Lecture 6A
Malthus and Pre-Industrial Stagnation

Macroeconomics (Quantitative)
Econ 101B

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Growth Is A Modern Phenomenon

- Real wages stagnant before 1800
- Sizable fluctuations before 1800, but not growth
- Growth begin around 1800 in Britain (and then spread)
- 18th and 19th century Britain is a major turning point in history which we now refer to as the Industrial Revolution

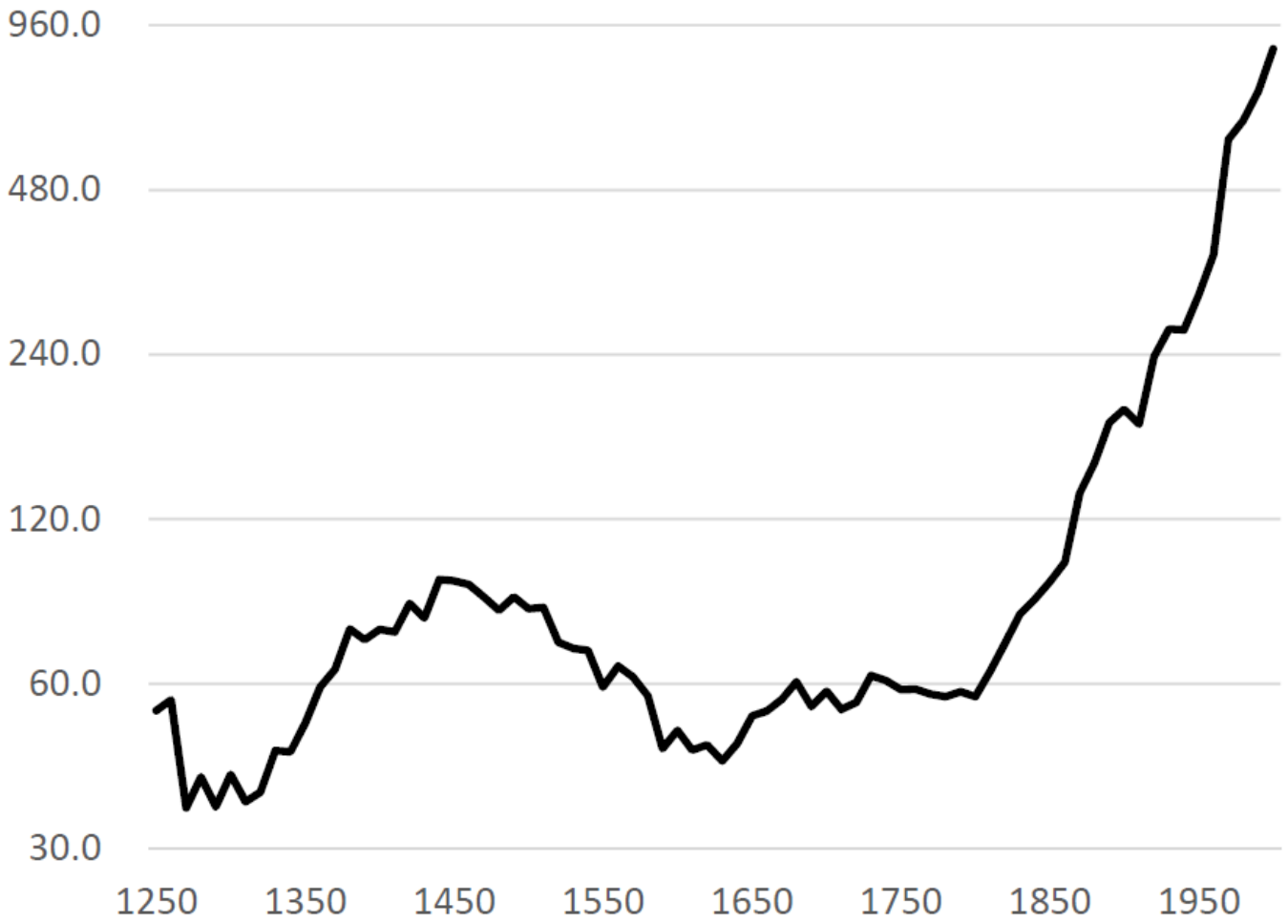


Figure 1: Real Wages of Laborers in England from 1250 to 2000

Key Questions About Origins of Growth

- Why was there no growth before the Industrial Revolution?
- Why did the Industrial Revolution happen?
  - Why did it happen in 18th and 19th century?
  - Why did it happen in Britain?
- Why did the Industrial Revolution result in modern sustained growth? (Why didn't it peter out like earlier "golden ages"?)

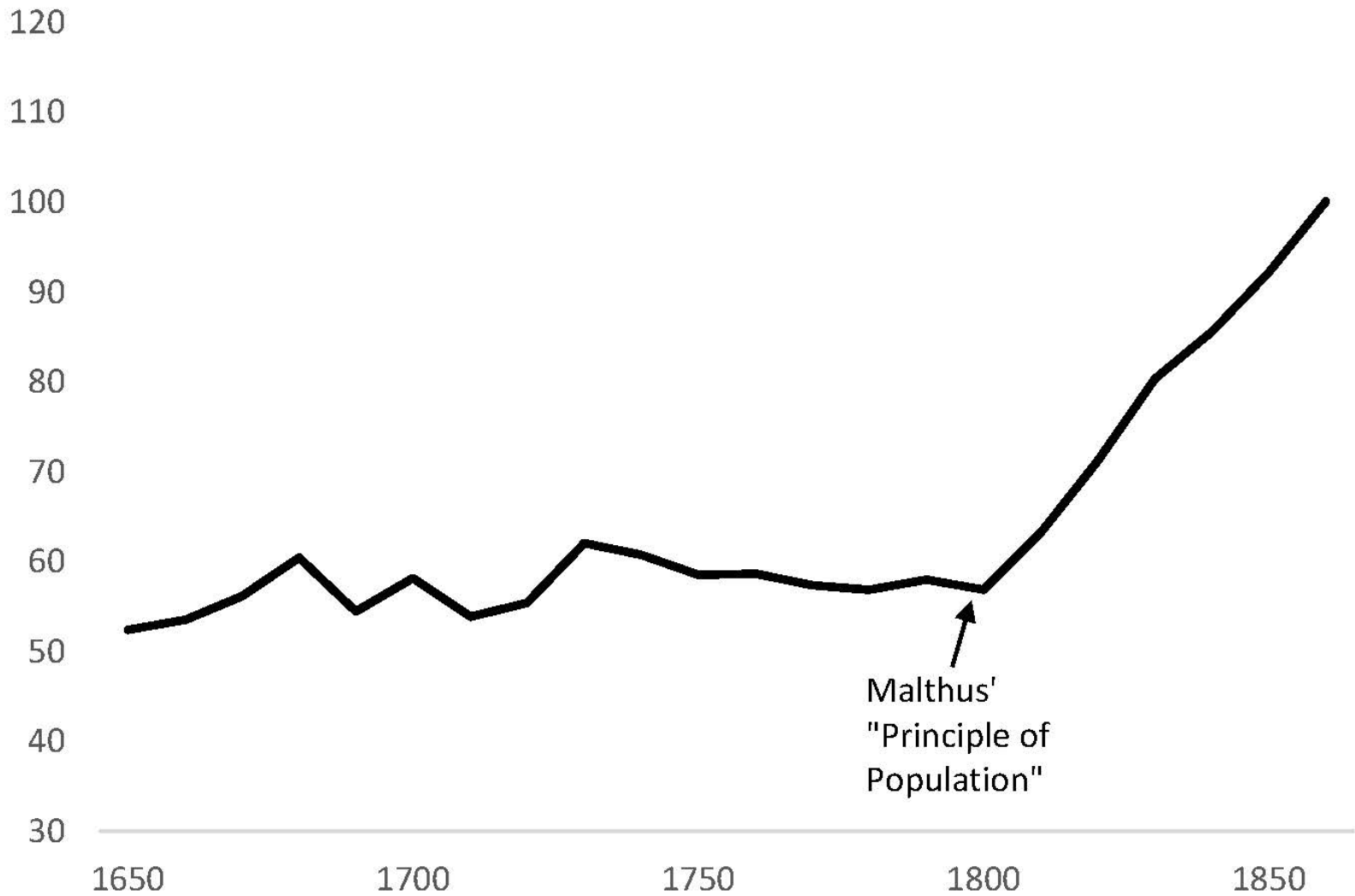
Why No Growth Before the Industrial Revolution?

- Despotism: Those that grew rich got attacked by poorer neighbors
- Lack of freedom: Slavery and serfdom widespread. Cage of norms impedes occupational freedom.
- Vested interests favoring status quo: Powerful forces working against innovation and change
- Population dynamics: Higher wages lead to population growth, which pushed down wages

Malthus' Idea

- In 1798, Thomas Malthus published an essay titled *An Essay on the Principle of Population*
- Argued that sustained growth in real wages was impossible in the long run
- If real wages increased, this would lead to an increase in population that would only stop when wages had been bid down to subsistence

Malthus' Unfortunate Timing



Source: Clark (2010)

Malthus Model: Production

1. Production Function:

$$Y_t = A_t D^a L_t^{1-a}$$

   - Y_t denotes output at time t
   - A_t denotes productivity at time t
   - D denotes land (constant over time)
   - L_t denotes labor at time t
   - Production function is constant returns to scale in land and labor. But land is fixed.
   - There are diminishing returns to labor alone.

Malthus Model: Labor Demand

2. Labor Demand:
   - We assume that there is a competitive labor market. As in lecture 2, firms will hire labor to the point at which wage is equal to marginal product of labor

$$w_t = (1 - a)A_t \left(\frac{D}{L_t}\right)^a$$

Malthus Model: Labor Supply

3. Labor Supply:
   - Labor supply equals hours per person times population:

$$L_t = H_t N_t$$

   - For simplicity: $H_t = H$ (hours constant)
   - We abstract from the labor-leisure decision discussed in lecture 3

Malthus Model: Population Growth

4. Population Growth:
   - Population growth governed by real wage:

$$N_{t+1} = \frac{w_t}{w^s} N_t$$

   - w^s "subsistence" wage
   - Population will grow when standard of living is above subsistence

Malthus Model: Population Growth

- People have a natural tendency to continually produce children
- Absent “checks” on this, population will grow
  - “Positive checks” increase death rate (war, disease, severe labor, poverty)
  - “Preventive checks” reduce birth rate (birth control, delayed marriage, infrequent coitus)
- Simplest formulation: Abject poverty only check that is sufficiently strong to stop population growth

Malthus Model: Population Growth

- Rewrite equation as:

$$N_{t+1} = \frac{w_t}{w^s} N_t \quad \rightarrow \quad \frac{N_{t+1}}{N_t} = \frac{w_t}{w^s}$$

  - Population grows whenever wages are above subsistence $(w_t > w^s)$
  - Population shrinks whenever wages are below subsistence $(w_t < w^s)$

Malthus Model: Plagues

- One more element important to make sense of data in middle ages: Plagues
- Plagues: Exogenous shock to population growth ξ_t
- Population growth equation becomes:

$$\frac{N_{t+1}}{N_t} = \left(\frac{w_t}{w^s}\right)\xi_t$$

  - Years with no plague $\xi_t = 1$
  - Years with plague $\xi_t < 1$

The Malthus Model: Key Equations

$$w_t = (1-a)A_t\left(\frac{D}{HN_t}\right)^a$$

$$\frac{N_{t+1}}{N_t} = \left(\frac{w_t}{w^s}\right)\xi_t$$

- How many endogenous variables?
  - Two for each time period: w_t and N_{t+1}
  - What about N_t? It is endogenous in the previous period.
  - What about N_0? It is exogenous (initial condition)
- **Dynamic model**:
  - Population growth equation links period t and period $t+1$
  - Solution at period $t+1$ depends on outcome in period t

Population Dynamics

- Let's plug the labor demand equation into the population growth equation :

$$\frac{N_{t+1}}{N_t} = \left(\frac{w_t}{w^s}\right)\xi_t$$

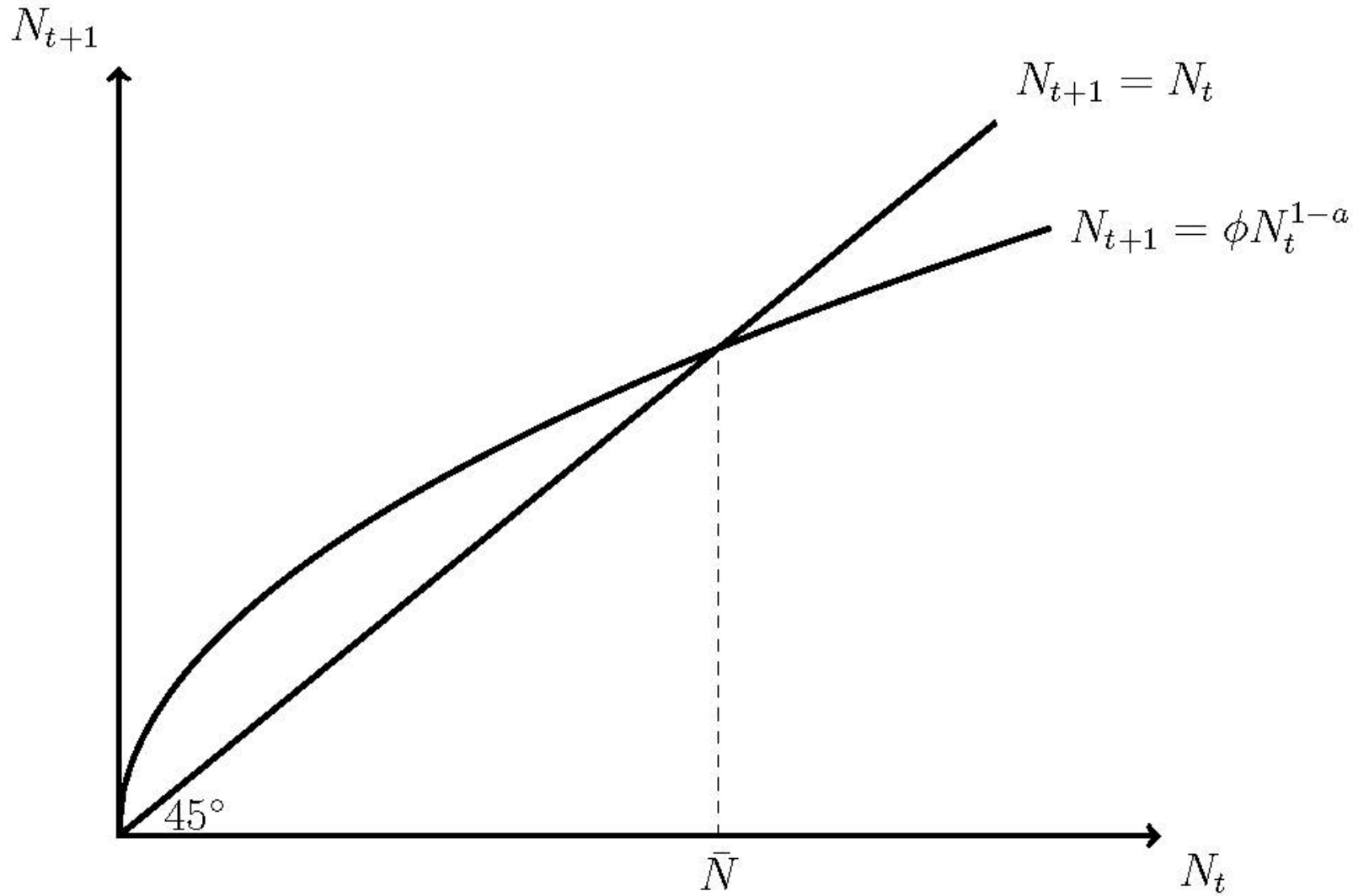
$$\frac{N_{t+1}}{N_t} = \left(\frac{(1-a)A_t}{w^s}\right)\left(\frac{D}{HN_t}\right)^a \xi_t$$

Population Dynamics

$$N_{t+1} = \phi A_t \xi_t N_t^{1-a}$$

- Difference equation for dynamics of population
- We solve it graphically
- Solved analytically in textbook chapter

Population Dynamics



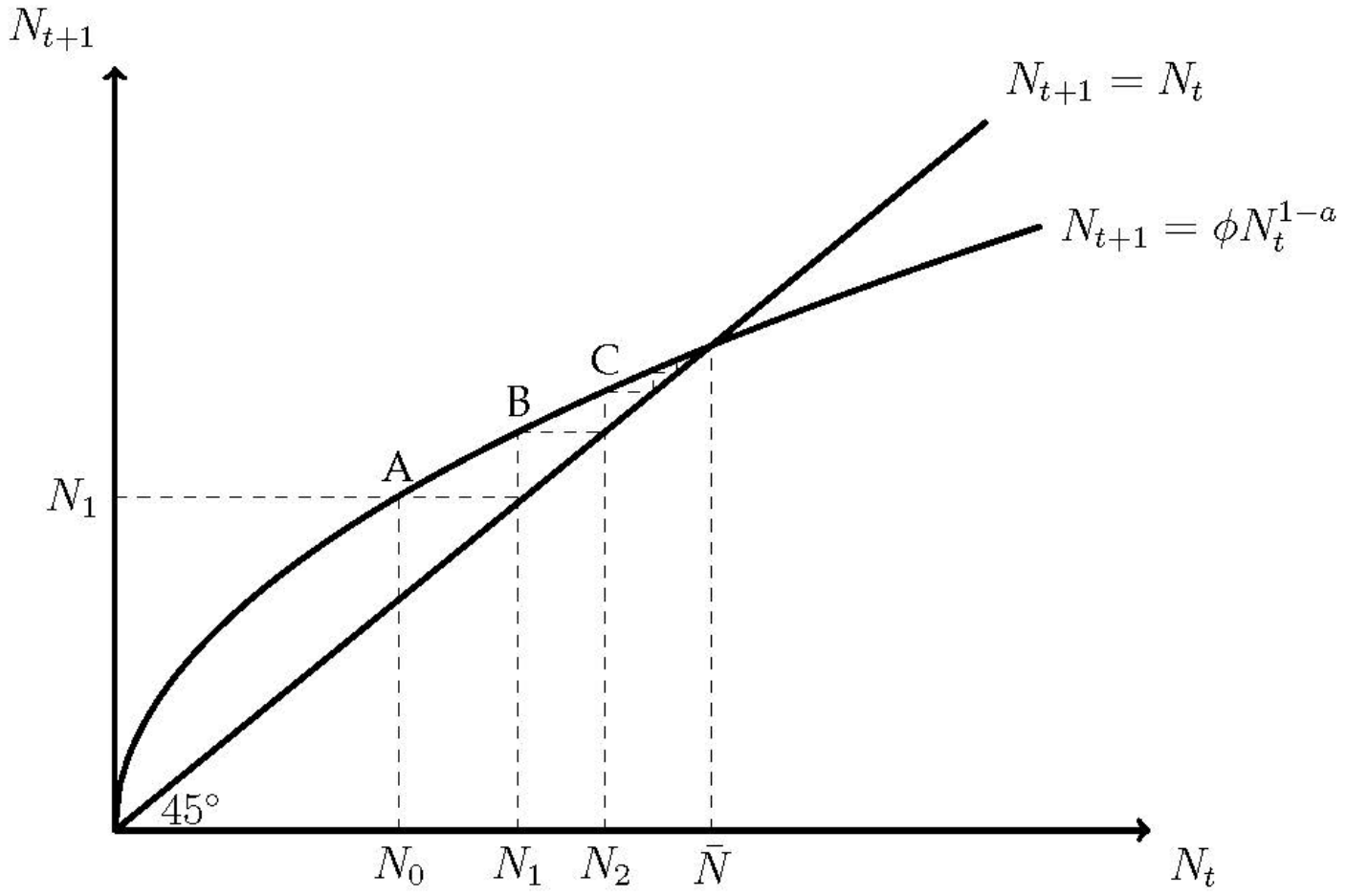
Population Dynamics

$$N_{t+1} = \phi A_t \xi_t N_t^{1-a}$$

- Suppose for simplicity that $A_t = 1$ and $\xi_t = 1$

$$N_{t+1} = \phi N_t^{1-a}$$

- If $\phi N_t^{1-a} > N_t$ then $N_{t+1} > N_t$
- If $\phi N_t^{1-a} < N_t$ then $N_{t+1} < N_t$
- If $\phi N_t^{1-a} = N_t$ then $N_{t+1} = N_t$



Steady State Population

$$N_{t+1} = \phi A_t \xi_t N_t^{1-a}$$

- A steady state for N_t is a value for N_t at which $N_{t+1} = N_t$, i.e., the population is "steady"
- Population will reach such a point after long period of no "shocks" (e.g., $\xi_t = 1$ and $A_t = 1$)
- We denote steady state for N_t by $\bar{N}$
- We can solve for the steady state analytically

Solving for Steady State

1. Suppose there is a steady state $\bar{N}$. Then $N_{t+1} = N_t = \bar{N}$. So, replace N_{t+1} and N_t with $\bar{N}$ in population dynamics equation. Also, set shocks to normal values (i.e., $\xi_t = 1$):

$$\bar{N} = \phi A_t \bar{N}^{1-a}$$

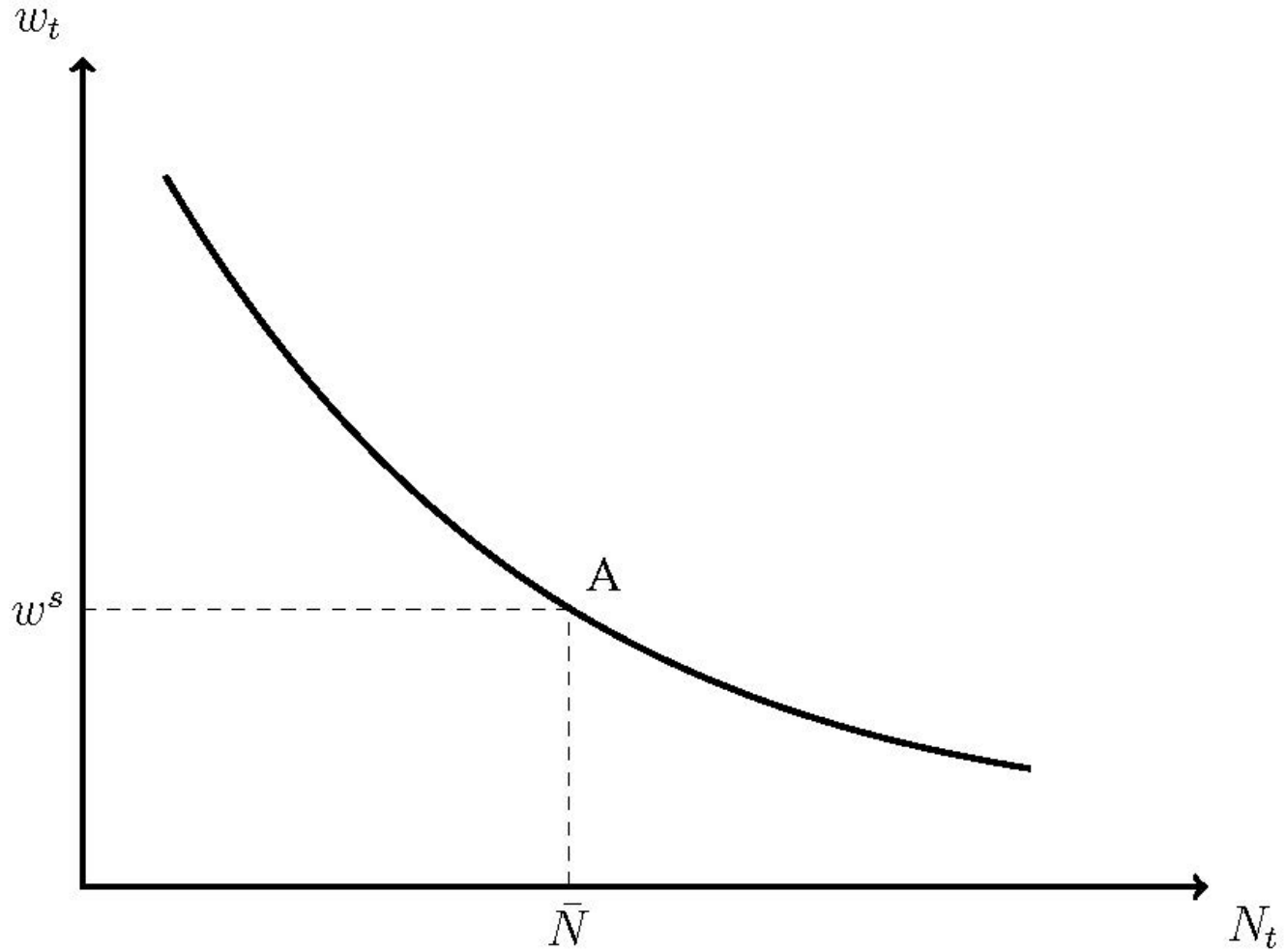
2. Solve for $\bar{N}$:

$$\bar{N} = (\phi A_t)^{\frac{1}{a}}$$

Real Wages in the Malthus Model

- Labor demand:

$$w_t = (1-a)A_t\left(\frac{D}{HN_t}\right)^a$$



The Malthus Model

Graphical analysis consists of four key plots:

1. Population dynamics plot (N_{t+1} against N_t)

$$N_{t+1} = \phi A_t \xi_t N_t^{1-a}$$

2. Labor demand plot (w_t against N_t)

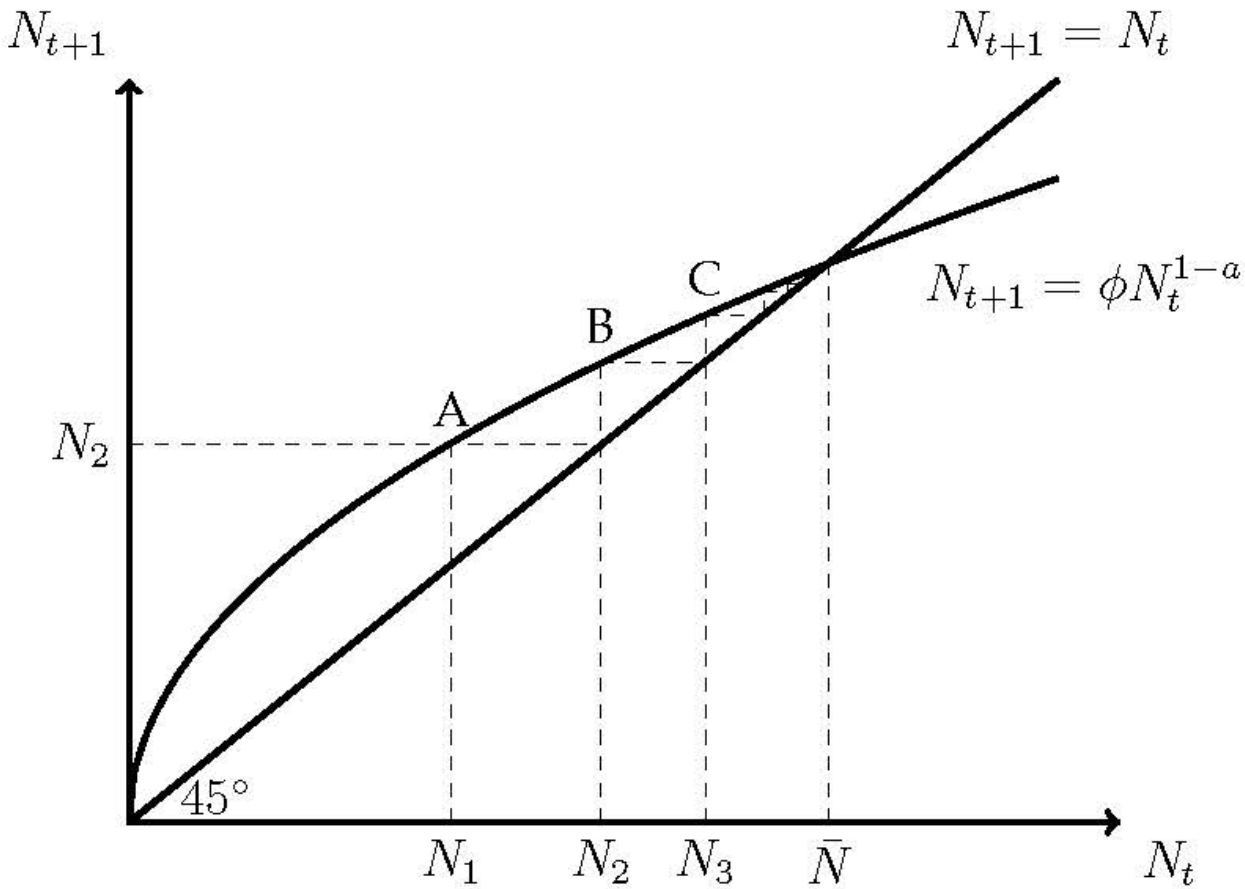
$$w_t = (1-a) A_t \left(\frac{D}{H N_t} \right)^a$$

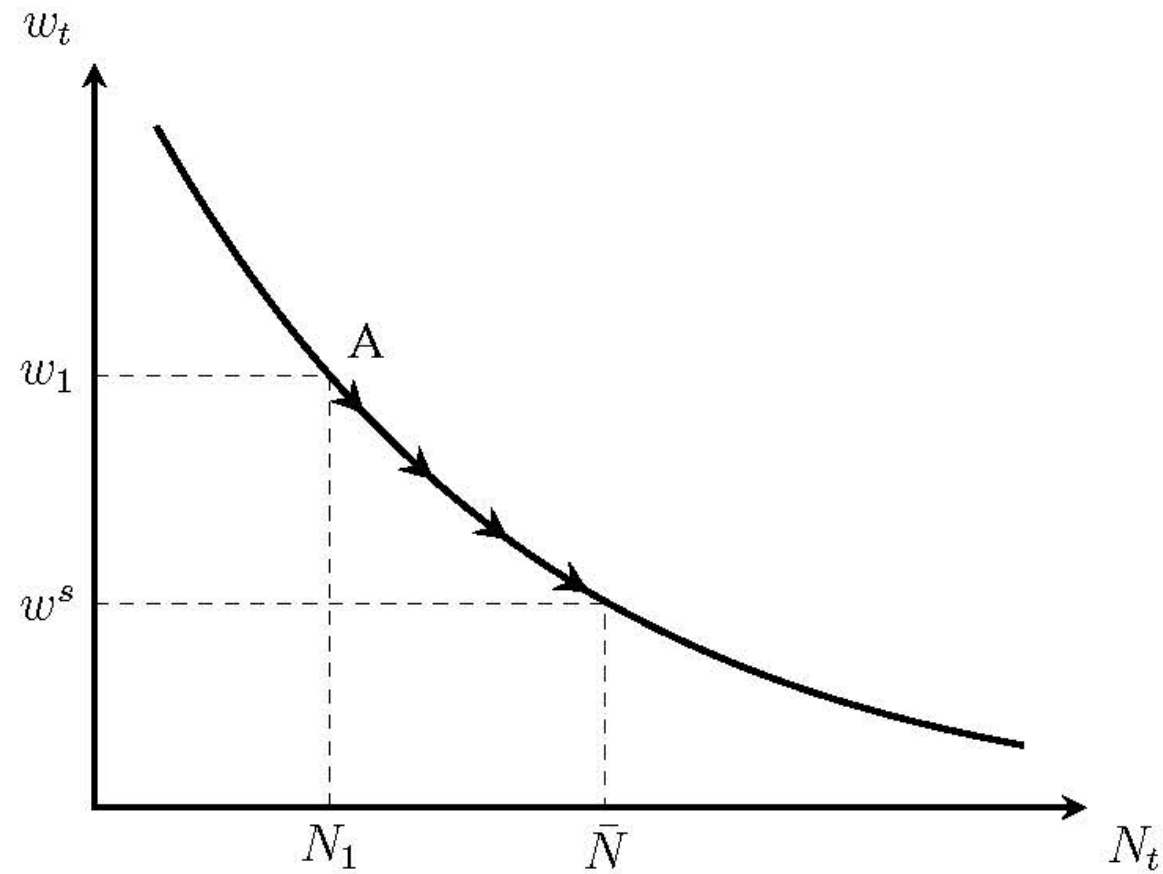
3. Time-series plot of population (N_t against t)
4. Time-series plot of wages (w_t against t)

Responses to Shocks

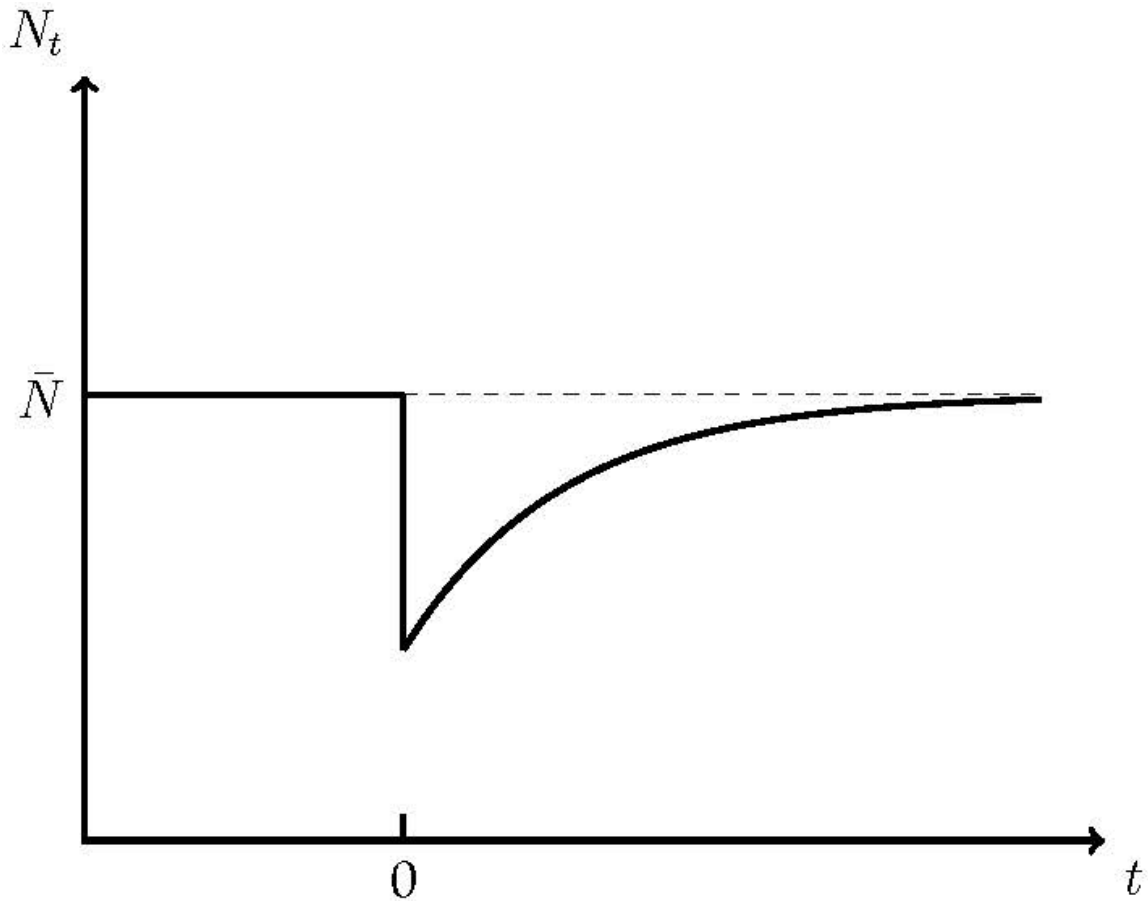
- What happens to population and wages in the short run and long run after these shocks:
  1. Black Death ($\xi_t < 1$)?
  2. Increase in technology ($A_0 > 1$)?

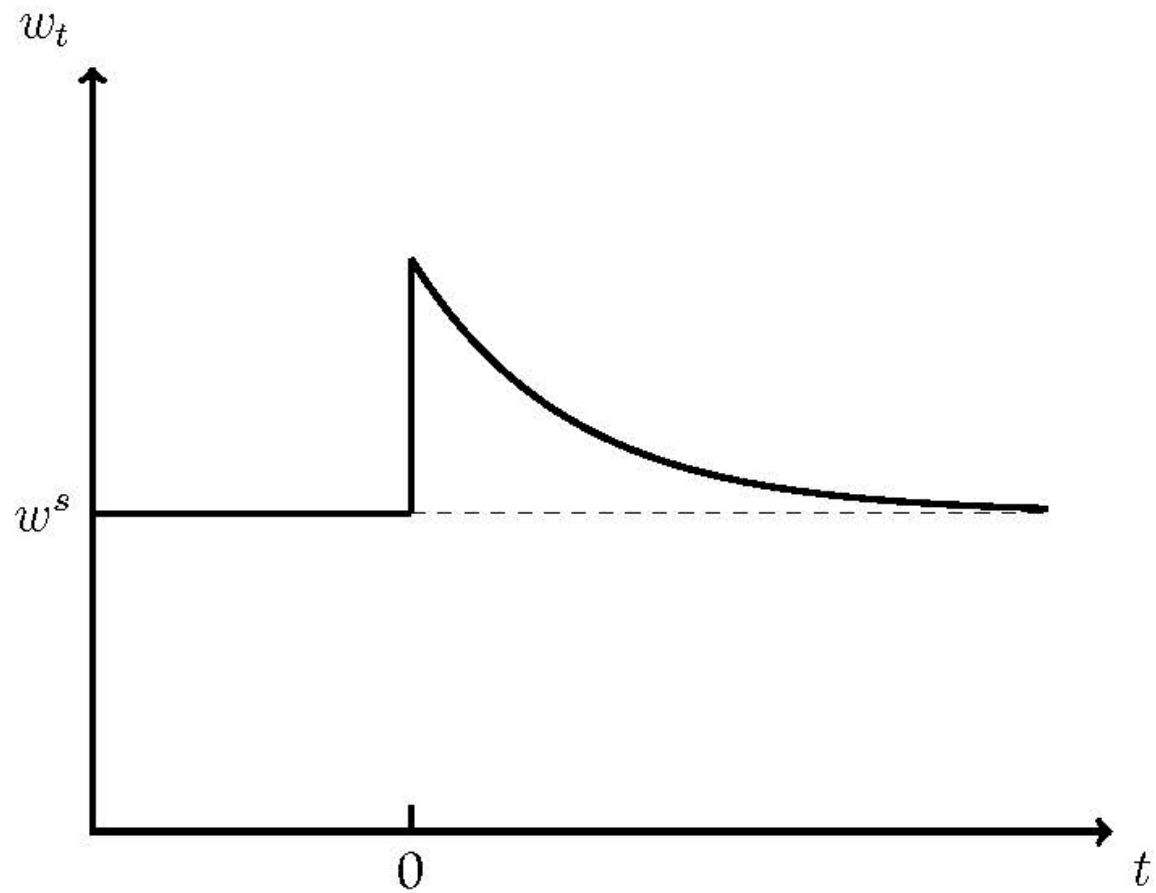
Black Death


N_{t+1}
$N_{t+1} = N_t$
$N_{t+1} = \phi N_t^{1-a}$
C
B
A
N_2
45°
N_1
N_2
N_3
$\bar{N}$
N_t

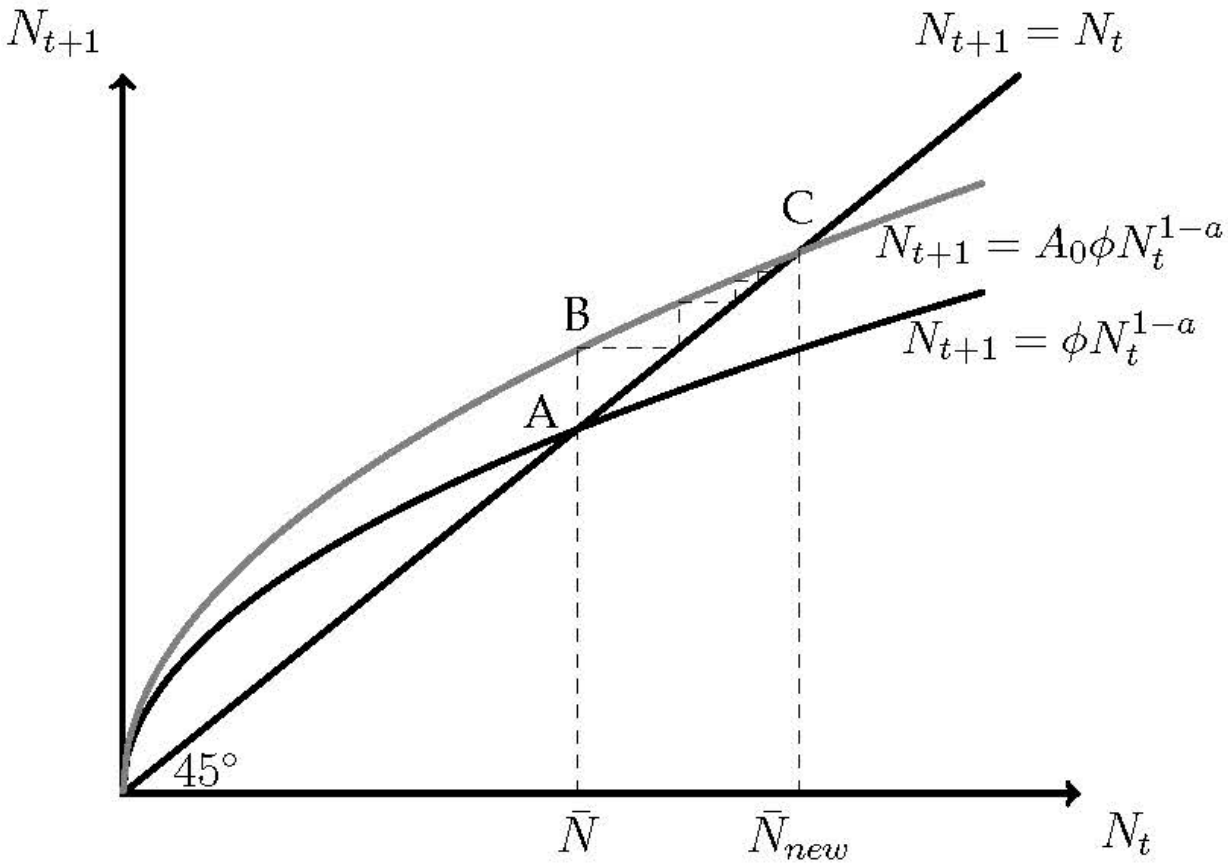

w_t
A
w_1
w^s
N_1
$\bar{N}$
N_t

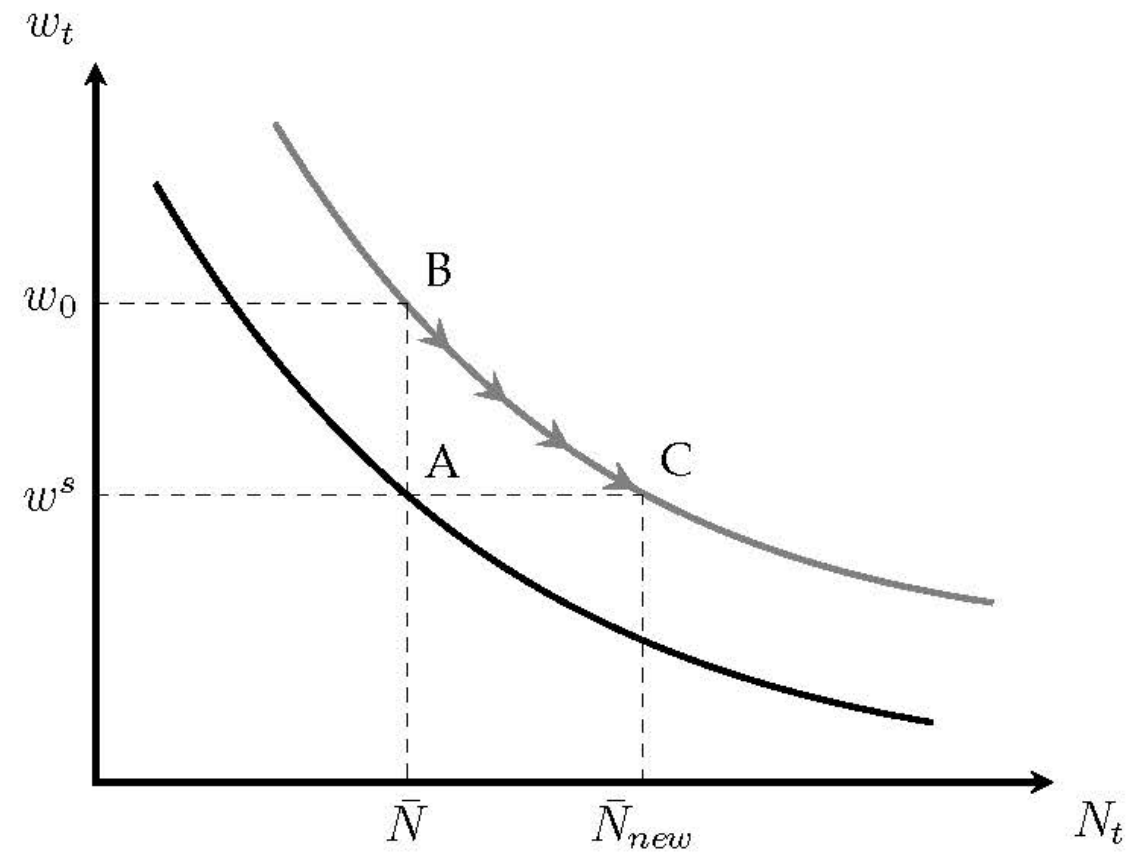
Black Death



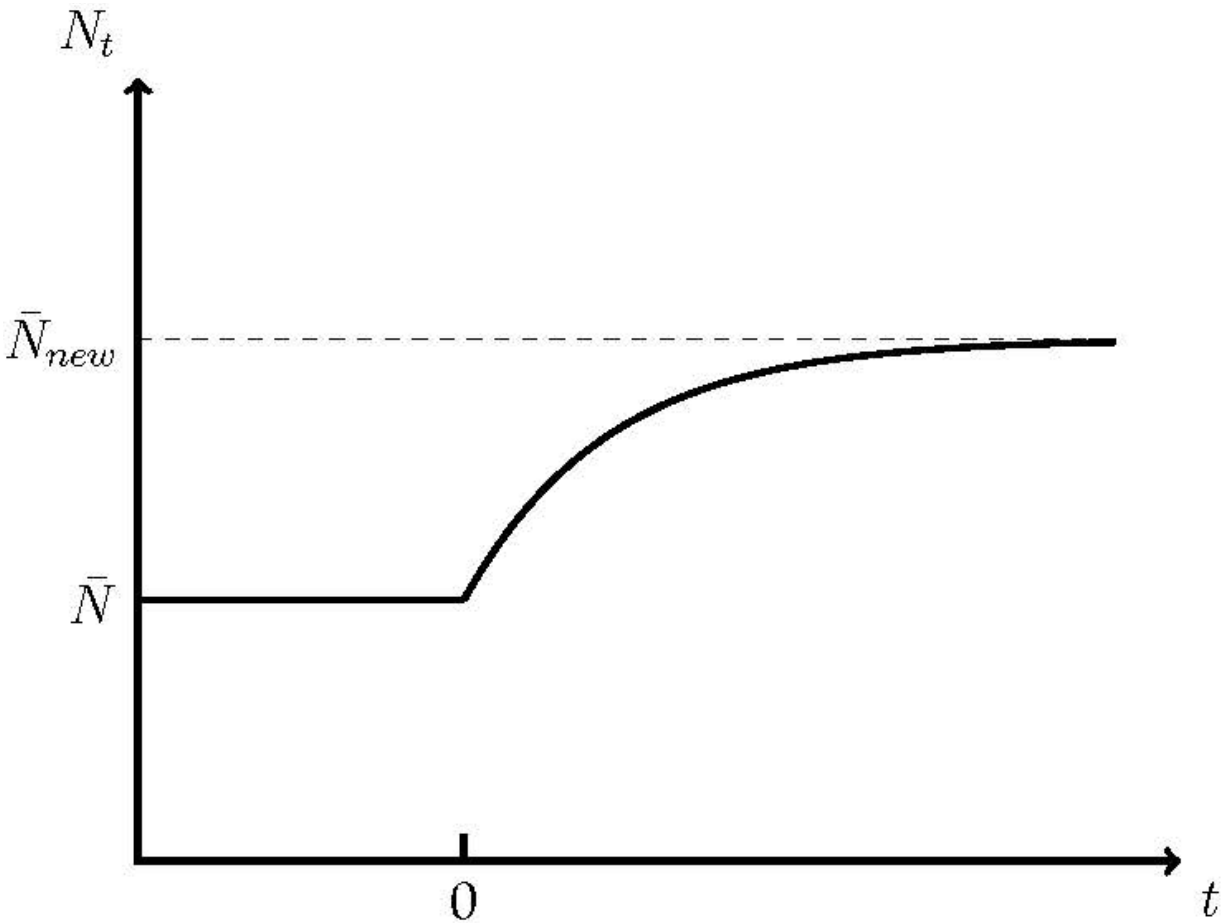


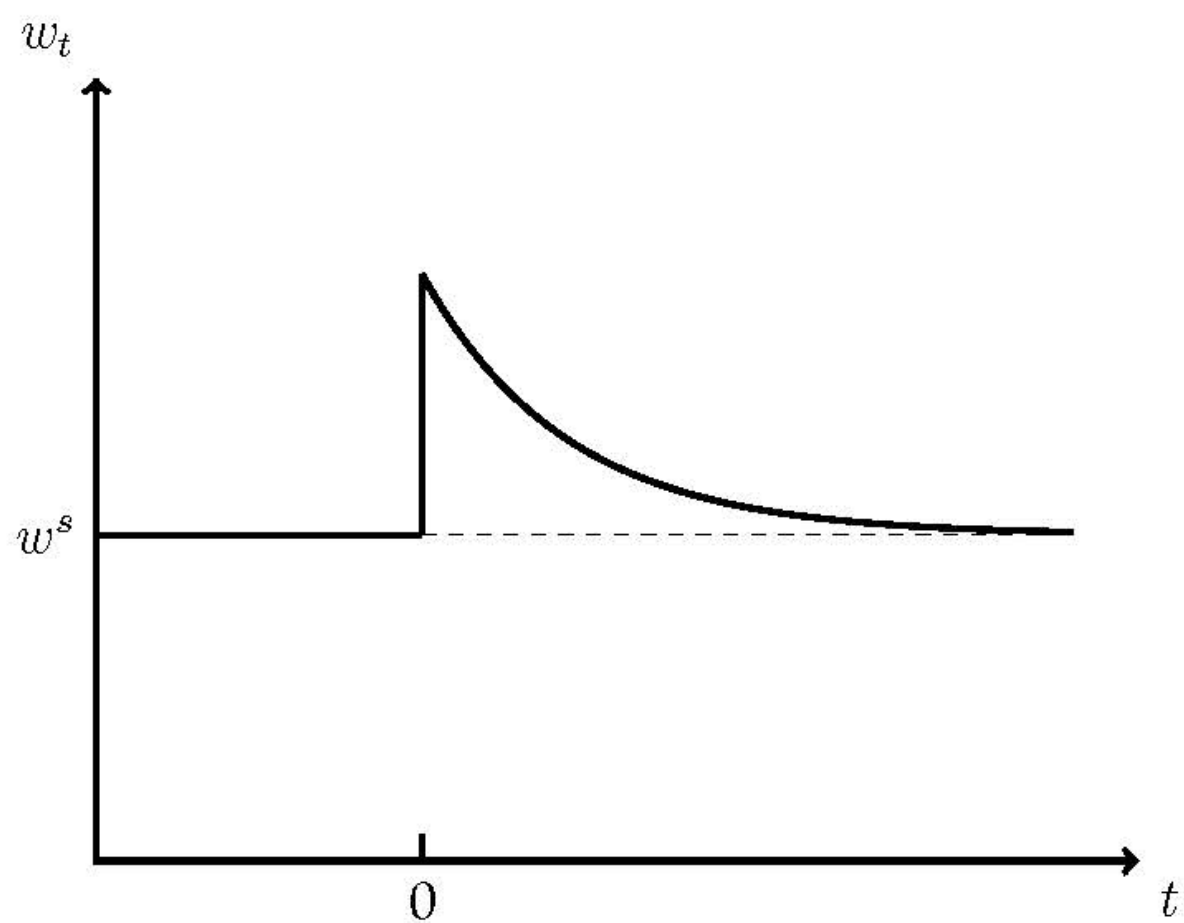
Increase in Productivity





Increase in Productivity





Responses to Shocks

- What happens to population and wages in the short run and long run after these shocks:
- Black Death ($\xi_t < 1$)?
  - Population falls in the short run but returns to same steady state.
  - Wages rise in the short run but then fall to same steady state
- Increase in technology ($A_0 > 1$)?
  - Population begins to grow and grows to new steady state
  - Wages rise in the short run but then fall to same steady state

Wages in England 1250-1860

- Can we use the Malthus model to make sense of the evolution of real wages in England from 1250 onward?
- Two striking facts:
  - No growth (same in 1750 as in 1250)
  - Big rise (1300-1450) and then fall (1450 to 1640)
- Malthus model suggests that evolution of the population may help us understand changes in real wages

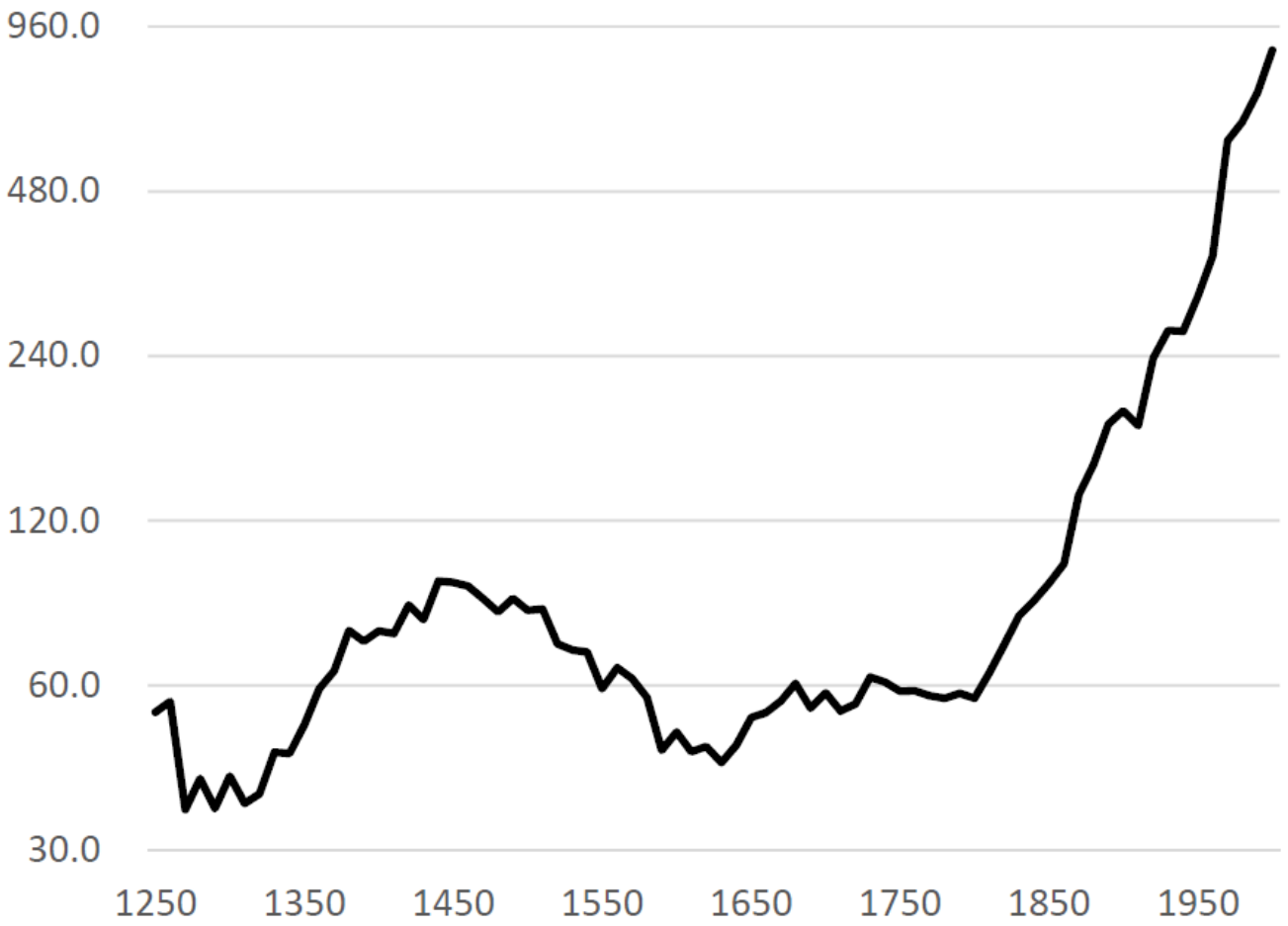
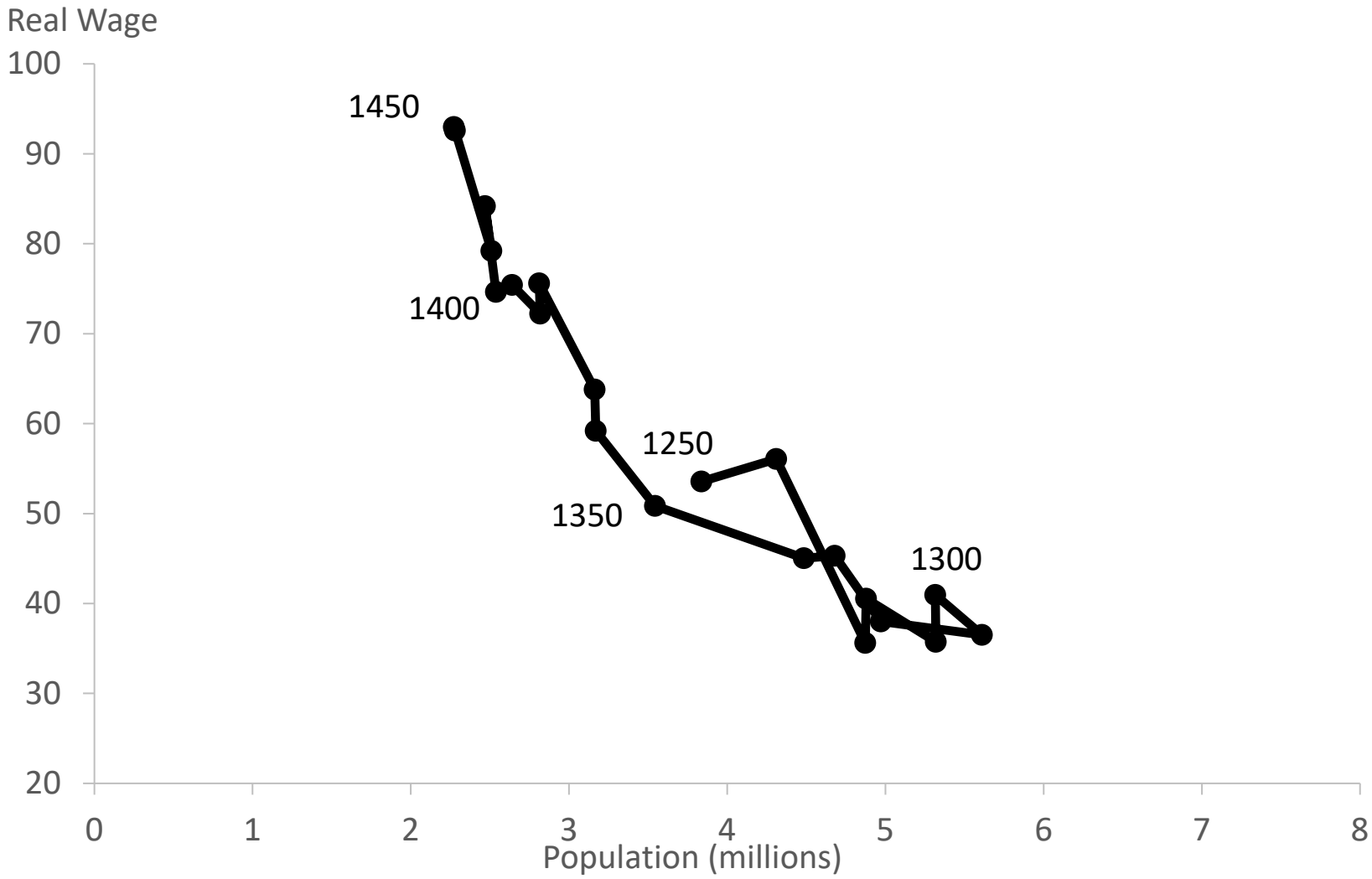


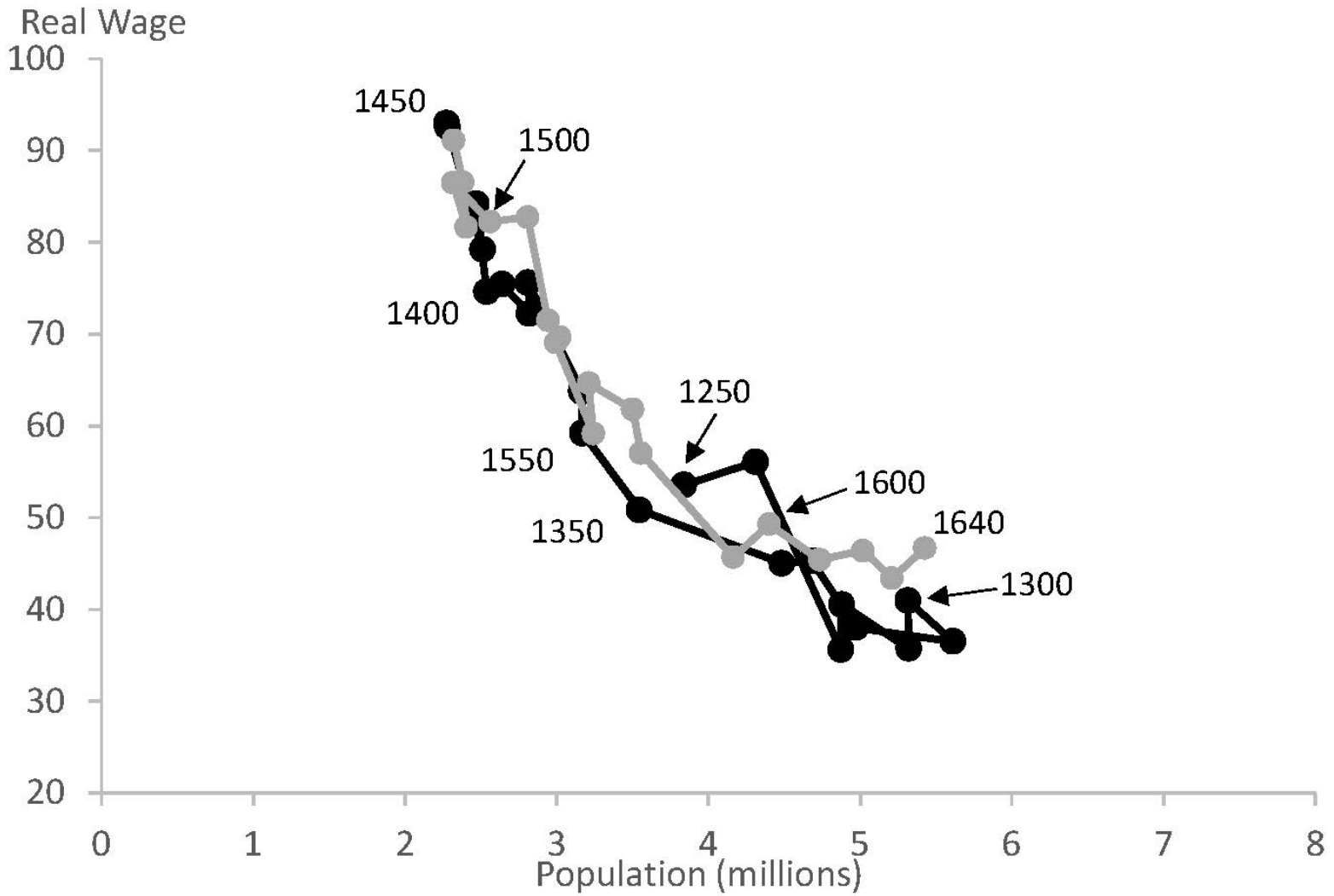
Figure 1: Real Wages of Laborers in England from 1250 to 2000

Real Wages of Laborers in England 1250-1450



Source: Clark (2010)

Real Wages of Laborers in England 1250-1640



Source: Clark (2010)

Real Wages of Laborers in England 1250-1640

- 1250-1310:
  - Population rises and real wages fall
- 1310-1450:
  - Population falls and real wages rise
  - Black Death in 1340s. Waves of plagues afterwards
- 1450-1640:
  - Population rises and real wages fall
  - Economy “recovers” from plagues

Success of Malthus Model

- Big rise and fall of real wages may have seemed puzzling before
- Malthus model provides an explanation:
  - Real wages rose as plagues halved the population
  - Real wages fell as population recovered

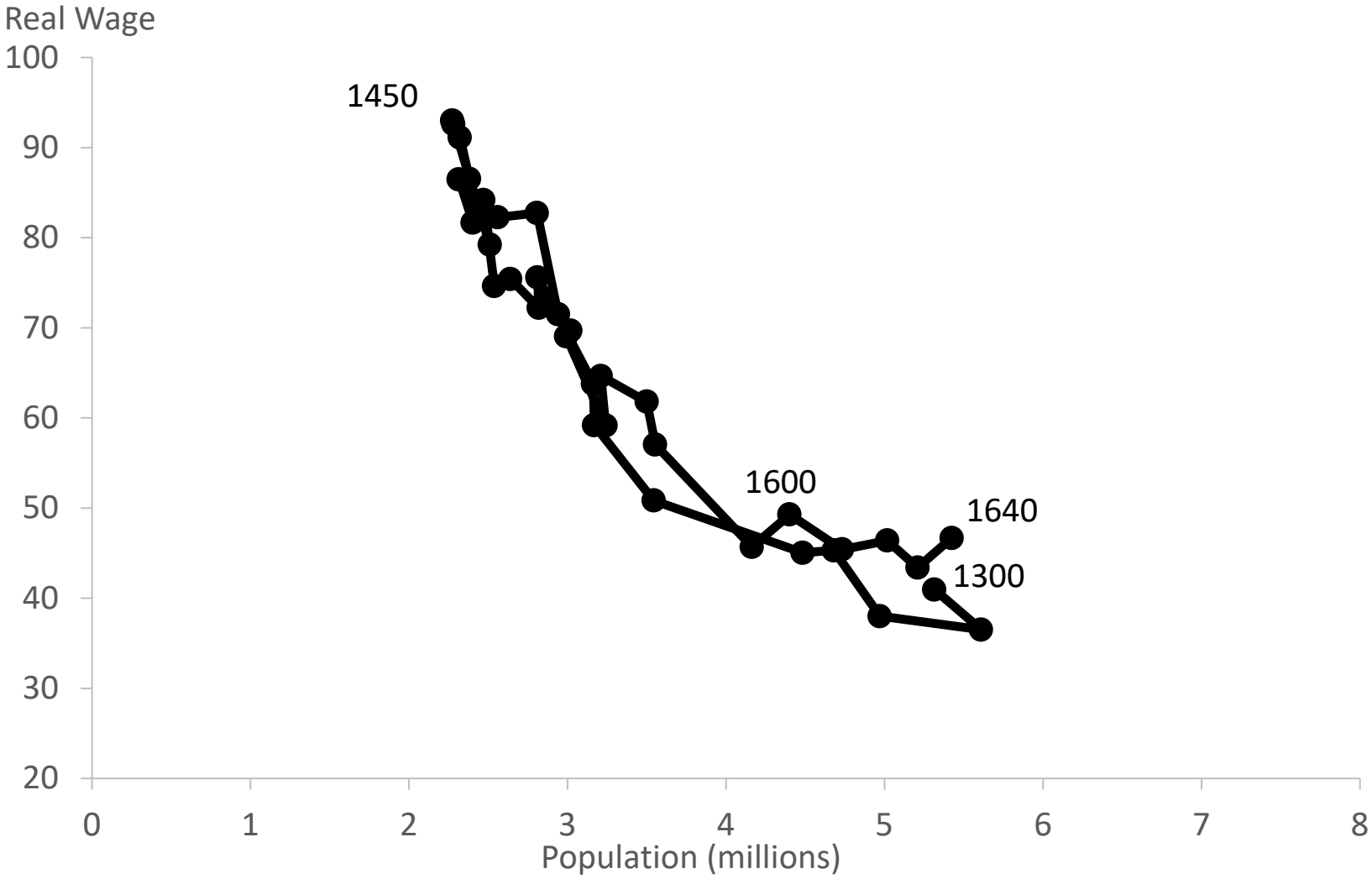
Technical Change in England 1250-1640

- 1250-1640:
  - Real wages and population moved up and down a stable labor demand curve

$$w_t = \phi w^s A_t \frac{1}{N_t^a}$$

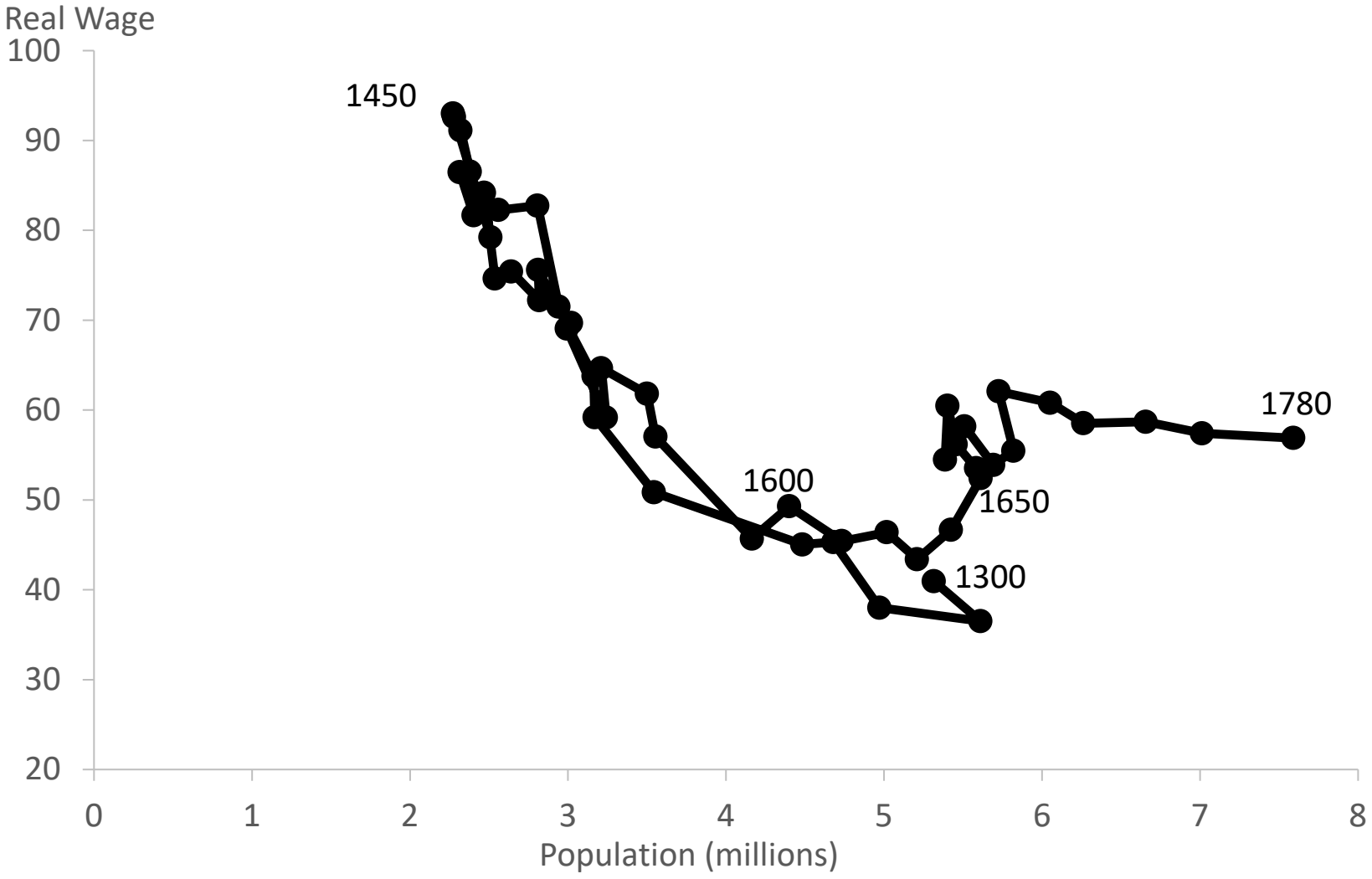
- What does this imply about changes in productivity in England from 1250 to 1640?
  - There was essentially no change in productivity ($A_t = \bar{A}$). No technical change. (Why?)
  - Increases in A_t shift the labor demand curve out

Real Wages of Laborers in England 1300-1640



Source: Clark (2010)

Something Changed Around 1650

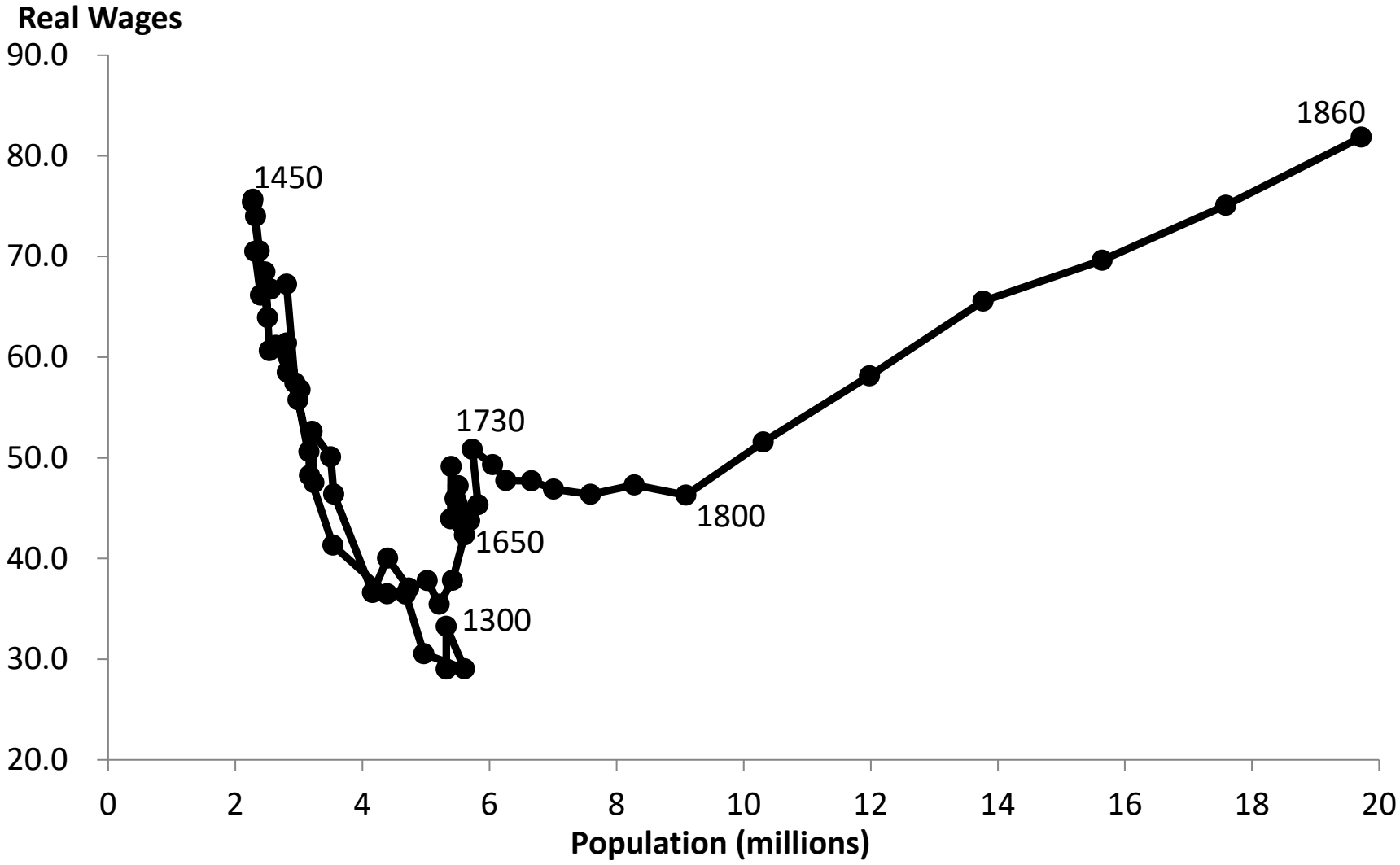


Source: Clark (2009)

Something Changed Around 1650

- Points move off the curve!!
- What does this mean about productivity?
  - Productivity started increasing (A_t started growing)
- From 1640-1730: Mostly increase in wages
  - Great Plague of London in 1665-6
- From 1730-1800: Mostly increase in population
  - Recovery from plagues? Increase in health? Engel‘s pause?
- Around 1800: Huge acceleration

Real Wages of Laborers in England 1290-1860



Malthus' Unfortunate Timing

- Malthus sometimes get a bad rap
  - Prediction that wages were doomed to stay at subsistence turned out to be wrong after his writing
  - But his theory was arguably correct for all of history up until his writing!!
- What changed after 1800?

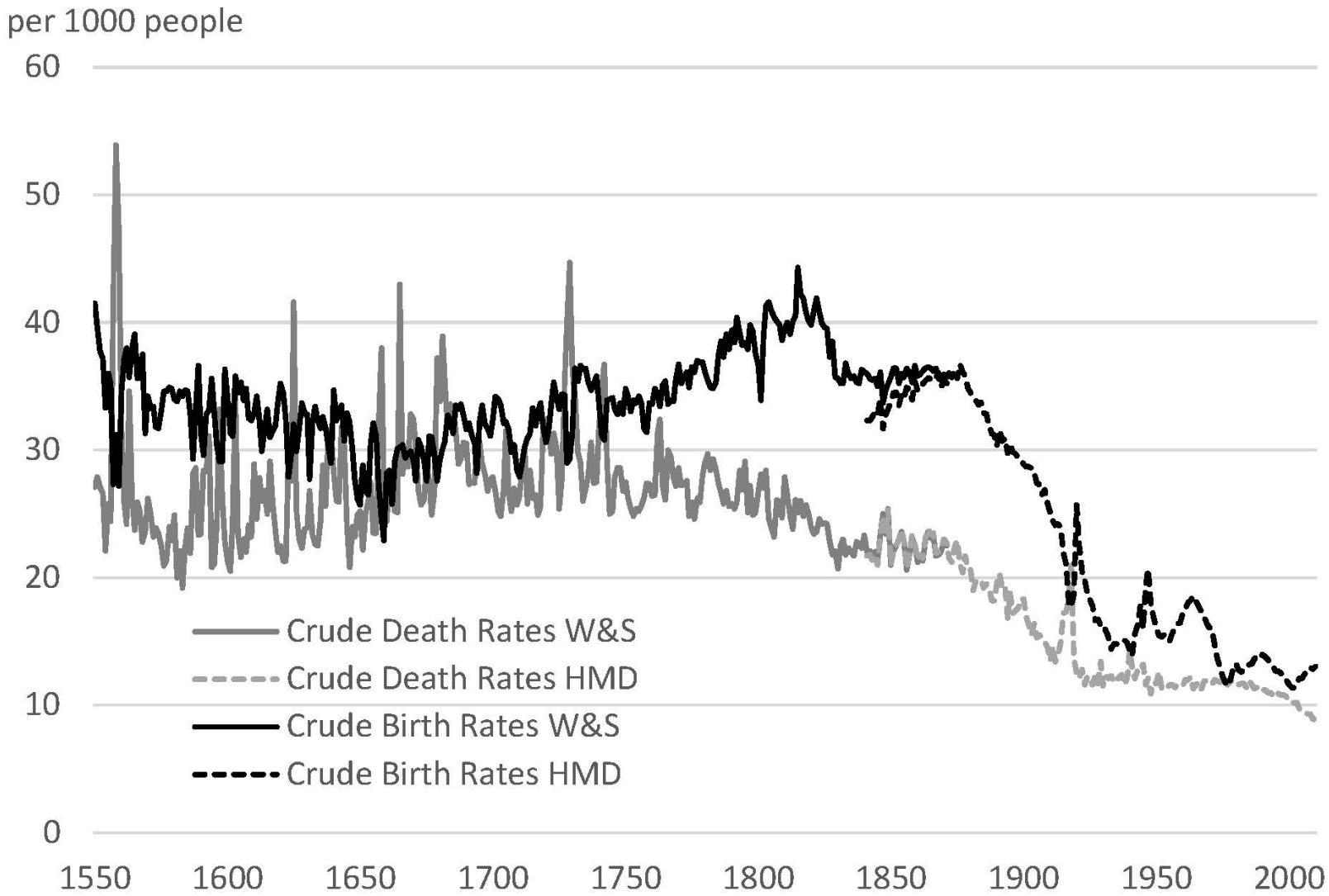
Why Is World No Longer Malthusian?

1. Technological growth overwhelmed Malthusian forces
   - Population forces Malthus emphasized are slow
   - Fast enough technology growth my overwhelm them
2. Land less important in production
   - Existence of a fix factor of production (land) important for logic of Malthus model
   - Land became much less important after 1800 due to invention of the steam engine
   - Land no longer needed to produce energy

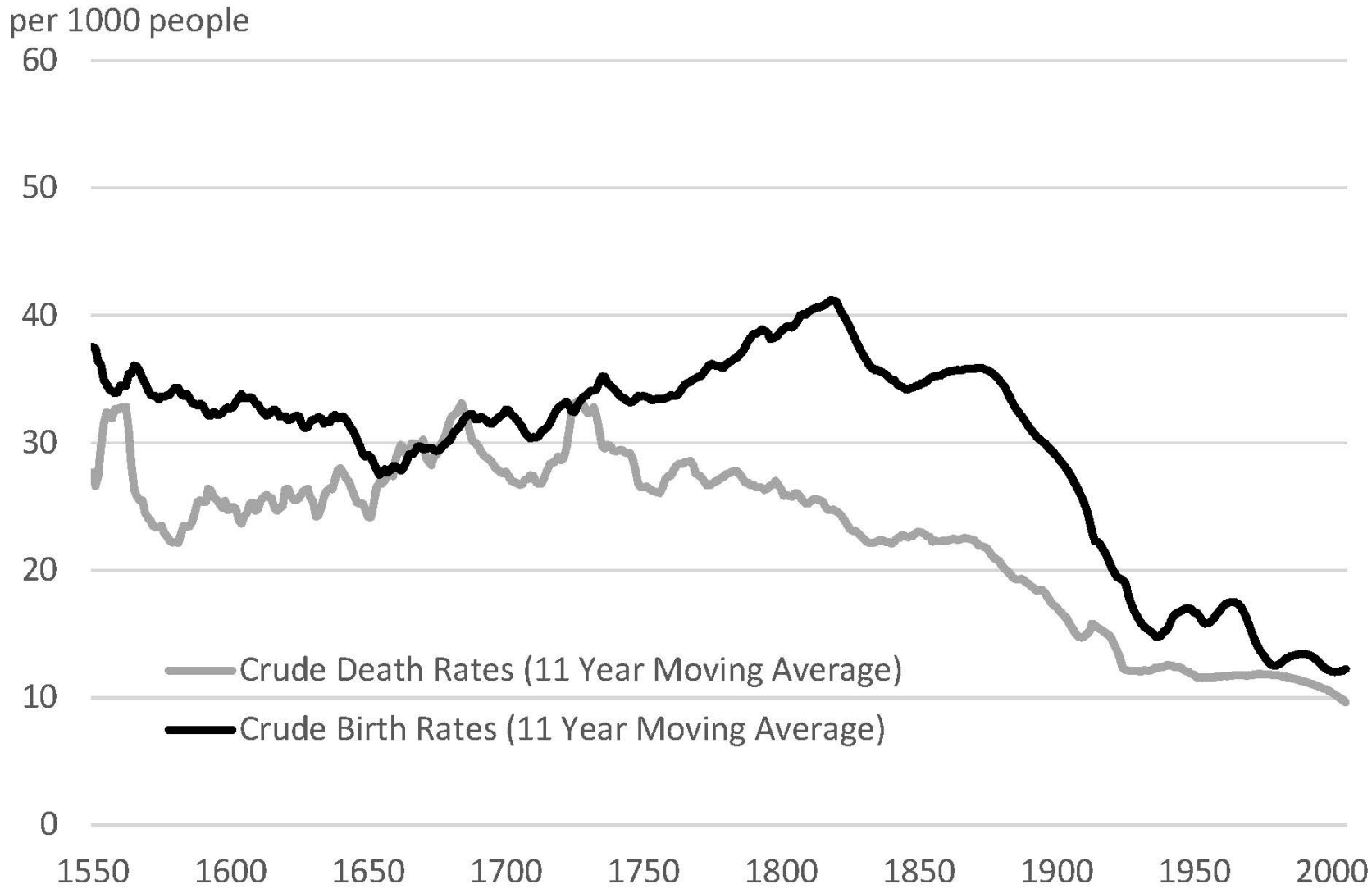
Why is World No Long Malthusian?

3. Demographic Transition
   - Data on birth rates and death rates support Malthus' model quite well up until 1825
   - After 1825, relationship between birth rates and real wages assumed by Malthus breaks down (and particularly after 1880)

Demographic Transition in England



Demographic Transition in England



Demographic Transition

- High wages no longer associated with high population growth in England
- Same pattern observed for all countries when they develop
- Why did birth rates fall?
  - Improved contraceptive methods
  - Trade-off between quantity and “quality” of children?
  - Women’s empowerment