The Slowest Potential Output Growth in U. S. History: Measurement and Interpretation

Robert J. Gordon, Northwestern University and NBER

For Presentation at CSIP Symposium on “The Outlook for Future Productivity Growth,”
Federal Reserve Bank of San Francisco
November 14, 2008
In the midst of a world economic crisis, it is a luxury for us to think about long-run economic growth issues in the US.

This paper addresses the need to forecast future productivity and potential GDP growth in logical steps.

How have trends changed over recent years and decades? That requires that we estimate trends in a formal way.

Everyone in the audience must have a copy of the paper, since I’ll refer to equations and tables.
The Industry of Decomposing Productivity Trends and Cycles

- Where is it?
- If I’m missing references, please let me know and I’d be delighted to include them. To separate trend from cycle is to revisit Okun’s Law.
- To forecast, one must know recent and current trends in each of the components of the Okun’s law decomposition.
- To estimate trends, one must use statistical detrending methods.
- To relate future potential GDP growth to future productivity growth, one must have forecasts of the links between productivity and output.

**THE OUTPUT IDENTITY**

\[ Y = \frac{Y}{H} \times \frac{H}{E} \times \frac{E}{L} \times \frac{L}{N} \times N \]
Let’s separate trend from cycle in output and productivity in order to make sensible forecasts.

I’ve been writing about this for years (1979, 1993, 2003), and preliminary presentations of the 2008 version were given as keynote speeches in Hangzhou China (9/19/08) and Budapest (Halloween 2008). This set of results has been de-bugged.

The pre-Broadway tryouts are over; this is opening night in front of the true experts on this topic.
It’s the slowest right now and will possibly be even slower over the next 20 years.

Yes, this symposium is about productivity growth, but I am here to convince you that potential GDP growth is important in its own right.

Potential Output is of Interest Separately from Productivity because it matters for:
- LR government budget & Social Security exhaustion date
- World balance of saving and investment
- US as an economic engine for the world
- LR US demand for investment, residential housing, infrastructure
The Slowest Potential Output Growth in U. S. History

- Potential Output = Trend Output = $Y^*$
- Until recently it was common for forecasters to project $Y^*$ growth at 3 to 3.5 percent, some even projected 4 percent (including my ex-student, JP Morgan’s J. Glassman)
- Yet the facts provide an unhappy reality
  - 1997-2008 actual $Y$ growth only 2.75
  - Trend growth currently 2.5
What is Causing Slow $Y^*$ Growth

- It was commonly assumed that US $Y^*$ growth would slow due to less population growth.
- But so far, population growth has not declined.
- Instead, the culprits are slower growth in productivity, hours/employee, and LFPR.
- Much of this paper develops methods and implements them to separate cyclical movements from underlying trends.
Three Goals of the Lecture for the U. S.

- **#1:** Project US $Y^*$ 2008-2028 and the components of the **OUTPUT IDENTITY**
- **#2:** New interpretation of recent behavior of these components
- **#3:** Develop techniques for separating trends from cycles and analyzing the cyclical behavior of the components

The paper does this in reverse order: detrending first, then interpretation, then forecasts.
General Issues Raised by Projections for the U. S.

- The need to make future projections of $Y^*$ raises a general issue: how much of the past is relevant?
  - We project future population assuming that baby boom of 1947-64 will not happen again.
  - We assume Great Depression and WWII will never happen again.
  - But what is the right time horizon to look backward at productivity growth?
  - US: fast 1947-72, slow 72-95, fast 95-2004, slow 2004-08. What happens next??
Preliminaries: Total Economy not NFPB

- Look at equations starting on p. 9
- The output identity is a simple decomposition for the total economy
- But to link potential GDP to NFPB productivity involves extra terms that have no easy interpretation
- This paper (2008) differs from my previous paper using the same techniques (2003)
Topical Issues Addressed with this methodology

- Separate all components of “output identity” into trend, cycle, and residual
- Were “jobless recoveries” of 1991-92 and 2001-03 unusual?
- Was fast productivity growth 2001-03 just a repeat of 1991-92?
- How is the productivity growth slowdown of 2004-08 to be interpreted?
To begin: History of U.S. Growth in $Y^*$ since 1875

- Can’t Use Statistical Trends like H-P
  - Distortion in Great Depression and WWII
  - Standard HP quarterly parameter of 1600 implies that $Y^*$ growth declines from +3% in 1929 to \textit{minus 7\% per year} in 1933


- Post-1954 trends taken from research reported later

- See Table 1 and Figure 1
Trend Real GDP Growth between Benchmark Years and Quarters, 1875-2008
Questions about This History

- The most dramatic episodes are slow growth 1913-28 and fast growth 1928-50
  - Contradicts real business cycle theory about Great Depression
  - Raises puzzle about 1913-28, a dynamic period when electricity was applied in manufacturing often cited by Abramowitz, David, and Wright

- Otherwise stable growth 1975-1913 and 1950-72, then continuous slowing down
Using the “Output Identity” to Link Income per Capita to Productivity

- *(1)* \[ Y = \frac{Y}{H} \times \frac{H}{E} \times \frac{E}{L} \times \frac{L}{N} \times N \]
- Four of five of these exhibit procyclical behavior (not population 16+)
- BUT concept of productivity usually discussed in U.S. is for NFPB sector
- This equation works as long as our data are for *total economy productivity* and *total economy hours per employee*. 
The Output Identity
Allows us to . . .

- Estimate trends in any of the variables, call $x$ the log of a variable and $x^*$ its trend
- $\Delta x$ is the growth rate of the actual value and $\Delta x^*$ is the growth rate of the trend
- $\Delta(x-x^*)$ is the growth rate of the ratio of actual to trend for any variable, e.g., the log growth rate of the “GDP gap”
- We estimate regressions with $\Delta(x-x^*)$ as the dependent variable for four components of the output identity (excluding population)
Simplest Method to Measure Trends: TTB Method

- TTB is log-linear Trends through Benchmark quarters
- These Benchmark Quarters are those when unemployment roughly equal to the natural rate (actual U going down, not up)
- Turn to Table 2, shows 7 periods
- The output identity introduces the question – why doesn’t growth in $Y/N$ equal historical growth in $Y/H$ in every year or historical interval?
Some of What We Learn from Table 2

- Real GDP growth slowed down as in Table 1 and the chart
- The five components must add up to real GDP growth by definition
- Productivity growth soared after 1995 but real GDP continued to slow down
- Hours per employee were strongly negative in 2 periods, moderately negative in 2 periods, near zero otherwise
- Employment rate barely moves, by assumption in choosing benchmark quarters
More About Table 2

- LFPR rose strongly 1964-87, not since then (this raises growth in \( Y/N \) relative to \( Y/H \) before 1987 and reduces it since 1987)
- Note negative correlation between trend growth in hours per employee and LFPR
- Working-age Population growth peaked before 1977 but held up relatively well 1997-2007
Table 3: How is Y/N Related to Y/H for Total Economy?

- Turn to Table 3
- Now compare annual growth rates in Y/N and Y/H for the same time intervals
- By definition any discrepancies must be equal to three labor market variables taken together
- Labor-market variables explain changing relationship between growth in Y/N and Y/H
- Important Issue – is Y/H growth negatively correlated with net contribution of labor market variables?
- Next slide presents the numbers of Table 3
Table 3 in Color: How \( Y/N \)
Grows Differently than \( Y/H \)

<table>
<thead>
<tr>
<th>Benchmark Period</th>
<th>Percent per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954:1-1964:3</td>
<td>2.30</td>
</tr>
<tr>
<td>1964:3-1972:1</td>
<td>1.91</td>
</tr>
<tr>
<td>1972:1-1977:3</td>
<td>1.41</td>
</tr>
<tr>
<td>1977:3-1987:3</td>
<td>1.58</td>
</tr>
<tr>
<td>1987:3-1997:2</td>
<td>1.87</td>
</tr>
<tr>
<td>1997:2-2007:2</td>
<td>1.58</td>
</tr>
<tr>
<td>2007:2-2008:2</td>
<td>1.21</td>
</tr>
</tbody>
</table>

Real GDP per capita

Labor Market Variables
Output Per Hour
Next we turn to results of statistical trends

- Hodrick-Prescott filter
  - Bends too much at standard parameter of 1600
  - Even a parameter of 6400 bends too much, esp in 1978-83

- Kalman filter
  - Allows feedback from other variables, we allow feedback from GDP $\Delta(y-y^*)$
Productivity Trends: TTB vs. Kalman (TE not NFPB)
Next Charts Show Components of Output Identity

- Each chart plots the Kalman trend against the 8-quarter change in the actual value.
- Also shown in the paper (in the bottom frame of Figures 4-7 and 9) are the ratios of the level of actual to trend.
Kalman Trend vs. Actual 8-Quarter Changes for TE $Y/H$
Trend TE Hours/Employee: benefit starvation => PT work?

- Actual
- Kalman

Year

Percent per Year
-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5
The Trend Employment Rate (E/N): Nothing Happens by Assumption (Based on NAIRU)
Trend for LFPR: The Women Entered but now transition to retirement
Population Growth: No Business Cycles but it Matters in Future Forecasts
Adding Components for Real GDP (Figure 9)
Conclusion About Real GDP Trend

- Slowdown from 4.4 in early 1960s to 2.6 now
- Viewed over decades, productivity growth is negatively correlated with labor force growth
- Hours per Employee growth also negatively correlated with LFPR growth
- Population Growth Decline has barely started, but immigration makes any forecast murky
How do Components React to Changes in Output Gap? (revisiting Okun’s Law)

- First method in Table 4, look at cyclical deviations in quarters that have peak and trough deviations for Q
- Regressions are preferable: Specification written as equation (7) on p. 28
\[ \Delta x'_t = \sum_{i=1}^7 \alpha_i \Delta x'_{t-1} + \sum_{j=1}^4 \beta_j \Delta y'_{t-1} + \phi x'_{t-1} + \sum_{k=1}^4 \gamma_k D_k + \epsilon_t \]

**Specification of Regressions**

- Dependent variables in Table 5 are first differences of ratios of actual to trend
- \( \Delta x'_t = \Delta(x_t - x^*_t) \)
- In order from left to right
  - \( H/E, E/L, L/N, \) Aggregate \( H, Y/H \)
- Specification in equation (7) on p. 28:
  \[ \Delta x'_t = \sum_{i=1}^7 \alpha_i \Delta x'_{t-1} + \sum_{j=1}^4 \beta_j \Delta y'_{t-1} + \phi x'_{t-1} + \sum_{k=1}^4 \gamma_k D_k + \epsilon_t \]
Motivation of End-of-Expansion Effect

- Firms consistently overhire in last stage of business expansion
- Defined as interval between peak of growth cycle and NBER peak
- Makes productivity growth low at EOE and relatively fast during recession and early recovery
- Dummy variables $1/M$ and $-1/N$, sum to zero
- Developed in Gordon (1979)
Aspects of Regression

Results in Table 5

- Shown are sums of coefficients
- ** indicates significance at 1 percent, * indicates significance at 5 percent
- Note significance of EOE dummy variables in most but not all periods
- Bottom of table shows EOE coefficients when they are all forced to be equal
- Summary of Responses from Tables 4 and 5 on the next slide
The 2008 Version of Okun’s Law

From Table 4

Long-run Response from Table 5

- Population
- LFPR
- Employment Rate
- Hours per Employee
- Output per Hour
“Early Recovery Productivity Bubble”

- Table 7
  - Top panel shows change in productivity relative to trend in first four quarters of recovery
  - Bottom panel the next eight quarters (i.e., quarters 5 through 12)

- On average 1.59 points vs. -0.11 points

- Largely explained by the productivity equation, relying on response to output change and to EOE effect

- Unusual about 2001-04, growth stayed above trend in next eight quarters
Cumulative Equation Errors, 1985-2008

Productivity Equation with 2000-03 EOE effect

Hours equation with EOE effect

Productivity equation without 2000-03 EOE effect
Now the Explanations of Changes in Productivity Trend

- 1995-2000 productivity growth revival, consensus that it was driven by production and use of ICT equipment
- *Negative* contribution of ICT investment to productivity acceleration in 2001-2004
- 2001-2004 further increase in trend growth
  - Savage corporate cost cutting
  - Intangible capital hypothesis
Explaining the Two Hypotheses

- **Cost Cutting in 2001-03**
  - Employment declined until mid-2003 while output increased
  - Result: unusual upsurge of productivity
  - Profits had been propped up by accounting scandals, then collapsed
  - More of manager pay relied on stock options than 10 years earlier
  - Great pressure to revive profits and stock prices by cutting costs, leading to massive layoffs

- **Oliner-Sichel-Stiroh (2007 BPEA) support:** cross-industry positive correlation profit decline and employment decline
Complementary Intangible Capital Hypothesis

- Benefits of late 1990s ICT investment was delayed
- “Learning lag” in how to use ICT investment, development of software
- Many of benefits of 1995-2000 ICT investment occurred with a lag in 2001-03
- Explains how output could grow with employment declining
Why Productivity Trend Growth Slowdown 2004-07?

- Profits revived, reducing pressure for cost cutting. Employment grew again.
- ICT investment did not revive; returned to pre-1995 values as share of GDP.
Why Did Productivity Grow Faster than Trend 2007-08?

- Employment declined slowly and steadily January, 2008 until now
- Real GDP grew in first half 2008
- Strong productivity growth, but temporary
  - GDP growth in early 2008 represents shift to exports
  - Capital intensive, high productivity
  - Composition effect, exports of commodities use little labor
Back to Original Topic: Future Growth in Potential Output, see Table 9

- Key assumptions: population growth, productivity, hours per employee
- No assumed change in employment rate
- Future Growth Rates that we need to forecast:
  - TE Output per Hour
  - TE Hours per Employee
  - LFPR
  - WA Population
Thoughts about TE Productivity

- Ponder the actual growth rates
  - 1987:3 – 1997:2  1.31
  - 1997:2 – 2004:2  2.42
  - 2004:2 – 2008:2  1.34

- On which period should we base future forecasts?
Surely there are Reasons to Disregard 1972-87 but what about 1987-97??

- Economy torn apart 1972-87
  - Price controls and their termination
  - Food price shocks
  - Oil shocks
  - Productivity growth slowdown
  - Killer interest rates 1980-1982

- But 1987-97? Core of the Solow Computer-Productivity Paradox

- Why Couldn’t 1987-97 occur in 2008-18?
Inherent Problems in Extrapolating 1997-2004

- Savage cost-cutting was a one-time event
- Intangible capital is basically a delay hypothesis. There must be something to be delayed
Jorgenson Optimism according to *Time* magazine

- Still ample room for big productivity payoff for ICT investment in medical care, universities, government
- We’re all experts on universities
  - Low-hanging fruit has been plucked
    - Card catalogues => rows of computers
    - We’ve replaced secretaries by hordes of IT experts to help faculty and students
  
- Increase productivity? Raise student-faculty ratio
Tales of Medical Care

- My provider: Northshore University Healthcare System
- Fully computerized by 2003, won national prize for extent
- Paperless, prescriptions zapped to Walgreens, no paper referrals
- Yet let me tell you from 3 weeks in the hospital in May, 2008 . . .
Arbitrary Choice of Future Productivity Growth Rate

- Actual fact 1.7 1987-2008
- I choose 1.6, not as low as 1987-97 or 2004-08
- This translates to roughly 2.0 for NFPB productivity
- Note that the difference between NFPB and TE moves with NFPB
Projections of Hours, Employment, Population

- This round of forecasts lean on current BLS projections 2006-16 for pop & LF.
- Numerous debates about the SS Trustee projections are skipped over in this version, especially about immigration.
- Pop 0.9, LF -0.1, hours -0.05
- Table 9 puts it together
Conclusion: Should I tell my students a new story?

- Rule of 70
- U. S. Y/N 1929-2007 = 2.16 AAGR
- This means standard of living doubles every 32 years
- When my 20-year old students are 84, their Y/N will be quadruple today
- But will this happen in light of today’s forecast of Y/N growth of 1.45?