

Tennessee Valley Authority (TVA) Uses Option Purchase Agreements (OPA) to Acquire Power

- In 1994, Tennessee Valley Authority, the largest public power utility in the United States, undertook a long-term strategic analysis of the energy demands of its customers into the 21st Century and develop "robust" supply channels, which were not affected materially by external shocks and offered flexibility.
- TVA adopted as one channel an innovative proposal to meet incremental capacity needs by using derivative contracts to buy power as an alternative to building new generating plants.
- The proposal called for the creating of new financial contracts, Option Purchase Agreements, long-dated call(put) options on power purchased from (sold to) counterparts that could deliver the power into the grid.
- As a consequence of the implementation of OPA, TVA did **not** build two nuclear power plants [equivalent to 35 conventional ones]
- In 2016, TVA was responsible for 3.50% of all electric power generation in the United States.

 Source: Peter Tufano, "Tennessee Valley Authority: Option Purchase Agreements", HBS Case 9-296-038, February 1997

Accelerating Pace of Technological Progress in Financial Services



Sources: Arner, Barberis, and Buckley (forthcoming); Quinn and Roberds (2008); World Economic Forum (2015).

Bond Innovation :SeLFIES = Standard-of-Living Indexed, Forward-starting, Income-only Securities

- **Forward-starting bond**:
  - Starts paying at a pre-determined future date (e.g., 2030, 2031…)
  - Periodic level-payouts for a fixed period (e.g., 20 or 25 years),with no principal or "balloon" payout at maturity…like an annuity with a pre-set period for payouts
  - Payouts are indexed to per-capita consumption: hedges both consumption inflation and standard-of-living risks
- **Simple structure**: each bond pays $5 real per year for 20 years
  - ✓Participant selects and buys bond just using their retirement date and requires no other information and no need to take further future actions
  - ✓Buying the bond today locks in retirement cash flows in the future
  - ✓Payments are protected against *both* inflation and standard-of-living changes
  - ✓Consumption CAPM predicts that an asset which is perfectly correlated with aggregate consumption would be a universally demanded asset for investors

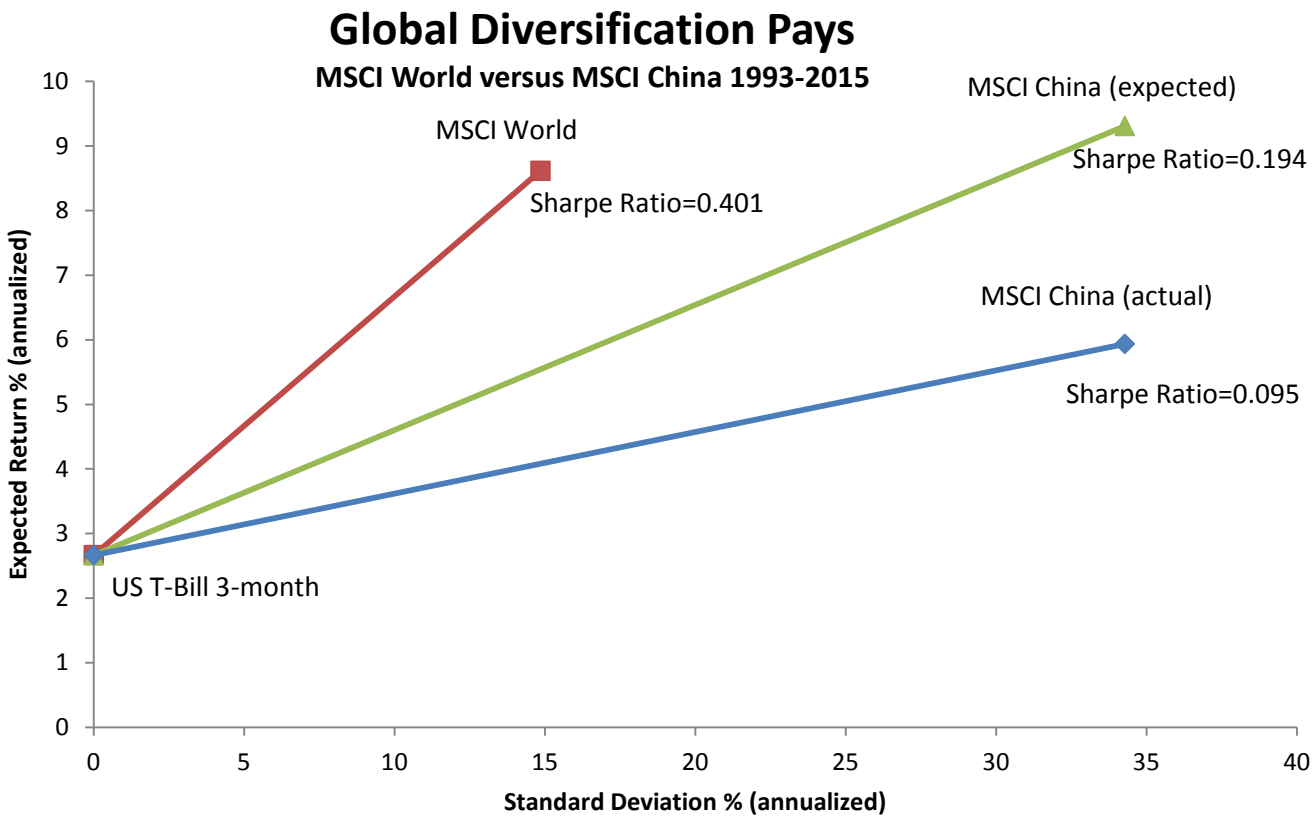
Addressing Multiple Policy Objectives with a Single Bond Innovation: Retirement Income, Funding Infrastructure and Hedging Tax Revenues by Issuing SelFIES

- **SeLFIES = Standard-of-Living Indexed, Forward-starting, Income-only Securities**
- **<u>An bond innovation that addresses multiple policy objectives:</u>**
- Retirement funding improvements for individuals and institutions; improve maturity-matching of funding for infrastructure investments; reduce government tax-revenue risk
- Provides a precise match to cash flow income needs of retirees, so no further transactions
- Addresses the challenge of a lack of financial literacy for retirement savers
- Pattern of delayed payouts for many years and then level payouts match infrastructure cash inflow pattern to avoid refinancing risk and cost
- For governments with VAT, the bond payments are hedged by VAT revenues and hedges tax revenue risk
- A new-design bond issued by government to improve financial market "completion"

Capital-Controls Stabilization,Governance and Local Investment Policies Have "Side-Effect" Cost of Inefficient Diversification

Cost of Restricting Investing and Risk-Bearing to Domestic Holders Can be Substantial – China as a Case Study

MSCI World versus MSCI China 1993-2015



Source: MSCI China total return index, MSCI World total return index, U.S. 3 month T-Bill rate, 1993-2015. Returns in USD. "Expected" = expost 0-alpha, conditional on World realized return

Financial Innovation Can Create Improved Policy-Objectives Implementation without the Unintended Cost of Inefficient Risk Diversification by Separating Risk Flows from Capital Flows, Investment and Governance

Before: SWF/ Pension Fund 100% invested in China A Share stocks

China SWF/Pension Fund Return = Return on Chinese A Share stocks
Concentrated Equity Risk

Enter into a Total-Return Swap contract where SWF/Pension Fund

Pays: Return on Chinese A Share stocks

Receives: Return on World stocks

After: Still 100% invested in China stocks as policy requires + swap contract which provides the efficient diversification

China SWF/Pension Fund Return = Return World stocks
Well-Diversified Equity Risk

Note: China only has a cash outflow from the swap when China market outperforms the world markets which are "good times" for China and no need for capital-flight controls and actually receives cash inflow in "bad times". Non-Chinese counterparty gets efficient exposure to China A Shares from a credit-secure counterparty in size. May also help mitigate "asset bubble" risk in local market.

Relative Advantage of Country Swaps for Diversifying Risk

- *Lower Cost of Capital* through increased global risk-bearing of a country's risks
- *Always Natural Counterparties Available*: if a country has "too much" risk exposure to itself for efficient diversification, the rest of the world has "too little" risk exposure to that country.
- *Low-Cost Implementation:* Transact directly among sovereign wealth funds, government pension funds, reserves, and central banks, with no need to incur intermediary cost and credit risk
- *Minimizes Moral Hazard* of expropriation, repudiation, taxes or accounting
- *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

Relative Advantage of Country Swaps for Diversifying Risk

- *Locals perform* industrial governance, trading in shares in local market, and local intermediation distribution of exposures to global asset returns
- *Country* retains full benefits/losses of local-country-specific component of industry returns; it keeps all of its “alpha” and avoids ex-post political risk accusation of “selling off the crown jewels of the country too cheaply”
- *Robust* with respect to local financial system design: works with financial stabilization policies (including capital controls) , pay-as-you-go pension system, or no local stock market at all
- *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
- *Insurance version:* country swaptions

Derivative Markets and Financial Innovation

- Derivatives are efficient “adapters” between heterogeneous financial systems, which improve global financial integration and diversification
- Derivatives provide efficient implementation of the three methods of managing risk: diversification, hedging and insurance
- Derivatives permit efficient risk diversification while implementing other objectives by separating risk-bearing choices from comparative advantage, cash investment, governance, liquidity, expropriation, and tax issues.
- Development of derivative markets for equities, interest rates, currencies and commodities promotes financial stability by multiple channels for risk transfer and information-extraction from prices
- Derivatives can improve the efficiency of open-market and stabilization operations: efficient trading and issue “open-market policy” securities
- Informed regulation to realize the benefits of financial innovation while managing its risks.

References

Bodie, Zvi and Robert C. Merton, “International Pension Swaps”, *Journal of Pension Economics and Finance*, March 2002: 77-83.

Breeden, Douglas, “An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities”, *Journal of Financial Economics,* 7 1979, 265-296.

Merton, Robert C., “Country Risk”, Commentary, *Risk Magazine*, July, 1999.

_____, “Swapping Countries”, Insights, ICBI 2002 Conference Highlights, PricewaterhouseCoopers, 2002

_____, “Foreword: On Financial Innovation and Economic Growth”, *Harvard China Review*, (Spring 2004): 2-3.

“International: Countries Can Gain by Swapping”, Briefs, *Oxford Analytica*, March 15, 2005, Oxford.

Merton, Robert C. and Arun Muralidhar, “Time for Retirement “SeLFIES”? *Investments and Pensions Europe,* April 2017, 3-4.

_____, “SelFIES Can Improve the Nation’s Retirement Security”, Industry Voices, *PLANSPONSOR*, November 20, 2017.

Speaker Profile

Robert C. Merton is the School of Management Distinguished Professor of Finance at the MIT Sloan School of Management and John and Natty McArthur University Professor Emeritus at Harvard University. He was the George Fisher Baker Professor of Business Administration (1988–98) and the John and Natty McArthur University Professor (1998–2010) at Harvard Business School. After receiving a Ph.D. in Economics from MIT in 1970, Merton served on the finance faculty of MIT's Sloan School of Management until 1988 at which time he was J.C. Penney Professor of Management. He is currently Resident Scientist at Dimensional Fund Advisors, where he is the creator of Target Retirement Solution, a global integrated retirement-funding solution system

Merton received the Alfred Nobel Memorial Prize in Economic Sciences in 1997 for a new method to determine the value of derivatives. He is past president of the American Finance Association, a member of the National Academy of Sciences, and a Fellow of the American Academy of Arts and Sciences.

Merton has also been recognized for translating finance science into practice. He received the inaugural Financial Engineer of the Year Award from the International Association for Quantitative Finance (formerly International Association of Financial Engineers), which also elected him a Senior Fellow. He received the 2011 CME Group Melamed-Arditti Innovation Award, and the 2013 WFE Award for Excellence from World Federation of Exchanges. A Distinguished Fellow of the Institute for Quantitative Research in Finance ('Q Group') and a Fellow of the Financial Management Association, Merton received the Nicholas Molodovsky Award from the CFA Institute. He is a member of the Halls of Fame of the Fixed Income Analyst Society, Risk, and Derivative Strategy magazines. Merton received Risk’s Lifetime Achievement Award for contributions to the field of risk management and the 2014 Lifetime Achievement Award from the Financial Intermediation Research Society.

Merton’s research focuses on finance theory, including lifecycle and retirement finance, optimal portfolio selection, capital asset pricing, pricing of derivative securities, credit risk, loan guarantees, financial innovation, the dynamics of institutional change, and improving the methods of measuring and managing macro-financial risk. Merton received a B.S. in Engineering Mathematics from Columbia University, a M.S. in Applied Mathematics from California Institute of Technology and a Ph.D. in Economics from Massachusetts Institute of Technology and holds honorary degrees from eighteen universities. http://robertcmerton.com/