Sustainability: An Economist’s Take

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What Is Sustainability?

- A fuzzy concept

- Abstract definition: “Sustainability is the ability to continue a defined behavior indefinitely”

- It’s fuzzy for good reasons
  
  1. disciplines define it differently, to suit their needs
  2. it quickly becomes politicized, also to suit users’ needs
Stein’s Law:

“If something cannot go on forever, it will stop.”
Wiser Than You Might Think

▶ Stein’s point: It’s not terribly useful to point out something cannot continue forever

1. Few things actually do go on forever
2. More important to talk about the possible resolutions

▶ Static perspective

▶ to imagine something continuing indefinitely, you are necessarily holding many things constant

▶ outside of the laboratory, things are rarely constant

▶ Dynamic perspective

▶ acknowledges that things can and do change

▶ enforces “forward thinking:” imagining the future
Discussions of sustainability necessarily involve human behavior.

Human behavior depends on beliefs about the future.

Those beliefs feedback to affect behavior today.

Current behavior influences future outcomes.

Economic’s key contribution is to formalize the role of expectations.

Scientists often ignore this critical channel.

- particles don’t form expectations
This Talk

- Emphasizes forward thinking & dynamics
- Illustrates by historical examples that “experts” have rarely been right about the future
- Uses an extended example—fiscal sustainability—to show
  - static thinking
  - dynamic thinking
  - how & why they are different
Ultimately, I come out being optimistic

Some clarifications...

I am not saying that left to its own devices, the private sector will resolve various sustainability problems efficiently or fairly.

Many sustainability issues involve externalities that unfettered competition does not handle well.

Resolutions to unsustainable situations have winners & losers.

There is a role for government & democratic processes.

But the government’s touch should be light, with an eye to getting incentives right.

Some sustainability issues are intrinsically in the hands of government—like monetary, fiscal & financial policies.
**Limits to Growth**

- Extremely influential 1972 book—written by MIT team of scientists—concludes

- “If present growth trends in population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next 100 years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity.”

- This is scary: we are now nearly half way to the limit

- The study was conducted by highly-regarded scientists, but not economists
“If present growth trends...continue unchanged....”

Implicit assumption is that even in the face of evidence of unsustainability, behavior will persist.

Violates Stein’s Law

- long before the “sudden and uncontrollable decline,” relative prices will rise signalling anticipated shortages
- higher prices raise incentives to innovate
- innovation entails changes that contradict the supposition of no change
“...the application of technology to apparent problems of resource depletion or pollution or food shortage has no impact on the *essential* problem, which is exponential growth in a finite and complex system.”

The logic (as far as I can tell):

Technological advance $\Rightarrow$ more pollution $\Rightarrow$ food shortage $\Rightarrow$ death

Or

Pollution abatement $\Rightarrow$ exponentially growing costs $\Rightarrow$ industrial output grows $\Rightarrow$ food shortage

Underlying the results is a “natural” limit to growth in population & capital

Implies that technology cannot relax this limit

Why is the system “finite”? 
Some Facts About Technology

- Economists model GDP as produced by labor, capital and productivity
  \[ Y = AF(L, K) \]
- \( A \) is total factor productivity
- Higher \( A \) means given labor & capital inputs produce more output
- Sources of TFP growth
  - invention of new products, tools, and technical processes
  - reductions in the cost of extracting or producing raw materials and energy
  - reductions in the cost of transforming those inputs into finished products
- Major inventions: steam locomotive, telegraph, electricity, combustion engines, chemicals, information technology
- A lot of on-going research digs into sources of growth in TFP
Some Facts About Technology

- Over history, TFP has grown *exponentially* at varying rates

<table>
<thead>
<tr>
<th>Period</th>
<th>Growth Rate (%)</th>
<th>Doubling Rate (years)</th>
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<tbody>
<tr>
<td>1890–1920</td>
<td>0.46</td>
<td>152</td>
</tr>
<tr>
<td>1920–1970</td>
<td>1.89</td>
<td>37</td>
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<tr>
<td>1970–1994</td>
<td>0.59</td>
<td>119</td>
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<td>1994–1999</td>
<td>0.74</td>
<td>95</td>
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<tr>
<td>1999–2004</td>
<td>1.31</td>
<td>53</td>
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<tr>
<td>2004–2009</td>
<td>0.28</td>
<td>250</td>
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<tr>
<td>2009–2014</td>
<td>0.53</td>
<td>132</td>
</tr>
</tbody>
</table>

- These growth rates combine with growth rates in quality of labor force & capital stock to yield growth rate of GDP
Average exponential growth rate: 1.3%
Per Capita Income: Actual

U.S. Per Capita Real Income

Per Capita Income (2009 Dollars) in 2014
Actual: $50,009
Average exponential growth rate: 2%

Actual
To understand contribution of technology to economic growth...

Consider extreme pessimism:

- no improvement in technology since 1970
- what would income per person be in 2014?

Continue to assume improvements in labor force & capital quality
Per Capita Income: Actual & Hypothetical

U.S. Per Capita Real Income

Per Capita Income (2009 Dollars) in 2014
Actual: $50,009
No TFP Growth: $33,052

Two More Examples

1. Moore’s law: the speculation that the number of transistors on a silicon chip will double every two years
   - initially made by engineer at Intel in 1965
   - expected it to last at least a decade
   - now in its 50th year
   - despite repeated announcements of the law’s death
Moore’s Law Keeps Marching On
Two More Examples

1. **Moore’s law**: the speculation that the number of transistors on a silicon chip will double every two years
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2. **Oil & gas**: new technologies continue to
   - improve exploration & discovery
   - increase transportation efficiency
   - raise extraction rates
   - despite repeated warnings we are near the end
Innovations in Oil Extraction

Horizontal drilling: cost & environmental benefits
Prognosticating

- Scientists are terrible forecasters
- Arthur C. Clarke’s *Profiles of the Future*
- Two hazards of prophecy
  1. **Failure of nerve**: even given all the relevant facts, the prophet cannot see that they point to an inescapable conclusion
    - British scientists about Edison’s incandescent bulb: “good enough for our transatlantic friends... but unworthy of the attention of practical or scientific men.”
  2. **Failure of imagination**: when all available facts are appreciated and marshalled correctly, but the really vital facts are still undiscovered, and the possibility of their existence is not admitted
    - Ernest Rutherford, father of nuclear physics, derided those who predicted the ability to harness the energy in matter; 5 years after his death, the first chain reaction occurred in Chicago
Clarke’s Laws

1. “When a distinguished scientist says that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.”

2. “The only way to discover the limits of the possible is to venture a little way past them into the impossible.”

3. “Any sufficiently advanced technology is indistinguishable from magic.”
Fiscal Sustainability

- Especially since the 2008 financial crisis, we have heard

1. “...debt levels are near historic highs and are projected to grow unsustainably over the long run.” Committee for a Responsible Federal Budget

2. “It is urgent and essential that we put in place a plan to fix America’s debt.” Fix the Debt

3. Under current law, government debt is on a trajectory that is unsustainable. Congressional Budget Office

- The CBO regularly publishes projections in which debt explodes as a share of GDP
- Source of explosion is aging U.S. population coupled with promised, but not pre-funded, old-age benefits
All Populations Are Aging

Old-Age Dependency Ratios
Number Aged 0-14 and 65 or Older Per 100 Aged 15-64

Japan
Western Europe
United States
U.S. Unfunded Benefits

Transfer payments to Americans
Transfers payments to Americans
Transfers payments plus other government spending

- Debt projections combine these numbers with current tax law to produce path of debt
Government debt as percentage of GDP: Actual and Projected
Long-Term Fiscal Analysis

- These projections closely mimic *Limits to Growth* analysis

- They are “backward-looking” spreadsheet calculations that assume
  - policy behavior will never change
  - there is no feedback from debt to the economy
  - no role for expectations
Long-Term Fiscal Analysis

- Permanent exponential growth in debt as share of GDP cannot happen
  - interest on debt grows exponentially to exceed possible revenues
  - expecting this, bond holders will drive debt’s value to zero as bond yields rise precipitously
  - high yields transmit to other interest rates
  - can trigger a broader financial crisis & large output losses

- Projections violate Stein’s Law

- At best, the projections are useless
Problems With Conventional Analyses

- Applies to CBO, IMF & others

- Looks backward at fiscal policy behavior to ask:
  - If past policies were to persist indefinitely and nothing else were to change, what would be the path of debt?

- This is a profoundly uninteresting question
  - past policies won’t persist if debt explodes
  - everything else will change if people perceive debt may explode
1. Government bonds are an asset, priced in markets
   ▶ value of bonds depends on expected *future* payoffs
   ▶ if expected payoffs are low—which they are if debt is unsustainable—bond prices will be low
   ▶ low bond prices ⇔ high interest rates
     ▶ Greek government bond yields > 30% in 2011–12
   ▶ what’s the evidence on value of U.S. treasuries?
U.S. Debt: Face & Market Values Since Crisis

U.S. Federal Government Gross Debt-GDP

Face Value
Market Value

From 2009 to Present
Average Difference is $833 Billion
Average Federal Budget Deficit is $997 Billion

Financial markets are not concerned about sustainability
A More Useful Approach: Use Economics

1. Government bonds are an asset, priced in markets
2. Highly-valued debt does not imply can run current policies forever
   - it means that bond holders look forward—not backward
   - they believe past policies will not persist
   - some changes in policies will occur that make debt valuable
3. We want to model the forward-looking behavior that values bonds

4. Develop concept of a fiscal limit
   - model alternative resolutions to fiscal stress
   - offer menu of policy options and their macro consequences
   - permit expectations of future resolutions feedback to current equilibrium
   - capture uncertainty about the future

5. When debt is closer to the fiscal limit, it becomes riskier
   - likelihood of default rises
   - value of debt falls; interest rate increases
The Fiscal Limit

Fiscal limit answers: “given the economic environment, what is the distribution of government debt that can be supported?”

► it is uncertain: a probability distribution

► it is forward-looking—about expected policies & their credibility

► it depends on
  1. private behavior
  2. policy behavior
  3. fundamental shocks to the economy

► Government debt derives its value from future budget surpluses net of interest payments (“cash flows”)

► Fiscal limit distribution emerges from the distribution of expected present value of maximum primary surpluses
Illustrative Fiscal Limit

- Huixin Bi’s setup (European Economic Review 2012)
  - use formal economic model
  - peak of Laffer curve for labor taxes—maximum revenues
  - government transfers vary between stable & growing
  - fiscal reform: move from growing to stable transfers
  - connect model’s parameters & policy specification to data

- Closer debt is to its fiscal limit...
  - higher is probability of default
  - lower is its value—higher are interest rates

- Use framework to ask:
  - How do changes in economic conditions & policies shift fiscal limit and alter risk premia?
Non-Policy Shocks Affect Sustainability

Fiscal limit CDF computed using peak of labor Laffer curve, constant government purchases, current transfers regime, no seigniorage revenues.
Non-Policy Shocks Affect Sustainability

Fiscal limit CDF computed using peak of labor Laffer curve, constant government purchases, current transfers regime, no seigniorage revenues.

- High Productivity Raises a Country’s Sustainable Debt Level
Non-Policy Shocks Affect Sustainability

Fiscal limit CDF computed using peak of labor Laffer curve, constant government purchases, current transfers regime, no seigniorage revenues.

- Low Productivity Reduces the Country’s Sustainable Debt Level
Policy Actions Affect Sustainability

Fiscal limit CDF computed using peak of labor Laffer curve, constant government purchases, current transfers regime, no seigniorage revenues.

- Stable Growth in Transfers Raises the Country’s Sustainable Debt Level
Policy Actions Affect Sustainability

Fiscal limit CDF computed using peak of labor Laffer curve, constant government purchases, current transfers regime, no seigniorage revenues.

- Unstable Growth in Transfers Reduces the Country's Sustainable Debt Level
What Does This Show?

- Can say much more than “debt is unsustainable”
- Can deduce what kinds of policies are sustainable
  - need to take a stand on how policies might change
  - what the economy-wide consequences of those changes might be
- Interest rates signal what bond holders think about the future
  - if policies will shift to become sustainable
  - how policies might shift to become sustainable
Wrap Up

- Declarations of “unsustainability” from mechanical extrapolations of history are of limited interest
  - “sustainability” is about the future
  - beliefs about the future affect behavior today
- Implicit in Stein’s Law: When something unsustainable stops...
  - it stops for a reason
  - those reasons have consequences
- The interesting question that leads to constructive answers is:
  What policies can make the stopping least painful?
- In answering this, economists, scientists & policymakers need humility
  - being an expert ≠ knowing the future
Final Thought

- We need to be honest about our uncertainty about the future

“If we are less confident, it is because we know more, not because we know less.”

Angus Deaton
2015 Recipient of Nobel Prize in Economics