How to Project Long Run Growth and Inequality

• This talk:
  – Projecting long run growth
  – Projecting changes in income/wealth distribution
  – What are the linkages?
  – Focus on a particular linkage: accumulation of capital
Long Run Growth

• Standard Framework: Aggregate Production Function

\[ Y = AK^\alpha (hL)^{1-\alpha} \]
Growth Rates

$\left( \frac{\hat{Y}}{\hat{N}} \right) = \frac{\hat{L}}{\hat{N}} + \frac{1}{1-\alpha} \hat{A} + \frac{\alpha}{1-\alpha} \left( \frac{\hat{K}}{\hat{Y}} \right) + \hat{h}$
Growth Rates

\[
\left( \frac{\hat{Y}}{\hat{N}} \right) = \frac{\hat{L}}{\hat{N}} + \frac{1}{1-\alpha} \hat{A} + \frac{\alpha}{1-\alpha} \left( \frac{\hat{K}}{\hat{Y}} \right) + \hat{h}
\]

Demographic Drag

OECD Average 2015-2035 = -.4% per year
Growth Rates

\[
\left( \frac{\hat{Y}}{\hat{N}} \right) = \frac{\hat{L}}{\hat{N}} + \frac{1}{1-\alpha} \hat{A} + \frac{\alpha}{1-\alpha} \left( \frac{\hat{K}}{\hat{Y}} \right) + \hat{h}
\]

Human Capital Deepening

Example: France (1990-2010), average years of schooling of working age adults rose from 8.1 to 11.5

Implies \( \hat{h} = 1.19\% \) (Weil, 2014)

Not too hard to forecast
Growth Rates

\[
\left( \frac{\hat{Y}}{\hat{N}} \right) = \frac{\hat{L}}{\hat{N}} + \frac{1}{1-\alpha} \hat{A} + \frac{\alpha}{1-\alpha} \left( \frac{\hat{K}}{\hat{Y}} \right) + \hat{h}
\]

Productivity Growth (Solow Residual)
Growth Rates

\[
\left( \frac{\hat{Y}}{N} \right) = \frac{\hat{L}}{\hat{N}} + \frac{1}{1-\alpha} \hat{A} + \frac{\alpha}{1-\alpha} \left( \frac{\hat{K}}{Y} \right) + \hat{h}
\]

Productivity Growth (Solow Residual)

Technological Progress
Robert Gordon, GPTs, R&D, etc.

Institutional Change
Tax rates, labor market Institutions, regulation, etc.

Other
Resource shortages, Environmental degradation
Growth Rates

\[
\left(\frac{\hat{Y}}{\hat{N}}\right) = \frac{\hat{L}}{\hat{N}} + \frac{1}{1-\alpha} \hat{A} + \frac{\alpha}{1-\alpha} \left(\frac{\hat{K}}{\hat{Y}}\right) + \hat{h}
\]

Physical Capital Deepening

Saving rates
International Capital Flows

⇒ Thomas Piketty!
A Structure for Thinking About Inequality
Drivers of Changing Inequality

• Grouping of individuals into households
  – Assortative mating
  – Single parenthood
  – Differential fertility

• Distribution of characteristics across individuals/households
  – Distribution of education
  – Distribution of wealth

• Returns to individual characteristics / factors
  – Skill biased technological progress
  – Span of Control / Winner take all
  – Functional distribution of income

• Government policy
  – Progressivity of taxes / transfers / public services
  – Taxation of capital vs. labor
  – Labor market policies (unions, minimum wage, etc.)
Links Between Drivers of Average Income and Inequality

- Technology
- Human Capital Policy
- Labor Market Policy / Worker Protection
- Capital Accumulation
Links Between Drivers of Average Income and Inequality

• Technology
  – We don’t know if the trend rate of productivity growth is will speed up or slow down
    • Gordon: low hanging fruit
    • Rising R&D labor force due to China, India
  – We don’t know if the skill bias trend will continue
    • Self driving cars vs. MOOCs

• Human Capital Policy
• Labor Market Policy / Worker Protection
• Capital Accumulation
Links Between Drivers of Average Income and Inequality

• Technology

• Human Capital Policy
  – Investing more in human capital is everyone’s favorite pro-growth, anti-inequality policy
  – But: Costly; also, not everyone can be a robot designer
  – Irrelevant to the 1% issue

• Labor Market Policy / Worker Protection

• Capital Accumulation
Links Between Drivers of Average Income and Inequality

- Technology
- Human Capital Policy
- Labor Market Policy / Worker Protection
  - Standard view is equity-efficiency tradeoff
  - Maybe there is an aggregate demand channel that goes the other way, i.e. more equality leads to better growth
    - But aggregate demand is not supposed to be relevant for long run growth
- Capital Accumulation
Links Between Drivers of Average Income and Inequality

• Technology
• Human Capital Policy
• Labor Market Policy / Worker Protection
• Capital Accumulation
  – Rising $K/Y$ is good for aggregate growth
  – Piketty tells us that the driving force of rising $K/Y$ is rising wealth inequality
  – Wealthy have low MPC out of wealth
Cornerstone of the Piketty Architecture:

• “Capital” and “Wealth” are sufficiently similar that they can be thought of as a single entity

• This entity is well measured by the market value of wealth:
  – “the total market value of everything owned by the residents and government of a given country at a given point in time, provided that it can be traded on some market.”
Capital vs. Wealth

• When they are the same thing:
  – Closed economy
  – No other stores of value
  – Price of capital fixed at 1

• To the extent that they differ:
  – Capital = stuff that is used in producing output
  – Wealth = claims convertible into consumption now or in the future
“Market Wealth”

• Includes:
  – standard capital: structures, equipment, and infrastructure
  – land (both land underlying residential real estate as well as farmland); mineral deposits
  – precious objects such as gold and paintings
  – the value of intellectual property, brand recognition, and market power that are captured in market valuations of corporate equity.

• Everything at current market valuation

• Measurement of Market Wealth (both aggregate and distribution) is central component of Piketty’s book.
Questions Raised by Piketty’s Book

- Is Market Wealth a good measure of capital?
- Is Market Wealth a good measure of wealth?

- Underlying calculations are in Weil (2014)
Market Wealth as a Measure of Capital
Advantages of Piketty Approach Relative to Perpetual Inventory

• Captures value-creating expenditures that are not measured as investment in NIPA.
• Don’t have to assume that all investment is equally productive (“CUDIE is not Capital”)
  – But this danger was most severe in the case of government investment, where the Piketty solution does not apply
• Incorporates effects of shifts (technological change, price, etc.) or mistakes that affect productivity of capital
• Don’t have to mess around with different depreciation rates for different types of capital.
Disadvantages of this Approach

• Re-valuations of capital for non-productivity reasons look like changes in the quantity of productive capital.
• Ignores components of productive capital that are not market wealth.
Figure 3.2. Capital in France, 1700-2010

National capital is worth almost 7 years of national income in France in 1910 (including 1 invested abroad).

Sources and series: see piketty.pse.ens.fr/capital21c.
Development Accounting

• Production function:

\[ Y = AK^{\alpha} (hL)^{1-\alpha} \]

• Growth rates:

\[ \hat{y} = \frac{1}{1-\alpha} \hat{A} + \frac{\alpha}{1-\alpha} \left( \frac{\hat{K}}{\hat{Y}} \right) + \hat{h} \]
Development Accounting for France

- $K/Y$ rises from 3.68 to 6.05 from 1990 to 2010
- Annual growth rate: 2.5%
- Take $\alpha$ to be 0.25 (avg. share in nat’l income in this period).
- Result: capital deepening contributed 0.83% per year to growth
- Actual growth of output per working age adult was 1.1% per year
Housing

• Housing services / domestic product rose from 6.7% to 8.7% between 1990 and 2010
• Housing capital / national income rose from 1.78 to 3.71
• If this represented new capital, it was not very productive
The Non-Housing Sector

- $K/Y$ for the non-housing sector rose from 1.88 to 2.60 between 1990 and 2010
  - growth rate of 1.6 percent per year.
- Taking capital’s share in income (for this sector) as the same 0.25 used above, this implies that capital deepening contributed 0.53% to annual growth
- That’s almost half of growth in output per worker over this period
“Thank You, Rich People”

“It was precisely the inequality of the distribution of wealth which made possible those vast accumulations of fixed wealth and of capital improvements which distinguished that age from all others. The immense accumulations of fixed capital which, to the great benefit of mankind, were built up during the half century before the war, could never have come about in a society where wealth was divided equitably.”

— J.M. Keynes (1920)
“Thank You, Rich People”

• If Piketty believed in growth due to capital deepening
  – Would see the mindless accumulation of wealth by rich people as a double-edged sword, rather than just a bad thing
  – Would predict severe growth slowdown when capital deepening stops
  – Would propose an alternative means of capital accumulation if we tax wealth
Why Capital Deepening is Not a Source of Growth

• Something funky in the production function

or

• There is just not that much capital deepening
  – PWT (8.0), $K/Y$ in France rises from 3.26 in 1990 and 3.59 in 2010 (0.48% annual growth vs. 2.5% or 1.6% in Piketty data)
Is Capital Deepening due to Capital Gains?

• Private wealth / income rose from 3.11 to 5.52

\[ \text{Growth of } K/Y = \text{saving induced} + \text{capital growth} - \text{capital gains of income} \]

\[ 2.91\% = 2.80\% + 1.58\% - 1.47\% \]

• If there were no capital gains, \( K/Y \) would have risen by 30%, not 78%
Capital Revaluations

• One obvious contributor is decline in the safe real interest rates
• Also decline in perceived risk (inflation, Communism)
• Elimination of *de jure* and *de facto* controls on capital income, as well as threats thereof
• All of this increases the multiple of price relative to current earnings of a piece of capital
Aside: Rent Control

• Imposing rent control lowers market value of capital asset.
• Correspondingly creates steam of benefits to renters, but this is (mostly) not capitalized and traded – thus outside Piketty’s capital measure.
• Does not destroy capital in the short run.
Market Wealth as a Measure of Wealth
Market Wealth as a Measure of Wealth

• Things left out
  – Human capital
  – Transfer wealth

• These are important for both aggregate wealth and for the distribution of wealth
Human Capital as Wealth: Measurement from Investment Flows

- French educational expenditure as share of GDP in 2010 was 6.3%.
- Accounting for opportunity cost should roughly double that.
- Investment in Physical Capital was 21.4% of GDP
- Human Capital probably depreciates more slowly than Physical Capital
- So stock of Human Capital should be more than half as large as stock of Physical Capital
Human Capital as Wealth: Measurement from Asset Valuation

• Question: What is the value of the stock of Human Capital?
  • Answer: The PDV of future payments to existing human capital.

• Question: What are payments to human capital?
  • Answer: the wage bill less payments to raw labor.

• Question: What is raw labor?
Raw Labor in the Production Function

• Mankiw, Romer, and Weil

\[ Y = F(K, H, L) \]

MRW claim \( F(\cdot) \) is Cobb Douglas with \( L \) share of 1/3

• Mincer approach

\[ Y = F(K, hL) \quad h = \exp(\psi s) \]

“raw labor” earns a share \( 1/\exp(\psi s) \) of wages
What is Raw Labor?

Mankiw, Romer, and Weil

Mincer

Jorgenson and Fraumeni
Bottom Line from Models

• It is surely the case that investment in human capital, and its capitalized value, is much greater today than 100 or 300 years ago.

• Including value of human capital would lead to large rise in wealth/income over this period.
Somewhat Arbitrary Calculation

• Look at France for the period 1870-2010
• Average years of schooling for working age adults rose from 4.0 to 12.6
• Applying Mincer approach says that just over half of 2010 wages are payments to this additional Human Capital
• Wages are ¾ or national income, so post-1870 Human Capital earned 3/8 of national income
• Capitalizing this flow to current adults yields 4.7 times national income
Distribution of Human Capital Wealth

- Human Capital is less unequally distributed than market wealth, and the two are imperfectly correlated.

- Important mechanism:
  - Early years of education most valuable
  - Limit to amount of human capital investment in one person
  - Thus poorer individuals/families will put all investment in human capital; richer folks will hold bulk of wealth in non-human form
Distribution of Total Wealth

• Distribution of wealth inclusive of human capital will be less unequal than market wealth

• This effect should have lowered overall wealth inequality over the last 150 years
Transfer Wealth (Public)

• Transfer wealth: the survival-weighted discounted difference between expected transfers received and transfers to others.

• Public transfer wealth is the part of that relating to transfers from and to the government.
An Aside: Retirement

- Striking fact in Piketty is the constancy of the wealth/income ratio for 300 years
- One reason that this is striking is because of the invention of retirement and life cycle saving
- Prior to 1900, people worked pretty much until they died
- Now, they enjoy many years of consumption without working
Life Cycle Saving

• Funding retirement consumption should produce a large amount of $W/Y$

• Plain vanilla example
  – Work 20-65, live to 80; no uncertainty; 4% real interest, 1% real income growth, zero population growth; 60% replacement of terminal wage; flat income in retirement; constant saving rate in working years.

• Yields wealth/income ratio of 2.9
Life Cycle Saving – Continued

• One would think that the rise of LC saving would be inconsistent with constancy of $W/Y$.

• The explanation is that a lot of LC saving is in transfer wealth, not capital.
Rentiers vs. Pensioners

Rentiers
- Consume, don’t work
- Own claims to capital or land that pay rents
- Assets can be sold or borrowed against
- Control rights
- Housing wealth is partially a claim on future generations

Pensioners
- Consume, don’t work
- Own transfer wealth
- Transfer wealth can’t be sold or borrowed against
- No control rights
- Transfer wealth is a claim on future generations
- Can be taken away with the stroke of a pen
<table>
<thead>
<tr>
<th>Rentiers</th>
<th>Pensioners</th>
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Fungibility of Annuities and Market Wealth

• The hero of Balzac’s *Pere Goriot* converts his holdings of market wealth into an annuity

• Common financial advice in the US today is to delay onset of Social Security by spending market assets, thus buying a bigger annuity
Transfer Wealth: Distributional Aspects

• Strong age component: negative for young, positive for older workers and retirees
  – Since asset holdings also have this pattern, the age component of transfer wealth exacerbates inequality
  – But as Piketty points out, most inequality in market wealth is within age groups, not between
Transfer Wealth: Distributional Aspects

- Transfer Wealth largely displaces life cycle saving in Market Wealth for low end of income distribution, but not for high end.
  - US, population 65 and over: Social Security accounts for 84% of income in second quartile

- Thus a measure of total wealth inclusive of Transfer Wealth will be more equal than Market Wealth
Conclusion Part 1

• Market Wealth is a problematic measure of either productive capital or wealth
• Of the two, wealth is more central to Piketty’s broader concerns with distribution
• But Market Wealth is only a part of total wealth
Conclusion Part 2

- Market Wealth differs from Human Capital and Transfer Wealth in that it is inherited while other two forms are not.
- Exclusive focus on Market Wealth is circular.
  - Inheritance contributes particularly to Market Wealth inequality, while Market Wealth is sole contributor to inheritance.
  - For issues other than inheritance, a broader measure of wealth is appropriate.
- But: In last 3 decades, inequality of Market Wealth has increased while not much has happened to other types.
Conclusion Part 3

• Despite my complaints with Piketty, K/Y is probably an issue where “pro growth” and “anti inequality” policies go in opposite directions

• Human capital and (maybe) aggregate demand are areas where “pro growth” and “anti inequality” go hand in hand

• For other drivers of growth and inequality, not so clear
The End
Parking lot
Human Capital

• A lot of money is spent on education
• Average years schooling, population 25-65, rose from 8.08 in 1990 to 11.49 in 2010
• 0.17 years of education per year
• Assume 7% Mincerian return
• \( \hat{h} \) was 1.19% per year
• Accounts for all of growth in income per worker
Other Differences Between Capital and Wealth

• Political interests not fully aligned
  – e.g. Global warming

• Return to wealth differs from return to capital
  – Return to capital is what appears in the famous “r > g” -- this relates to production function, EOS
  – Return to wealth (at high end) depends on risk bearing
Human Capital / Output
Valuation from Cash Flows -- continued

• Assume
  – 40 year working life
  – r-g=4%
  – Population evenly divided among ages

• PDV of labor income of current workers relative to total wages is 12.5 (math next slide)

• So capitalized value of human capital is about 6.25 times national income!
Math Underlying that Statement

• PDV of wages of current workers relative to current wage; N year working life; constant sized population

\[
\frac{1}{N} \int_0^N \int_a^N e^{(g-r)(x-a)} \, dx \, da =
\]

\[
\frac{1}{N} \left( \frac{1}{r-g} \right) \left[ N - \left( \frac{1}{r-g} \right) \left( 1 - e^{(g-r)N} \right) \right]
\]
House Prices and Housing Capital

• Rise in price for existing housing due to
  – Shifts in preferences
  – Reduced discount on future streams
  – (combined with): rise in construction costs (either permanent or temporary)

To the extent that it is this stuff, no real change in quantity.
House Prices in France

Beware quality/structural effects.

- Disposable income per household (average value, stock)
- Existing-home price index, France (index, flow)
- Housing expense per household (from National accounts) (average value, stock)
- Rent index, France (index, stock)
- Construction cost index (index, flow)

Constant currency, basis 1965=1

![Graph showing trends in house prices in France from 1960 to 2015.](image-url)
Public Transfer Wealth

• Lee and Mason (2011)

• For US and Europe average:
  – Public transfer wealth per adult is 1.34 times average wage of 30-49 year olds
Individual #1
- age, gender
- education
- experience

Individual #2
Individual #3

Households

Capital Market

Labor Market

Capital income

Factor Payments

International Capital Flows

Firms

Government

Purchases

Consumption

Revenue

Product Market

International Trade

Wages

Assets

International Capital Flows