Chameleon Models: The Misuse of Theoretical Research in Financial Economics

Presentation to

FARFE

Foundation for the Advancement of Research In Financial Economics

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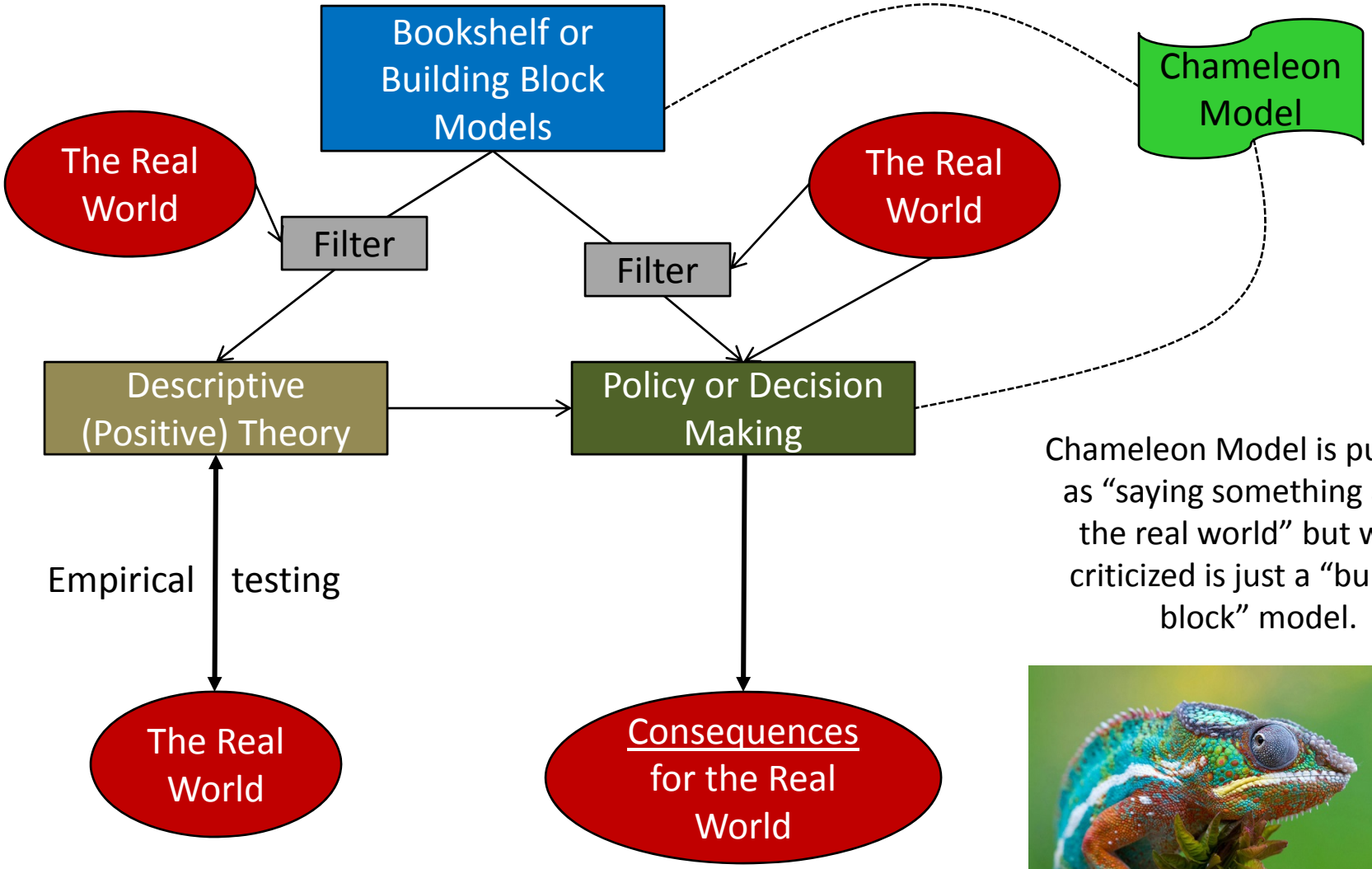
Stanford University

"Cherry Picking" In Theoretical Research

- Cherry Picking in Empirical Research = Carefully Selecting Data to Support a Desired Result
  - If one has sufficient freedom to select the data, one can support almost any result.

- Potential Cherry Picking in Theoretical Research = Searching for a Set of Assumptions that Produces a Desired Conclusion
  - If one has sufficient freedom to select assumptions, one can create a model to support almost any result.
  - Are the assumptions reasonable?
  - Are there other more reasonable assumptions that explain what we see?



Chameleon Model is put forth as "saying something about the real world" but when criticized is just a "building block" model.

Case Study #1

Why High Leverage is Optimal for Banks

Harry DeAngelo and René M. Stulz*

April 2013
Revised August 2013

Quoted from: DeAngelo and Stulz

To establish that high bank leverage is the natural (distortion-free) result of intermediation focused on liquid-claim production, the model rules out agency problems, deposit insurance, taxes, and all other distortionary factors. By positing these idealized conditions, the model obviously ignores some important determinants of bank capital structure in the real world.

However, in contrast to the MM framework – and generalizations that include only leverage-related distortions – it allows a meaningful role for banks as producers of liquidity and shows clearly that, if one extends the MM model to take that role into account, it is optimal for banks to have high leverage.

Quoted from: Bacardi and Mondavi

To establish that high intake of alcohol is the natural (distortion free) result of human liquid-drink consumption, the model rules out health problems, DUIs, spouse abuse, job loss and all other distortionary factors. By positing these idealized conditions, the model obviously ignores some important determinants of human alcohol consumption in the real world.

However, in contrast to the alcohol neutral framework – and generalizations that include only overconsumption-related distortions – it allows a meaningful role for humans as producers of that pleasant "buzz" one gets by consuming alcohol, and shows clearly that if one extends the alcohol neutral model to take that role into account, it is optimal for humans to be drinking almost all of their waking hours.

Some Necessary Adjustments

Why High Leverage is Optimal for Banks

Harry DeAngelo and René M. Stulz*

April 2013
Revised August 2013

Why "High" Leverage is Optimal for Banks
in an Idealized Model that Omits Many Things of First-order Importance

Harry DeAngelo and René M. Stulz*

April 2013
Revised August 2013

Capital punishment
Forcing banks to hold more capital may not always be wise

The Economist
Sep 14th 2013

"In a new paper Harry DeAngelo of the University of Southern California and René Stulz of Ohio State University show that this premium means that banks, unlike other firms, are not indifferent to leverage, as the Modigliani-Merton theorem suggests. Mr DeAngelo and Mr Stulz show that it is better for banks to be highly levered even without frictions like deposit insurance and implicit guarantees. Banks would still choose to be levered because the liquidity premium lets them borrow cheaply."

The Economist
September 14, 2013

Manipulating Symbols

θ = "liquidity spread" or rate-of-return discount that those purchasing liquidity from banks accept in exchange for assured future access to capital.

ϕ = "loan spread" or rate-of-return premium paid on bank loans by those with limited access to capital markets.

DeAngelo and Stulz, "Why High Leverage is Optimal for Banks", page 9

- The casual reader of the paper might think that since θ is what the authors seem to be arguing justifies a bank's high leverage, the higher is θ, the higher should be the bank's leverage.
- The casual reader would be wrong.

Manipulating Symbols

The key implication of our analysis is that the bank's optimal capital structure maximizes liquid claim issuance against its asset collateral. The optimal leverage ratio (based on the values of D and E when x = 1 and $\theta > 0$) is:

$$D/(D + E) = 1/[1 + \theta + \phi z] \quad (5)$$

Optimal bank leverage is generally high. To see why, examine (5) and note that one would as an empirical matter expect θ and ϕz to be small positive numbers. Huge liquidity premiums ($\theta >> 0$) or huge loan spreads ($\phi >> 0$) seem implausible as an equilibrium property in today's market where shadow banks produce massive supplies of relatively liquid claims and junk bonds are used aggressively as substitutes for bank loans. Hanson, Kashyap, and Stein (2011) apply the estimates of Krishnamurthy and Vissing-Jorgensen (2012a) to argue that a plausible upper bound on θ is 0.01.

DeAngelo and Stulz, "Why High Leverage is Optimal for Banks", pages 12 and 13

Manipulating Symbols

"E" includes capitalized value of spread income related to θ. As θ increases, E increases and "leverage" mechanically goes down.

The key implicati…ital structure maximizes liquid claim issuance against its ass…d on the values of D and E when x = 1 and θ > 0) is:

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Optimal bank leverage is generally high. To see why, examine (5) and note that one would as an empirical matter expect θ and ϕz to be small positive numbers. Huge liquidity premiums (θ >> 0) or huge loan spreads (ϕ >> 0) seem implausible as an equilibrium property in today's market where shadow banks produce massive supplies of relatively liquid claims and junk bonds are used aggressively as substitutes for bank loans. Hanson, Kashyap, and Stein (2011) apply the estimates of Krishnamurthy and Vissing-Jorgensen (2012a) to argue that a plausible upper bound on θ is 0.01.

DeAngelo and Stulz, "Why High Leverage is Optimal for Banks", pages 12 and 13

"[The DeAngelo and Stulz] model can explain a historical curiosity. Banks' capital ratios have fallen steadily over the past two centuries. This has often been attributed to the introduction of deposit insurance and the role of lenders of last resort, which reduced the cost of bank debt. But in America's case much of the drop in borrowing costs came before the creation of the Federal Reserve in 1913 and the introduction of federal deposit insurance in 1933.

An alternative explanation is that as banking became more competitive, lenders were forced to offer better terms to depositors, narrowing the liquidity premium. The model of Messrs DeAngelo and Stulz shows that as the liquidity premium shrinks, banks must crank up their leverage to compensate."

The Economist
September 14, 2013

The source of this misleading statement is the confused argument that DeAngelo and Stulz develop based on their mechanical result.

Case Study #2

A Theory of Bank Capital

Diamond and Rajan

Journal of Finance, December 2000

Bookshelf or Building Block Models

ABSTRACT

Banks can create liquidity precisely because deposits are fragile and prone to runs. Increased uncertainty makes deposits excessively fragile, creating a role for outside bank capital. Greater bank capital reduces the probability of financial distress but also reduces liquidity creation. The quantity of capital influences the amount that banks can induce borrowers to pay. Optimal bank capital structure trades off effects on liquidity creation, costs of bank distress, and the ability to force borrower repayment.

A Theory of Bank Capital

Diamond and Rajan

Journal of Finance, December 2000

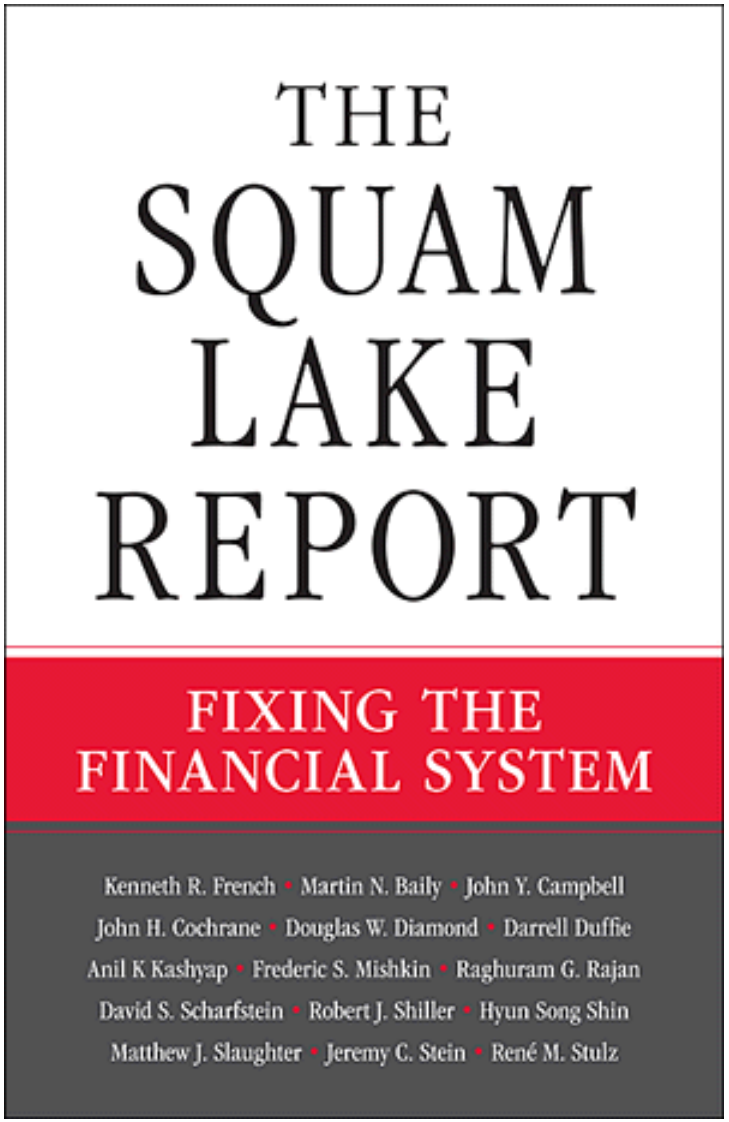
Bookshelf or Building Block Models

F. Holdup by an Intermediary

The relationship lender is an intermediary who has borrowed from other investors. In the same way as the entrepreneur can negotiate his repayment obligations down by threatening not to contribute his human capital, the intermediary can threaten not to contribute his specific collection skills and thereby capture a rent from investors.

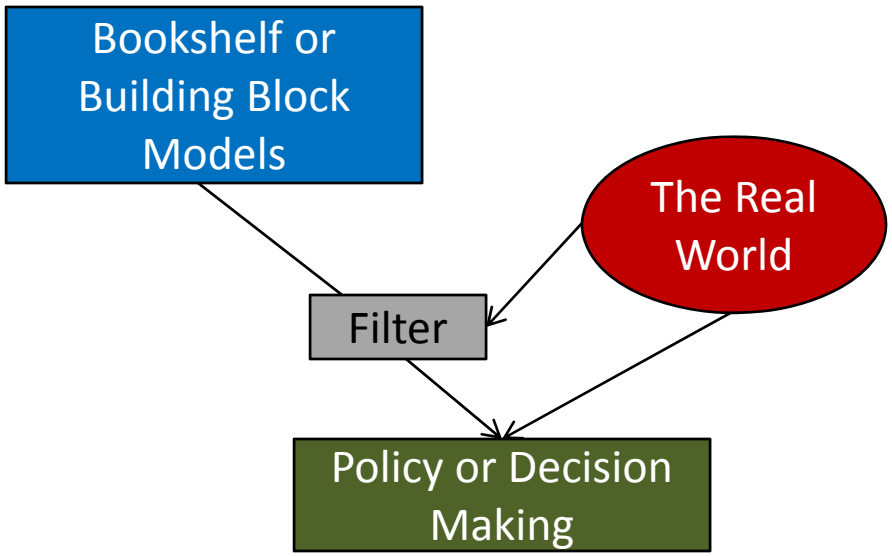
The Chameleon Leap

"The disciplining effect of short-term debt, for example, makes management more productive. Capital requirements that lean against short-term debt push banks toward other forms of financing that may allow managers to be more lax."



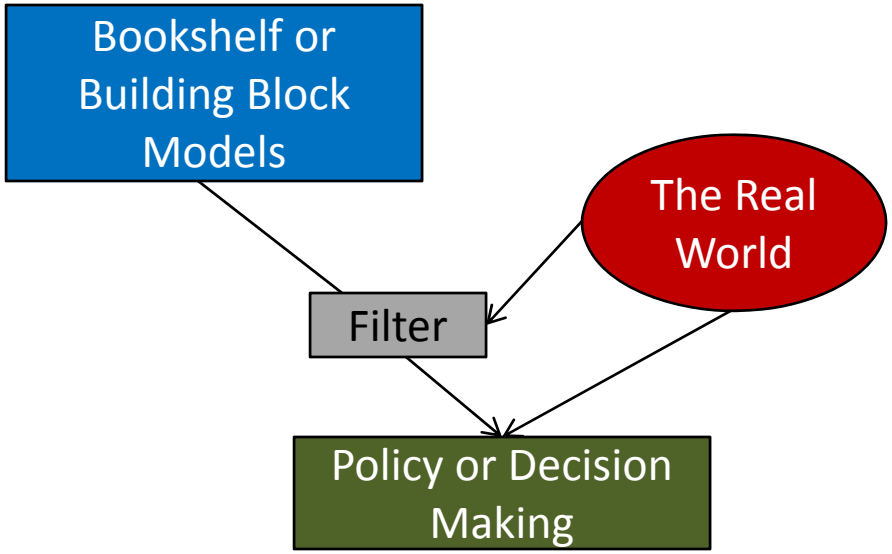
Filter Questions to Ask

- **Precisely who** is it who works at JP Morgan and Barclays and will threaten not to use his skills if investors don't cut him a better deal?
  - The CEO?
  - A loan officer in the bank?
- **Precisely which** loan or asset in a trillion dollar balance sheet is so big that this threat is of such consequence that it would cause creditors to run?
- **Precisely which** creditors are threatening to call the manager's bluff by running?
  - Not the insured depositors.
  - Not the repo lenders who have collateral and are not subject to the sequential service constraint.
  - Not long term debt holders who cannot run.
  - Who?



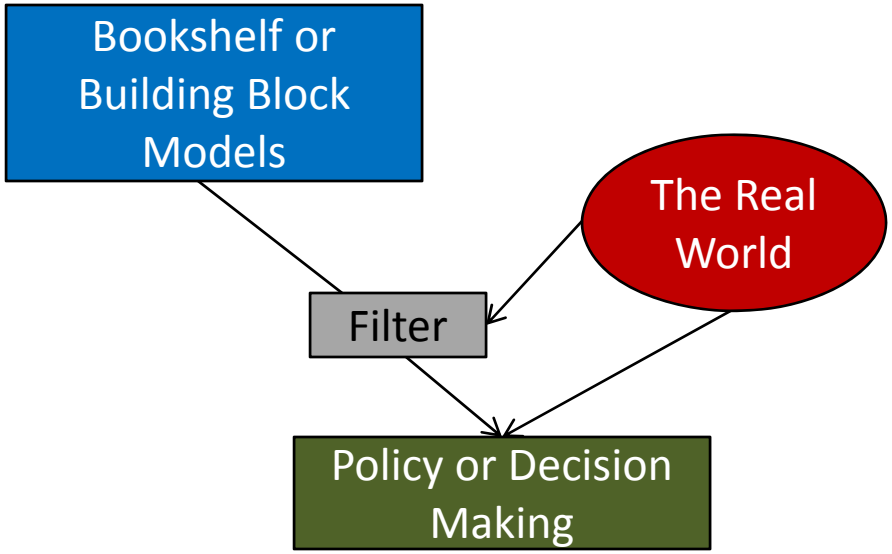
Filter Questions to Ask

- **Isn't** this a potential problem at other firms?
  - Can't the General Partners (GPs) in a private equity fund threaten not to do their work in realizing value from their portfolio firms unless the Limited Partners (LPs) cut them a better deal?
  - Can't Microsoft employees threaten not to finish the operating system unless they are cut a better deal.
- **Why** is fragility not used for other firms? How do they solve the problem?



Filter Questions to Ask

- **What level of "fragility" would be required to discipline Jamie Dimon?**
  - In the "London Whale" event of 2012, JP Morgan lost approximately $6.2B.
  - This did not cause a run on the bank.
  - Doesn't this mean that Jamie Dimon can hold up the bank shareholders for $6.2B?



Just Because We See It, Doesn't Make it Optimal

We Live in the Best of all Possible Worlds

Gottfried Wilhelm Leibniz

Reverse Engineering

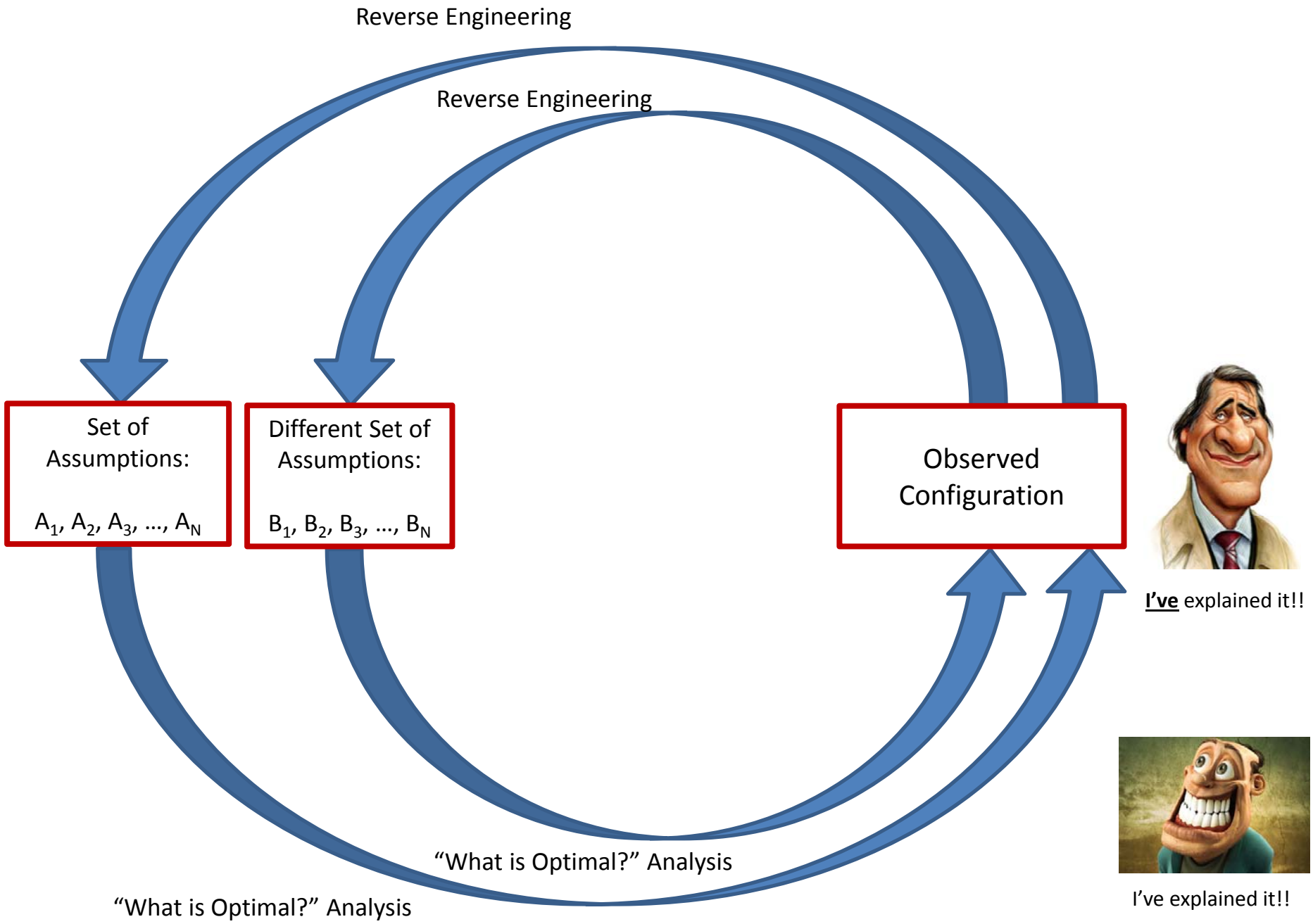
Set of Assumptions:

$A_1, A_2, A_3, \ldots, A_N$

Observed Configuration

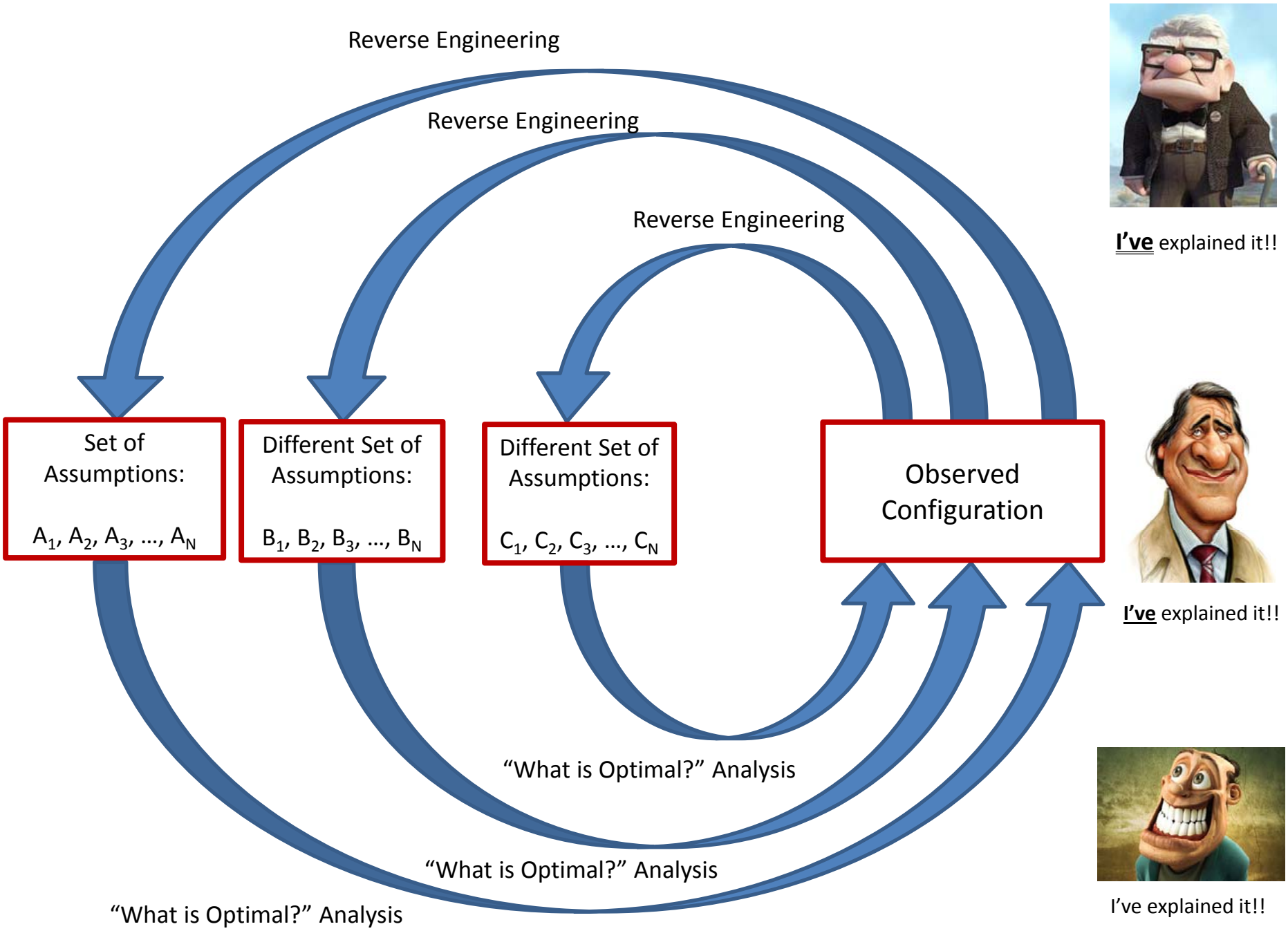
"What is Optimal?" Analysis

I've explained it!!



I've explained it!!

I've explained it!!



I've explained it!!

I've explained it!!

I've explained it!!

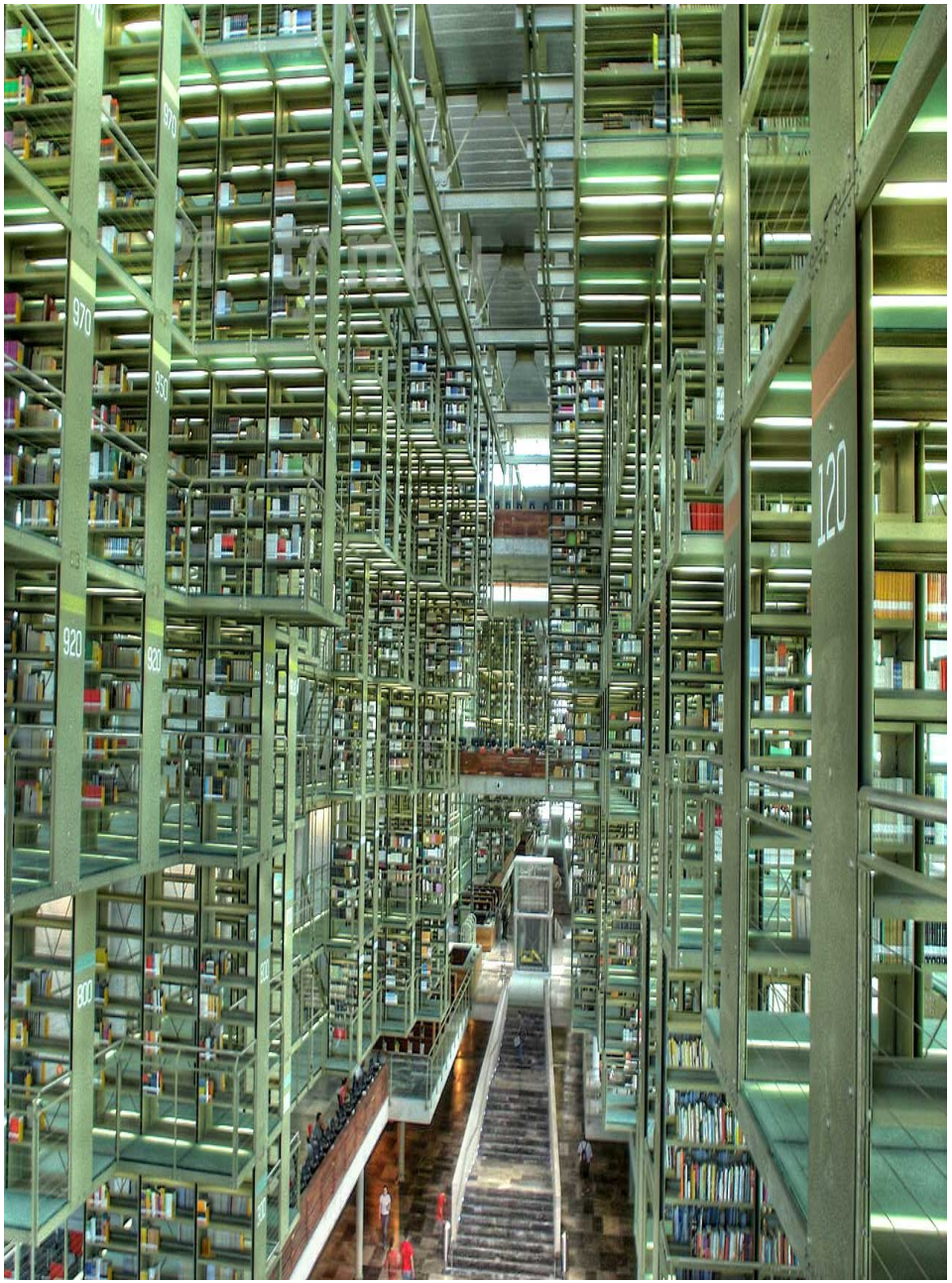
“Let A Thousand Flowers Bloom”

- “Our job as theorists is just to produce models that are internally consistent.”

- “Empiricists will test these models and tell us ones which ones survive.”

In other words, throw a bunch of stuff at the wall and see what sticks.

OGEI/PGJLXJ,IP
ESTHE3VU-QIvI
,LLiBRARYOOFy
q/RDAS/BYjFoV
EPZ BABELL.LAC
M?SPR/XıYq WA
L–LYA M CES/D
XH–JoRGEFORı4
LLUIS:CEcQ/3 L
JYBBBORGESDL
boN/K8A EOıı8



A Model from the Library of Babel

Model #675-BVX-25

- Because of the great complexity and opacity of modern financial institutions, bank managers have wide scope to take actions that benefit them and hurt shareholders and others. Call these opportunities "scams."
- The opportunities for managers to engage in scams arrive randomly according to a Poisson process with intensity λ.
- The bank manager has bounded processing abilities (limited "bandwidth") and this means that the probability that the manager will recognize any given scam opportunity and be able to take advantage of it depends on the amount of "bandwidth" he has available at the moment the scam opportunity presents itself.
- The most efficient way to prevent the manager from engaging in scams is to make sure that the manager has limited bandwidth available.

A Model from the Library of Babel

Model #675-BVX-25

- The amount of bandwidth the manager has available depends on the complexity of the bank's capital structure. A more complicated capital structure requires more of the manager's attention and leaves less bandwidth for identifying scams.
- Equity is simple (it is only common stock) but debt can be quite complicated (it varies in maturity, priority, and a host of other features). In other words, debt is more complicated than equity.
- It is therefore efficient to create a complex capital structure by using a lot of debt and making the structure of liabilities very complicated, since this will occupy more of the manager's bandwidth and reduce his ability to recognize and react to scam opportunities.

A Model from the Library of Babel

Model #675-BVX-25

- The model "explains" why banks' liabilities have become more complicated over time.
  - Increases in the opacity and the size of banks that have occurred over time have created more opportunities for bank managers to engage in scams (λ has increased).
  - More complexity is needed to occupy more managerial bandwidth.
  - (Note that this also "explains" why big banks have more complicated liability structures than smaller banks.)

A Silly Claim:

Model #675-BVX-25 should have equal standing with any and all other models until the “proper empirical tests” are run.

No,

Model #675-BVX-25 is a model based on assumptions that are far removed from what we know about the world. It does not pass the smell test.

The Dangers of “As If”

The accomplished billiard player may play “as if” he is solving complex mathematical equations, but this is the result of thousands of hours of play with immediate feedback.

The value of equity E and debt D of the equity-maximizing firm in each node on the grid (p, A, d) at time $t - \Delta t$ are determined by working backward in time:

$$E_{(t-\Delta t)}(p, A, d) = \max_{i \geq 0}\left[CFE_{(t)}(i)\Delta t + e^{-r\Delta t}\mathbb{E}_Q[E_{(t)}]\right]$$

$$= \max_{i \geq 0}\left[CFE_{(t)}(i)\Delta t + E_{(t)}(p, A, d)\right.$$

$$\left.+\Delta t\widehat{\mathcal{L}}[E_{(t)}(p, A - \gamma A\Delta t + i\Delta t, d)]\right]. \quad \text{(B2)}$$

The value of debt is dependent upon the equityholders decisions

$$D_{(t-\Delta t)}(p, A, d) = CFD_{(t)}\Delta t + e^{-r\Delta t}\mathbb{E}_Q[D_{(t)}]$$

$$= CFD_{(t)}\Delta t + D_{(t)}(p, A, d) + \Delta t\widehat{\mathcal{L}}[D_{(t)}(p, A - \gamma A\Delta t + i^*\Delta t, d)], \quad \text{(B3)}$$

where

$$\widehat{\mathcal{L}}[Z] = \frac{1}{2}\sigma_p^2 p^2 Z_{pp} + (r - \alpha)Z_p + (-\gamma A + i^*)Z_A - rZ,$$

where i^* is the investment strategy that solves (B2) at time $t - \Delta t$. $CFE(i)$ and CFD are cash flows to equityholders and debtholders, respectively.

$$CFE_{(t)}(i) = p \cdot c(A) - i - d - wF + w \cdot D_{(t)}(p, A, d) - \tau$$
$$\times\max[0,\ p \cdot c(A) - d - \gamma A] - C_{Equity}$$
$$\times\max[0,\ -p \cdot c(A) + d + i + wF$$
$$-w \cdot D_{(t)}(p, A, d)] - C_{Distress} \times max[0,\ s \cdot b - p \cdot c(A) + d]$$

$$CFD_{(t)} = d + wF - w \cdot D_{(t)}(p, A, d).$$

For each time step we also check whether or not it is optimal for the equityholders to increase/decrease the firm's debt level instantaneously. The firm increases its debt from F to $\widehat{F}$ $(F = \frac{\widehat{d}}{r})$ if the following condition is satisfied

$$E_{(t)}(p, A, d) < \max_{\widehat{d} > d}[E_{(t)}(p, A, \widehat{d}) + D_{(t)}(p, A, \widehat{d})$$
$$-F - C_{Debt}\widehat{F}],\ E_{(t)}(p, A, \widehat{d}) > 0. \quad \text{(B4)}$$

A Dynamic Model of Optimal Capital Structure
Sheridan Titman and Sergey Tsyplakov
Review of Finance, 2007

“As If” Does Not Apply

- Unlike a billiard player who makes hundreds of shots a day and gets immediate feed back, a CFO makes a very limited number of capital structure decisions in a career and gets extremely noisy and hard to interpret delayed feedback.
- It is wishful thinking to think that some particular CFO, let alone the average CFO, is calibrating and solving a complex dynamic programming problem.

Why Models in Finance are Not Anything Like Models in Quantum Mechanics

The Case of Quantum Mechanics

We don't observe anything about what "motivates" electrons and photons to make decisions.

$$i\hbar\frac{\partial}{\partial t}\Psi(r,t)=\left[\frac{-\hbar^2}{2m}\nabla^2+V(r,t)\right]\Psi(r,t)$$

$$\left(\beta mc^2+\sum_{k=1}^{3}a_k p_k c\right)\Psi(r,t)=i\hbar\frac{\partial}{\partial t}\Psi(r,t)$$

We do observe something about the paths they take.

Models do not contradict other things we know about electrons and photons.

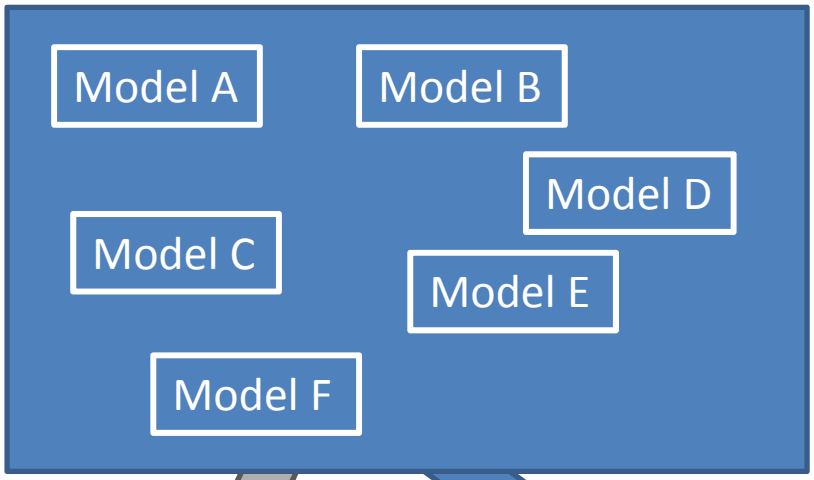
Models make predictions in extremely close accord with observational data.

Observation and experiments produce voluminous empirical data.

Why Models in Finance are Not Anything Like Models in Quantum Mechanics

The Case of Finance

We observe a lot about decision makers making financial decisions. We can even ask them what they are doing (or at least what they think they are doing)



We do observe various paths taken as a consequence of decisions: e.g., capital structures.

Models often contradict things we know about actors: Can CFOs really calculate E(t-Δt)(p, A, d)?

Models fit data in a rough way. Models that fit very well are often over-fitted

Observation produces some often "noisy" empirical data. Experiments are difficult.

The Cult of Subtlety

- Theories that are “deep” and produce surprising results that are explained by subtle and complex reasoning are intrinsically interesting (and fun to develop) ….

  But that doesn’t make them true or useful.

- Chasing subtlety for its own sake can lead us far off the path.

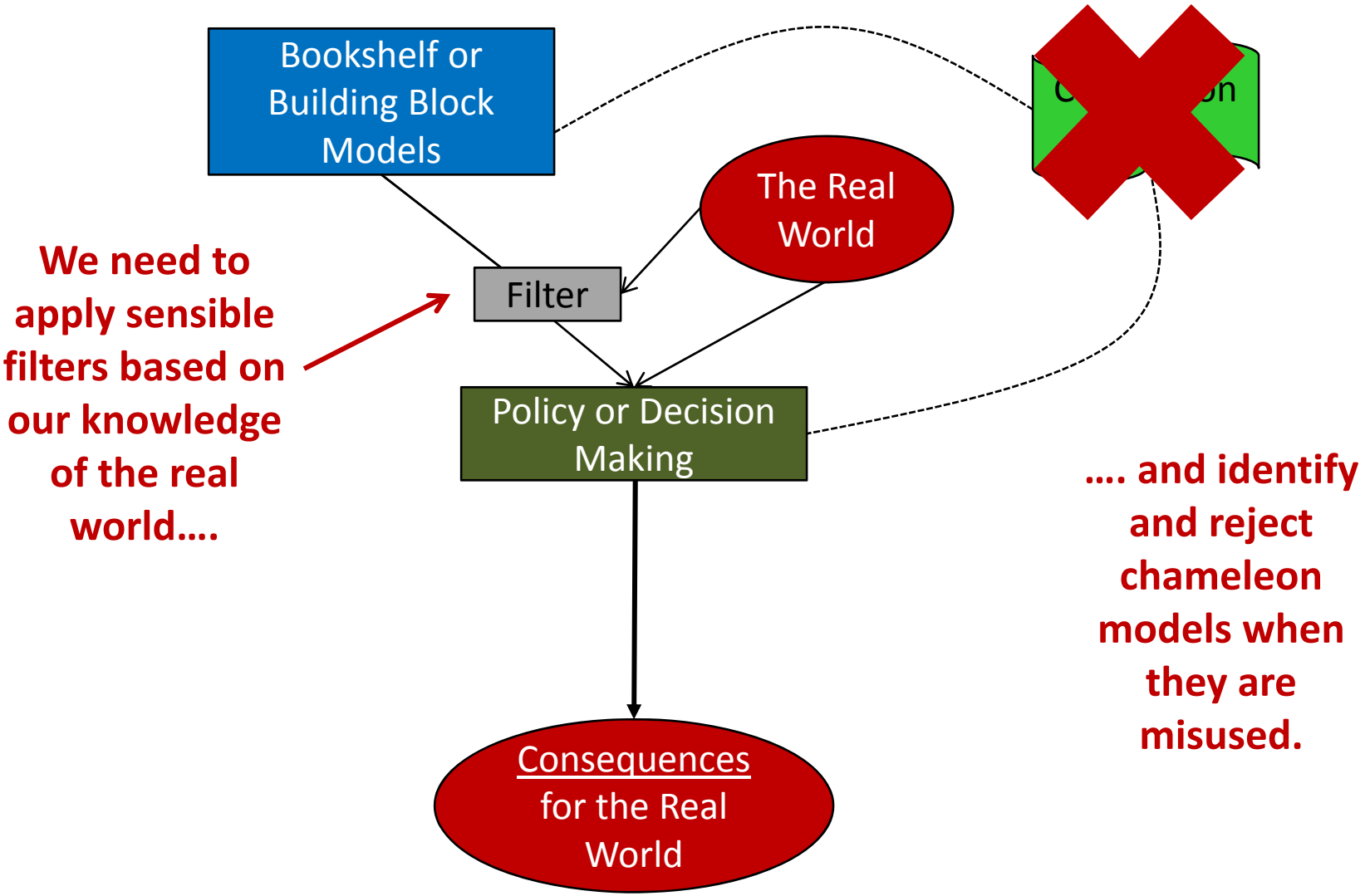
VERY IMPORTANT

- I am not in any way saying anything against bookshelf or building block models.
  - Making assumptions and tracing through their implications is the primary source of our intuitions and insights about economic phenomena.
  - The discipline of developing internally consistent models is absolutely critical to thinking clearly.

Bookshelf or Building Block Models

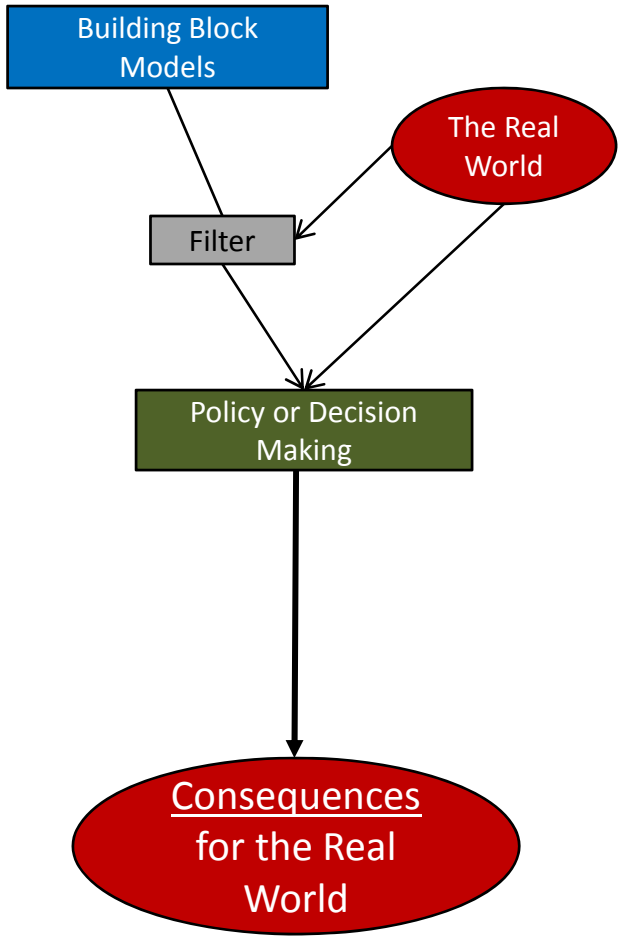
VERY IMPORTANT

- The issues I am raising all have to do with what happens when we take the models off the book shelf and try to connect them with the real world.


Bookshelf or Building Block Models
The Real World
Filter
Policy or Decision Making
Consequences for the Real World
We need to apply sensible filters based on our knowledge of the real world….
…. and identify and reject chameleon models when they are misused.

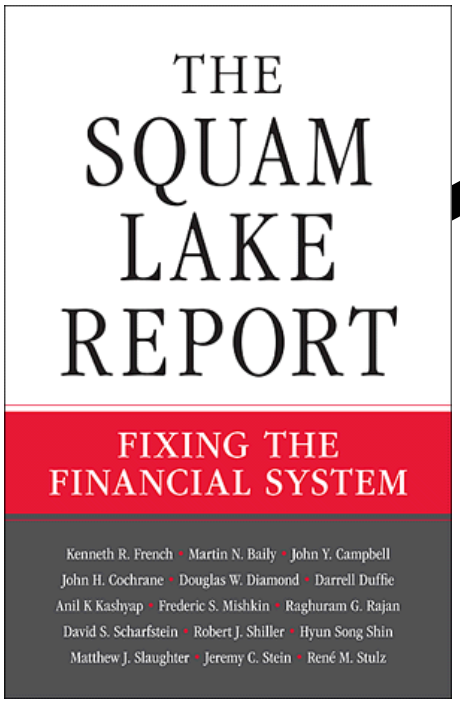
Am I Being Unfair?
Am I Way Out of Line?

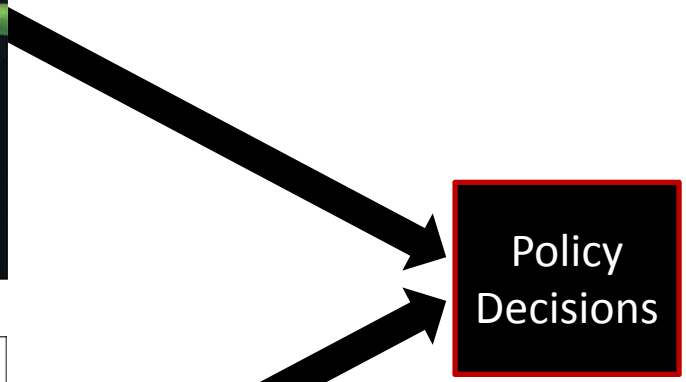
- Perhaps we have a tacit agreement not to ask filter questions, such as:
  - How does a CFO solve a complex dynamic programing problem?
  - How fragile do banks need to be to discipline managers like Jamie Dimon?
- If so, why are these questions out of bounds?



There is no problem if
all we are is an
enjoyable
discussion club
that is
isolated
from the
rest of the world
and is
free to make
its own rules.

But we aren't isolated….

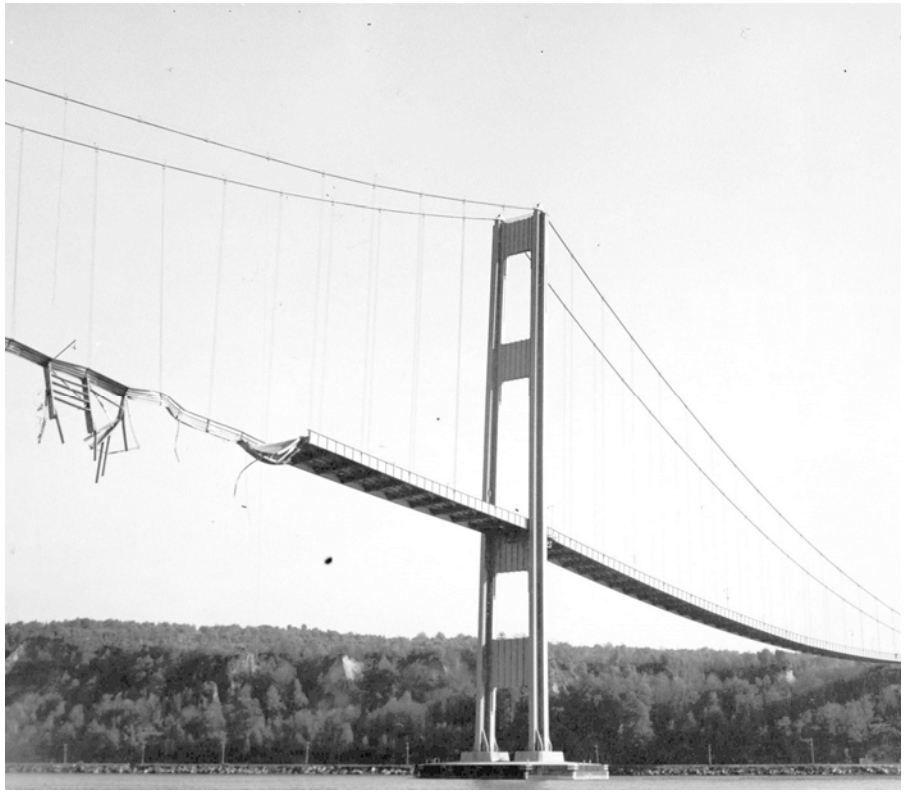




But Theory in Finance is hard to do…

- "We must make simplifying assumptions …."
- "All models are abstractions …."
- "Models should be judged by their predictions, not their assumptions …"
- "If my model 'explains' what I set out to explain, it must be taken seriously…"

Designing bridges is also hard to do… and bad assumptions have consequences.



Tacoma Narrows Bridge (1940)

“Science is what we have learned about how to keep from fooling ourselves.”