Secular Stagnation on the Supply Side: U.S. Productivity Growth in the Short and Long Run

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Conference on the Underwhelming Global Post-Crisis Growth Performance
Ottawa, June 8, 2015
Secular Stagnation:  slow growth not no growth

Most of my talk is about the U.S.

But almost everything here applies to Canada and the EU-15

At the end: charts comparing Canada, the U.S., and the EU-15 for output per hour, output per capita, and hours per capita
Secular Stagnation
1938 and 2015 As the Mirror Image

• Sources emanate from supply side:
  – Hansen in 1938: slowing population growth and end of territorial expansion
    • “the whole new outfit of capital formerly needed by the added population is now no longer needed”
  – Today 2015: slowing potential GDP growth
    • Potential Output per Hour
    • Potential Hours of Work
      – Working-age Population
      – Falling Labor-force Participation Rate (LFPR) reduces Hours per capita
    • “the whole new outfit of capital formerly needed by the added population is now no longer needed”

• Mirror-image Interpretation, Hansen 1938 vs. U.S. now
Chains of Causation

• AS Effects directly reduce output per capita growth:
  – Declining LFPR
  – Declining productivity growth

• For any given rate of output per capita growth
  – Slower population growth reduces potential GDP growth

• Implies Lower Net Investment
  – Basic idea: long-run steady state with fixed capital-output ratio
  – Slower output growth means slower growth in capital to maintain fixed capital-output ratio

• Lower net investment: reduces aggregate demand and feeds back to lower productivity growth
Employment-Population Ratio and GDP Gap, 1919-1941

Figure 1. Output Gap vs. Log Employment-Population Ratio, 1919 to 1941, 1928=0.
Decline in Population Growth
As Seen From 1938 and 2015

Figure 2. Annualized Five-Year Growth Rate of U. S. Population, 1875 to 2060.
Why Hansen Wasn’t Worried About Productivity Growth

Figure 3A. Annual Growth Rate of Output per Hour, 1937-40 vs. 2009-14
Primary Source of Secular Stagnation is Slowing Productivity Growth

- Since Solow 1957: The history of TFP growth is the best guide to the importance of innovation

- The best organizing principle to think about innovation is to distinguish among the industrial revolutions (IR #1, IR #2, IR #3).

- IR #2 was without compare in its impact in creating rapid TFP growth for a full half century

- IR #3 has changed our lives but has raised TFP growth less, for only a decade instead of a half-century.
To Understand TFP History, We Need Definitions of the Three IR’s

• **The 1\textsuperscript{st} IR occurred 1770-1840, continued impact through 1900**
  • Steam engine, railroad, steamships, wood=>steel

– **The 2\textsuperscript{nd} IR occurred 1870-1920, continued impact through 1970 along at least 6 dimensions**
  • Electricity, light, elevators, machines, air conditioning
  • Internal combustion engine, vehicles, air transport
  • EICT: Telephone, phonograph, movies, radio, TV
  • Running water, sewer pipes, and the conquest of infant mortality
  • Chemicals, plastics, antibiotics, modern medicine
  • Utter change in working conditions, job & home
Third Industrial Revolution

• Since 1960 the “EICT” Revolution (one dimension compared to the six dimensions of IR #2)

• Everything on this list has already happened; to continue TFP growth of 1970-2014 there must be a steady stream of innovations that are of similar importance
  – Entertainment: TV – color, cable, time shifting, HDTV, streaming
  – Information Tech – mainframes, minis, PCs, web browsers, e-commerce
  – Communications: mobile phones, smart phones
  – Productivity enhancers: ATM, bar-code scanning, lightning-fast credit card authorization
  – Search tools provide free information, both public and proprietary inside the firm
The Standard of Living Is Not the Same as Productivity Growth

- Total Output or GDP ($Y$).
- Total Hours of Work ($H$).
- Total Population ($N$).

- The Output Identity

\[
\frac{Y}{N} \equiv \frac{Y}{H} \times \frac{H}{N}
\]
Real GDP Per Capita Is Not the Same As TFP And Does Not Measure Innovation

Figure 1. Prospective Level of 2020 Real GDP per Capita

2009 US Dollars

Year


2020: $64,753
2007: $49,260
2014: $50,253

Actual Values

1891-2007 Actual = 2.1%
Per-capita Real GDP Growth Now Is Below Pessimistic Trend

Figure 4. Level of Real GDP per Capita through 2014:Q3, Actual, Optimistic, and Pessimistic Growth Growth Rates

- 2007:Q1 $48,987
- 2014:Q3 $57,359
- 2014:Q3 $52,016
- 2014:Q3 $50,632

log percentage difference between red line and green line = 12.5%
between red line and black line = 2.7%

- 1891-2007 Actual = 2.1%

Actual Values
Per-Capita Income Growth Does Not Equal Productivity Growth

Figure 2. Annualized Growth Rates of Output per Hour, Output per Capita, and Hours per Capita, 1891-2014
The Same History, Just for Productivity \((Y/H)\) Growth

Figure 5. Annualized Growth Rates of Output per Hour, 1891-2013
Growth in Labor Productivity Over Three Eras

Figure 1-2. Average Annual Growth Rate of Output per Hour, Selected Intervals, 1890-2014
The Effect of Education and Capital Deepening

Figure 1-2. Average Annual Growth Rates of Output per Hour and Its Components, Selected Intervals, 1890-2014

- Education
- Capital Deepening
- TFP

1890-1920:
- Education: 1.75%
- Capital Deepening: 0.66%
- TFP: 0.39%

1920-1970:
- Education: 3.10%
- Capital Deepening: 1.10%
- TFP: 1.67%

1970-2014:
The Second Industrial Revolution vs. the Third Industrial Revolution

Figure 1-2. Average Annual Growth Rates of Total Factor Productivity, Selected Intervals, 1890-2014

- 1890-1920: 0.68
- 1920-1970: 2.03
- 1970-2014: 0.74
The Powerful But Delayed Effect of IR #2 on TFP Growth

Figure 3. Annual Growth Rate of Total Factor Productivity for Ten Years Preceding Years Shown, Years Ending in 1900 to 2014

1890-2014 Average Growth = 1.11 percent per year
IR #2 Created “Big Green” TFP; IR #3 Created “Little Green” TFP

Figure 6. Average Annual Growth Rate of Total Factor Productivity, Selected Intervals, 1890-2014
IR #3 Has Failed the TFP Test

- Failure #1: TFP growth post-1970 barely 1/3 of 1920-70
- Failure #2: IR #3 boosted TFP growth only briefly 1996-2004
- Brynjolfsson and McAfee: “We’re at a point of inflection of accelerating productivity growth”
- My response: “Could the productivity benefits of IR #3 be almost over?”
The IR #3 Changed Business Practices Completely 1970-2005

• Transformation in offices completed by 2005.
  – 1970 mechanical calculators, repetitive retyping, file cards, filing cabinets
  – 1970s and 1980s. Memory typewriters, electronic calculators, PCs with word processing and spreadsheets. E-mail.
  – 1990s. T-1 lines, in-house software. The web, search engines, e-commerce
  – 2000-05 flat screens, revolution in business practices was over

• Transformation in retailing completed by 2005
  – 1980s and 1990s Wal-Mart led big box revolution with innovations in supply chain and inventory management
  – Check-out revolution: bar-code scanners, credit/debit card authorization technology
More Achievements Completed by 2005

• Finance and Banking
  – 1970s and 1980s, ATM machines
  – 1980s and 1990s. Transition from multi-million share trading days to multi-billion share days

• How Long Ago Were the Creations:
Summary: Stasis Everywhere You Look

• Offices use desktop computers and proprietary information as they did 10-15 years ago
  — The Northwestern econ department staff, 1998 vs. 2015

• Retail stasis. Shelves stocked by humans, meat sliced at service counters, checkout bar-code scanning. Maybe card authorization a bit faster

• Medicine: electronic medical records largely rolled out, little or no change in what nurses and doctors do

• Higher Education: cost inflation comes from rising ratio of administrative staff to instructional staff
Stasis in Consumer Electronics

• NYT on Consumer Electronics Show, January 2014
• This show was a far cry from the shows of old . . . Over the years it has been the place to spot some real innovations (VCR 1970, CD 1981, HDTV 1998)
• This year’s crop of products seemed a bit underwhelming by comparison
• Editor of gadget website: “This industry that employs all of these engineers . . . Needs you to throw out your old stuff and buy new stuff – even if that new stuff is only slightly upgraded.”
Additional Evidence of Diminishing Returns

• Decline in Business “Dynamism”
  – Decline over last 30 years in creation of new firms
  – In recent years more exiting firms than entering firms

• Decline in labor market “Fluidity”
  – Decline in job and worker reallocation rates
Business “Dynamism” Represented by New Firm Entry

Figure 5. Rate of New Firm Entry and Old Firm Exit, 1978-2011
Stagnation Symptom #2: Declining Rate of Net Investment

Figure 7. Five-Year Moving Average of Ratio of Net Private Business Investment to Private Business Capital Stock, 1950-2013

1950-2007 Average
Stagnation Symptom #3: Growth in Manufacturing Capacity

Figure 8. Annualized Five-Year Change in Manufacturing Capacity, 1977-2014

Source: www.federalreserve.gov/datadownload/default.htm, G.17
Stagnation Symptom # 4: The Most Dynamic Part of Manufacturing Has Disappeared

Share of ICT Manufacturing Value-Added in Total Manufacturing Sector, 1972-2013

Share as a Percentage
#5 and #6: Computer Prices and the Demise of “Moore’s Law”

**Figure 9a. Rate of Change of Deflator for Information and Communications Technology Equipment, 1975-2014**

Source: NIPA Table 5.3.4

**Figure 9b. Years Taken for Number of Transistors on a Chip to Double**

Source: Intel Corporation website
Innovations Continue But How Important Are They?

• Medical and Pharmaceutical
  – Continuous slow but steady progress in advancing life expectancy (but US vs. Canada)
  – Coming collision between physical wellness and mental illness (Alzheimers)
  – Increasing costs of drug development, fewer important new drugs

• Small Robots and 3-D Printing
  – Robots date back to 1961, continued development is evolutionary not revolutionary
  – Amazon robots are not as smart as you might think
  – 3-D printing useful for development prototypes, not mass production
Innovations Continue But How Important Are They?

• Big Data and Artificial Intelligence
  – Predominant uses of big data are in marketing, zero-sum game
  – Application to legal searches, radiology reading evolutionary, not revolutionary
  – Next wave of replacement of humans: personal financial services (“Robo-advice”) and insurance agents

• Driverless Cars and Trucks
  – Truck drivers don’t just drive trucks, they unload them and stock the shelves
  – Wholesale trade isn’t just gee-whiz Amazon warehouses. Most of it involves delivering bread, coke, and beer
Slower Growth Goes Beyond Innovation

• The educational plateau -- Increase in educational attainment coming to an end
  – Goldin and Katz 0.35 percent contribution of education
  – Jorgenson -0.30 downward adjustment to education’s contribution, i.e., close to zero
• U.S. steady decline in league tables of high-school completion, four-year college completion
  – Poor preparation for college. International PISA test scores rank out of 34 OECD countries: US #17 in reading, 20th in science, 27th in math
• New issues of college affordability and $1.2 trillion of student debt
The Effect of Education and Capital Deepening

Figure 1-2: Average Annual Growth Rates of Output per Hour and Its Components, Selected Intervals, 1890-2014
Socioeconomic Changes with Adverse Future Implications

• Changes 1982 to 2008, children born out of wedlock
  – White high school grads 4 to 34 percent
  – White high school dropouts 21 to 42 percent
  – Black high school grads 48 to 74 percent
  – Black high school dropouts 76 to 96 percent

• Change 1960-2010, bottom 1/3 of white population
  – For 40-year-old women percent of children living with both biological parents declined from 95 to 34 percent
Socioeconomic Changes with Adverse Future Implications

• Future consequences of single-parent households
  – More children growing up in poverty
  – Greater likelihood of future high-school dropping out
  – Greater likelihood of criminal activity

• Additional adverse effects: 1979-2009 percent with prison records
  – White high school dropouts with prison records 4 to 28 percent
  – Blacks 15 to 68 percent
Trend in Labor Productivity Growth When Unemployment Rate is Fixed

Figure 10. Kalman Growth Trend of Output per Hour, 1953:Q1 to 2014:Q4
Potential Output Growth (at a Constant Unemployment Rate)

Figure 10. Kalman Growth Trends of Output, Hours, and Output per Hour, 1953:Q1 to 2014:Q4
# Productivity Growth in the Short Run: Implications for the Future

## Table 1
Annual Growth Rates, Selected Intervals, 2004-14

<table>
<thead>
<tr>
<th>Period</th>
<th>Real GDP</th>
<th>Aggregate Hours</th>
<th>Real GDP per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004:Q4 - 2009:Q4</td>
<td>0.83</td>
<td>-0.82</td>
<td>1.65</td>
</tr>
<tr>
<td>2009:Q4 - 2014:Q4</td>
<td>2.28</td>
<td>1.73</td>
<td>0.55</td>
</tr>
<tr>
<td>2004:Q4 - 2014:Q4</td>
<td>1.55</td>
<td>0.45</td>
<td>1.10</td>
</tr>
</tbody>
</table>

**Future Trend**

| Future Trend   | 1.50 | 0.40 | 1.10 |

**Memo: 1974-2004**

| Memo: 1974-2004 | 3.12 | 1.40 | 1.72 |
Figure 11. Actual GDP vs. Potential GDP, CBO vs. Alternative Measures, 2004:Q1 to 2024:Q4
Figure 12. Debt/GDP, Actual and Forecast, CBO and Alternative Projections, 2004:Q1 to 2024:Q4
Conclusions

• 70 percent of all TFP growth since 1890 occurred 1920-70

• The big impacts on TFP of IR #3 were largely completed by 2005
  – Innovation continues but is less important in its impact on labor productivity and TFP than in 1996-2004

• Educational plateau and socioeconomic decay subtract from future productivity growth

• Even if productivity growth returns to its 2004-14 average of 1.1, adding 0.4 points for hours yields potential output growth is only 1.5

• Implications of slow growth for fiscal solvency, debt-GDP ratio
Comparing Canada and the US: The Output Identity Again

• Total Output or GDP (Y).
• Total Hours of Work (H).
• Total Population (N).

Y&H refer to total economy

• The Productivity Identity

\[
\frac{Y}{N} \equiv \frac{Y}{H} \times \frac{H}{N}
\]
Ratios, PPP-Adjusted, Canada to US, Y/N, Y/H, and H/N, 1950-2013

Ratio of Canada to U.S., Hours per Person, Output per Person, and Output per Hour, 1950-2013

- Hours per Person
- Output per Person
- Output per Hour

Percent

Productivity Growth Rates, 5-YR MA, Canada and the US, 1955-2013

Five-Year Moving Average Growth Rate of Output per Hour, Canada and the U.S., 1955-2013
Canada and the EU-15 Output per Hour Relative to the U.S., 1950-2013

Ratio of Canada and EU15 to U.S., Output per Hour, 1950-2013
Output per Hour, Ratio of the EU-15 to Canada, 1950-2013
Ratios, Canada to US, Y/N, Y/H, and H/N

Ratio of Canada to U.S., Hours per Person, Output per Person, and Output per Hour, 1950-2013

Hours per Person
Output per Person
Output per Hour
Ratios Canada to U.S., Components of H/N, 1976-2013

Ratio of Canada to U.S., Hours per Employee, LFPR, and Employment Rate, 1976-2013

Percent

Hours per Employee

Employment Rate
Five Dimensions of Superiority of Canada to the U.S.

• A Labor Market That Has Escaped a Precipitous Decline in Labor-Force Participation
• Medical Care as a Right of Citizenship
• A University System without Exorbitant Tuition or Mountains of Student Debt
• An Immigration System Based on Skills
• A Well-Regulated and Stable Financial System