Where did the Productivity Growth Go?
Inflation Dynamics and the Distribution of Income

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Productivity Growth vs. Median Real Wages and Median Real Household Income

- Labor’s share of domestic income has been basically flat between 1997 and 2005. Implies CPH growth = LP growth

- But...
  - Real AHE growth has been zero for 5 years. Median wages grew at half the rate of productivity between 1995 and 2003
  - Median family income fell for five straight years between 2000 and 2004.
  - Big gap between the growth rates of real CPH and real ECI

- So who is getting the benefits of productivity growth?
  - The conflict between mean growth and median growth poses a basic question: is it a measurement issue or an income distribution issue?
First we look how productivity feeds into prices, wages, and profits

- Simple accounting identity proves that productivity growth benefits workers equally whether it cuts inflation or boosts nominal wage growth.
- An alternative outcome is that a productivity acceleration doesn’t affect prices or wages, just profits.
- We estimate price and wage Phillips curves, emphasizing productivity growth effects on both.

The puzzle of mean vs. median leads us to the key question: Who actually gets the wages and profits? This takes us to the IRS data.
A Simple Dynamic Model, see Part II pp. 9-14

- (Explain notation, levels vs. growth rates) Labor’s Share:
  \[ S = \frac{W}{P}/\Theta, \]
  \[ \theta = y - h, \]
  \[ s = w - p - \theta \]

- Wages and Prices:
  - This is not mean-reverting

\[ p_t = p_{t-1} - a(L)(\theta_t - \theta_{t-1}) + cs_{t-1} \]
\[ w_t = w_{t-1} + b(L)(\theta_t - \theta_{t-1}) - ds_{t-1} \]

\[ \Rightarrow s_t = (1-c-d)s_{t-1} + (a+b)(L)(\theta_t - \theta_{t-1}) - (\theta_t - \theta_{t-1}) \]
  -- s will find an equilibrium if -1<1-c-d<1

- Wage reactions and price reactions to productivity imply mirror reactions in s
The Enormous Discrepancy Between Productivity Growth and Real Wage Growth

The basic puzzle: as of July 2005, NFPB productivity growth 2001:Q1-2005:Q1 was 3.89 and real AHE only grew at 0.49. How can we explain this enormous gap? Was there a massive shrinkage of labor’s share?

Explanation #1: data revisions. 2001-05 productivity growth was reduced from 3.89% to 3.44%

Explanation #2: trend vs. actual. The H-P trend (6400 parameter) barely reached 3.0 percent when the actual 2001-2005 was 3.44%. See Figure 1.

Explanation #3: Full economy productivity 0.5% slower than NFPB. Why? Look at Table 1 and Figure 1.
Productivity Growth in the Total and NFPB Economy, 1950-2005
Continuing the Resolution of the 3.89 vs. 0.49 Percent Requires the Micro Data Analysis

- Why have medians grown so much slower than means?
- Not just income and wealth are concentrated, but income growth
- 80-90% of the wage distribution does not experience growth near that implied by productivity
Labor’s Share (Compensation divided by Domestic Income)
Some Things to Think About

- Apparent regime change around 1966
  - No good explanation so far
  - Our macro data analysis helps by linking labor’s share increase in late 1960s to the productivity growth slowdown

- Share is similar now to 1996. Smoothly varied in small range for past 30 years

- So what’s all the fuss about? It’s not that capital is gaining relative to labor, it’s *who* is getting labor’s share
The Inconsistent Wage Indexes, see Table 2

- CPH, ECI, and AHE all tell different stories
  - AHE only covers production/non-supervisory
- ECI is smoother than CPH, but not linked to NIPA data
- 1979-2005 average growth rates from Table 2: prody 2.05, CPH 1.32, ECI 1.02, AHE 0.34
- Abraham et al. (1999) argue that most of the AHE-CPH gap is due to AHE’s sample
  - Production workers not only make less, but have less growth
The Natural Rate Phillips Curve

- Natural rate hypothesis merged with supply shocks back at BPEA in the 1970s

\[ p_t = a(L)p_{t-1} + b(L)D_t + c(L)z_t + e_t \]

- \( D \) is demand (unemployment), \( z \) is supply shocks, \( e \) i.i.d error
- Restrict sum of LDV to unity, \( D^N_t \) is natural rate – implies constant inflation
- \( Z_t \) variables defined relative to zero

- Supply shocks are food-energy, imports, medical care, 2 year change in productivity trend, Nixon dummies (what’s new in this paper?)
Productivity Acceleration
(bottom frame Figure 5)
Allowing the NAIRU to Vary

- The Kalman smoother:

\[ p_t = a(L)p_{t-1} + b(L)(U_t - U^N_t) + c(L)z_t + e_t \]

- \[ U^N_t = U^N_{t-1} + \nu_t, \ E(\nu_t)=0, \ \text{var}(\nu_t)=\sigma^2 \]

- 2005:Q2, our natural rate is 5.3% – current unemployment is 4.9%

- Let’s look at how today’s estimate of the TV-NAIRU compares to “Goldilocks” seven years ago . . .
Today’s TV-NAIRU vs. Goldilocks version in 1998 (Figure 7)
Inflation Equation Results, see Table 3

- Naïve Phillips curve (col 1) is soundly rejected
- Past Goldilocks version (col 2) is improved
- Preferred version is in column 5
- Productivity enters with -1.3 sum of coefficients
- Equation is completely stable
  - We allow each coefficient to change and entire equation to shift at 1983:Q4
  - No slope change except for FAE
- Simulation mean error is 0.1
- **1995-2000:** Productivity growth revival lowers inflation by 0.5%
Post-Sample Dynamic Simulations
(this is Figure 6)
Wage Equations, see Table 4

- We use trend unit labor costs – change in CPH minus trend productivity growth is the dependent variable
  - Both CPH and LP are noisy. This paper always replaces actual productivity with trend
- Much more noise than inflation equation – $R^2$ drops from 0.94 to 0.57
- Simulations are ugly – mean error near 3
- Productivity acceleration significant and negative
Implied Equation for Labor’s Share, see Table 5

- Difference between TULC and inflation is change in labor’s share
- Lagged tls coefficients sum to -0.87 – equation is stable
- Sum of productivity terms from wage and price equations is negative
- Negative correlation with business cycle, see
  - The old countercyclical wage argument
## Counterfactual Simulations (Table 6)

Table 6

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean Change in Percent</td>
<td>Final Quarter 4-Quarter Change</td>
</tr>
<tr>
<td>A. <strong>NFPB Deflator</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Actual</td>
<td>5.34</td>
<td>9.39</td>
</tr>
<tr>
<td>2. Factual Simulation</td>
<td>5.52</td>
<td>9.41</td>
</tr>
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<td>3. Counterfactual Simulation</td>
<td>4.24</td>
<td>6.73</td>
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<tr>
<td>4. Factual Simulation Error (1-2)</td>
<td>-0.18</td>
<td>-0.02</td>
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<tr>
<td>5. Effect of Productivity Change (2-3)</td>
<td>1.28</td>
<td>2.68</td>
</tr>
<tr>
<td>B. <strong>Trend Unit Labor Cost</strong></td>
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<td></td>
</tr>
<tr>
<td>1. Actual</td>
<td>5.47</td>
<td>8.65</td>
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<tr>
<td>2. Factual Simulation</td>
<td>5.49</td>
<td>9.07</td>
</tr>
<tr>
<td>3. Counterfactual Simulation</td>
<td>4.03</td>
<td>6.06</td>
</tr>
<tr>
<td>4. Factual Simulation Error (1-2)</td>
<td>-0.02</td>
<td>-0.42</td>
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<tr>
<td>5. Effect of Productivity Change (2-3)</td>
<td>1.46</td>
<td>3.01</td>
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<tr>
<td>C. <strong>Change in Trend Labor Share</strong></td>
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<td></td>
</tr>
<tr>
<td>1. Actual</td>
<td>0.13</td>
<td>-0.74</td>
</tr>
<tr>
<td>2. Factual Simulation</td>
<td>-0.03</td>
<td>-0.34</td>
</tr>
<tr>
<td>3. Counterfactual Simulation</td>
<td>-0.21</td>
<td>-0.67</td>
</tr>
<tr>
<td>4. Factual Simulation Error (1-2)</td>
<td>0.16</td>
<td>-0.40</td>
</tr>
<tr>
<td>5. Effect of Productivity Change (2-3)</td>
<td>0.18</td>
<td>0.33</td>
</tr>
</tbody>
</table>
The Micro Side: Inequality and the Income Distribution

- To whom do the benefits of productivity growth accrue?
- Our contribution is a measurement of income inequality with a direct comparison to productivity growth
- Thus we focus on which percentiles of the income distribution received real income gains
- We started noting that medians grew much slower than averages. Here we uncover the nuts and bolts of why this happened
Sources of Income Inequality: IRS Microfile Data

- Cross-sectional data for 1966-2001
  - Heavily oversamples rich
  - Allows analysis of top .1% or .01%
  - 100-200,000 returns per year

- This study is based on roughly 5 million data points, a few more than the typical time series inflation equation!

- The IRS micro data file provides every type of income on tax returns – wages & salaries, rent, interest, dividends, business income, pensions

- ~90-95% of tax units file each year
Advantages of IRS Data over CE/CPS Data Used by Others

- Other papers (except Saez) understate increase in inequality
- CE/CPS data are top-coded, e.g., $35,000+ in 1972-73 (Krueger-Perri)
- Recall bias may vary with income
- IRS data are linked to actual records, W-2s and 1099’s
- What do we add?
  - Eliminating negative nonlabor income
  - Adjusting IRS income for fringe benefits and changing hours
Income Shares by Quantile

- Divide distribution at 20, 50, 80, 90, 95, 99, 99.9th percentiles

- 1966-2001 trends:
  - Income transferred from bottom 90% to top 10%
  - Top 0.1% share nearly quadrupled
  - 50-80 falls from 37% to 30%
  - 80-90 and 90-95 roughly fixed
Income Shares by Quantile

0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0.0
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4


99.9-100
99-99.9
95-99
90-95
80-90
50-80
20-50
Shares of New W&S, 1997-2001

- 99.9-100: 7.7%
- 99-99.9: 16.2%
- 95-99: 14.3%
- 90-95: 11.0%
- 80-90: 14.8%
- 50-80: 23.4%
- 20-50: 10.8%
- 0-20: 1.9%
- 99.9-100: 6.2%
- 95-99: 4.8%
- 80-90: 2.3%
- 50-80: 2.1%
- 20-50: 0.8%
- 0-20: 0.9%
What About Productivity?

- Adjust W&S upwards as wages take smaller share of compensation (~0.4%)
  - No assumption about level of W&S/Comp, just that change is same for everyone

- Add +0.22% for change in hours per tax unit
  - Assume changes in hours affect all equally

- Full economy productivity averaged 1.54%, compensation/GDP rose from 56% to 59%. Compensation should follow productivity
Almost Nobody Keeps Up

- The headline result: only the top 10% have experienced adjusted real income gains equal to or faster than productivity growth

- 90\textsuperscript{th} percentile grows at 1.77\%, 95\textsuperscript{th} at 2.06\%
- Everybody else slower than 1.54\%
- Productivity growth has not raised median wages – adjusted growth of median is only 0.9\%
- Could people be moving up across percentiles enough to account for this?
## Adjusted Growth Rates

### Adjusted Percentiles

<table>
<thead>
<tr>
<th>Year</th>
<th>20</th>
<th>50</th>
<th>80</th>
<th>90</th>
<th>95</th>
<th>99</th>
<th>99.9</th>
<th>Percent Wage Share of Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>8,554</td>
<td>27,059</td>
<td>49,960</td>
<td>63,817</td>
<td>77,094</td>
<td>120,862</td>
<td>270,320</td>
<td>88.1</td>
</tr>
<tr>
<td>1979</td>
<td>8,916</td>
<td>26,402</td>
<td>53,717</td>
<td>69,531</td>
<td>84,790</td>
<td>137,918</td>
<td>342,009</td>
<td>83.7</td>
</tr>
<tr>
<td>1987</td>
<td>8,353</td>
<td>26,562</td>
<td>57,064</td>
<td>76,457</td>
<td>96,591</td>
<td>169,973</td>
<td>517,644</td>
<td>82.6</td>
</tr>
<tr>
<td>1997</td>
<td>8,496</td>
<td>26,436</td>
<td>58,549</td>
<td>82,285</td>
<td>108,012</td>
<td>215,039</td>
<td>692,955</td>
<td>83.1</td>
</tr>
<tr>
<td>2001</td>
<td>9,335</td>
<td>28,559</td>
<td>63,715</td>
<td>90,473</td>
<td>120,630</td>
<td>239,982</td>
<td>806,157</td>
<td>83.2</td>
</tr>
</tbody>
</table>

### Percent Change

- 28.9
- 20.7
- 51.2
- 71.7
- 90.4
- 140.3
- 265.4

### Average Annual Growth Rate

- 0.73
- 0.54
- 1.18
- 1.55
- 1.84
- 2.50
- 3.70

### Hours Adjusted Growth

- 0.95
- 0.76
- 1.40
- 1.77
- 2.06
- 2.72
- 3.92

### Gap Between Productivity and Hours-Adjusted Growth

<table>
<thead>
<tr>
<th>Years</th>
<th>20</th>
<th>50</th>
<th>80</th>
<th>90</th>
<th>95</th>
<th>99</th>
<th>99.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>'66-'72</td>
<td>1.89</td>
<td>1.35</td>
<td>1.96</td>
<td>2.31</td>
<td>2.38</td>
<td>2.29</td>
<td>2.50</td>
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<tr>
<td>'72-'79</td>
<td>-0.37</td>
<td>-1.32</td>
<td>0.07</td>
<td>0.26</td>
<td>0.39</td>
<td>0.92</td>
<td>2.39</td>
</tr>
<tr>
<td>'79-'87</td>
<td>-2.45</td>
<td>-1.56</td>
<td>-0.88</td>
<td>-0.45</td>
<td>0.00</td>
<td>0.98</td>
<td>3.55</td>
</tr>
<tr>
<td>'87-'97</td>
<td>-1.39</td>
<td>-1.61</td>
<td>-1.30</td>
<td>-0.83</td>
<td>-0.44</td>
<td>0.79</td>
<td>1.36</td>
</tr>
<tr>
<td>'97-'01</td>
<td>0.75</td>
<td>0.33</td>
<td>0.51</td>
<td>0.77</td>
<td>1.16</td>
<td>1.14</td>
<td>2.18</td>
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<tr>
<td>Average</td>
<td>-0.62</td>
<td>-0.81</td>
<td>-0.17</td>
<td>0.20</td>
<td>0.49</td>
<td>1.15</td>
<td>2.35</td>
</tr>
</tbody>
</table>

### Gap Between Productivity and Hours-Adjusted Growth (Average)

- -0.62
- -0.81
- -0.17
- 0.20
- 0.49
- 1.15
- 2.35
Labor vs. Nonlabor vs. Total Income

Figure 12. Share of Top 10 Percent in Increase of Real Income, $2000, Selected Intervals, 1966-2001

<table>
<thead>
<tr>
<th>Period</th>
<th>Labor Income</th>
<th>Nonlabor Income</th>
<th>Total Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-79</td>
<td>30</td>
<td>25</td>
<td>55</td>
</tr>
<tr>
<td>1979-97</td>
<td>50</td>
<td>60</td>
<td>110</td>
</tr>
<tr>
<td>1997-2001</td>
<td>40</td>
<td>70</td>
<td>110</td>
</tr>
<tr>
<td>1966-2001</td>
<td>40</td>
<td>65</td>
<td>105</td>
</tr>
</tbody>
</table>
Income Mobility: IRS Panel Data, 1979-1990

- Random sample, 8,000-40,000 matches
- Enormous variation in growth rates, standard deviation 150 for adjacent years
  - Too few observations/too much variance to examine top quantiles
- Expect higher median growth than cross-sections show
- Adjusted median growth only 0.34%, vs. growth of -0.38% in cross section
  - Inner quartile range: -2.2% to 20.5%
  - Productivity growth of 1.26%
First extension: Income Mobility

- The Basement and Penthouse
- While inequality was increasing, there was no change in mobility (SOWA summarizes 2002 study by Bradbury-Katz)
  - About 50% in penthouse are still there one decade later
  - About 3% make it from basement to penthouse in one decade and vice versa

Bottom Line: Increased inequality has not been offset by increased mobility
Second Extension: Consumption Inequality

- Median income growth is slow, but we clearly consume far more now than 35 years ago.
- Upward bias in CPI and hence PCE.
- However, measures of consumption inequality (see Krueger-Perri 2002) do not include consumer durables, housing, health, and education, hence they understate the increase in consumption inequality.
- Debate in literature: Attanasio et al find increase in consumption inequality in 1990s, overturn Krueger-Perri findings.
Third Extension: Sources of Increased Income Inequality

- The top and the bottom are pulling apart
- At the bottom:
  - Reduced fraction of unionization
  - Immigration
  - Free trade, imports
  - Lower real minimum wage (not in paper)
- What about the top 1 percent?
The leading hypothesis in the Economics Literature is Skill-Biased Technical Change (SBTC)

- Why is this plausible theory wrong?
  - Fully half (49%) of income gains in the occupational group “managers”
  - Almost none in occupational groups related to computers
- Our conclusion supported by Card-DiNardo (JOLE 2002), published out of our discussant’s office
  - “The evidence linking rising wage inequality to SBTC is surprisingly weak”
Further Doubts on SBTC

- Why hasn’t Europe experienced the same increase in inequality?
- Inequality increased fastest between 1977 and 1992, exactly when productivity growth was slow.
- Analysis shows income moved to top 5% of distribution, smaller group than SBTC implies.
- CEO compensation rose 100% between 1989 and 1997, whereas math and computer sciences occupations rose only 4.8%.
The University of Chicago
Has the Answer

- Sherwin Rosen on the “Economics of Superstars”
- Entertainment and sports stars, technical change in a different form, increasing the audience (cable TV for sports, worldwide distribution for movies)
- Superstars include top-paid lawyers, doctors, even economists who refuse to leave Harvard when offered megabucks to go to Columbia
Conclusions and Further Research

- A Productivity acceleration reduces inflation and unit labor costs
  - Ambiguous effect on labor’s share, more precise research needed
  - Productivity slowdown of 1965-79 added to inflation acceleration of 1970s (along with FAE, imports, unwinding of Nixon controls)

- Not just income and wealth are concentrated, but real income *growth*

- Not just true of capital income, also of wage and salary income

- 80-90% of the wage distribution does not experience growth near that implied by productivity growth