# Clans, Guilds, and Markets: Apprenticeship Institutions and Growth in the Pre-Industrial Economy

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# Technological Progress in the Pre-Industrial Era

Western Europe pulled ahead of other world regions in centuries leading up to Industrial Revolution.

Faster technological progress **not** due to formal education or formal R&D by firms.

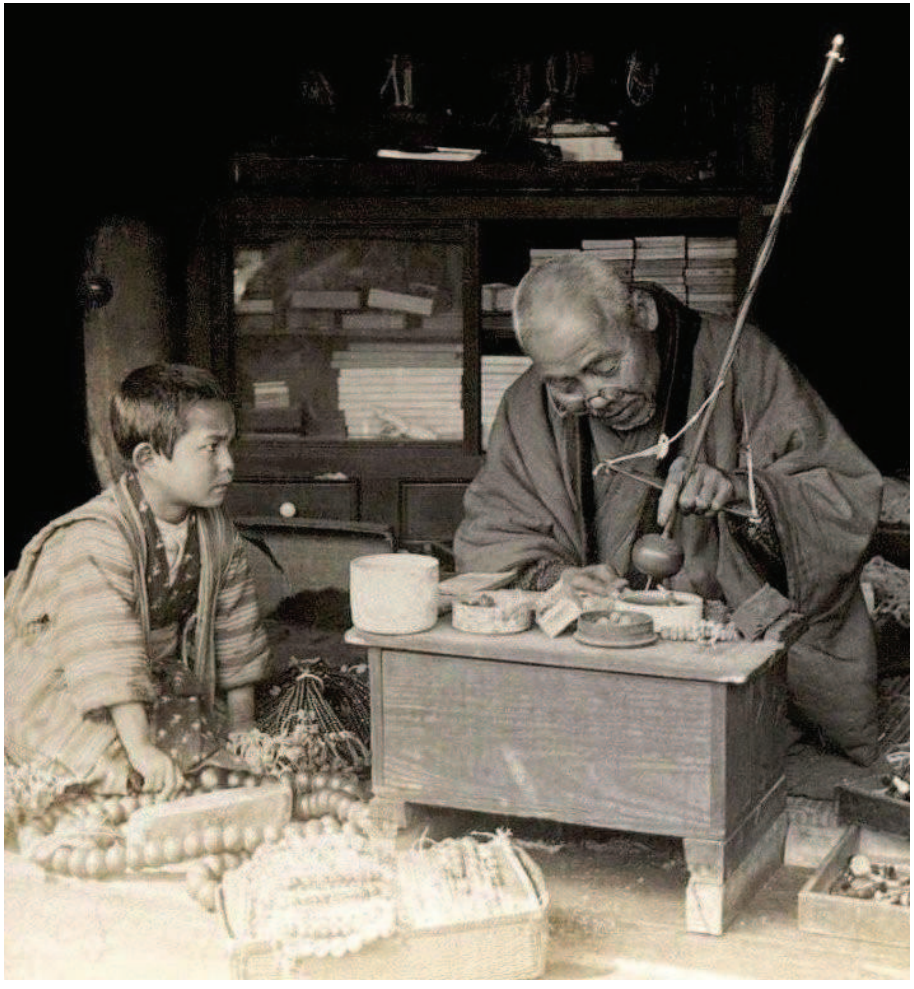
Instead, most people were illiterate, most knowledge was tacit, and knowledge was acquired person-to-person from elders: **apprenticeship**.

Aim: Examine role of apprenticeship institutions for explaining pre-industrial growth across world regions.

# Apprenticeship


Painting by Louis-Emile Adan (1839-1937).

# Apprenticeship



Bead maker, old Meiji-Era Japan.

# Building Blocks

Combine elements from different literatures:

- Malthusian model of income and population (Ashraf and Galor 2011).
- Models of technological progress based on person-to-person transmission of ideas (Kortum 1997, Lucas 2009, Lucas and Moll 2011, Perla and Tonetti 2014, Alvarez, Buera, and Lucas 2014, Luttmer 2014).
- Interaction of social capital and institutional change in economic history (Greif 1993, 1994, Greif and Tabellini 2010).

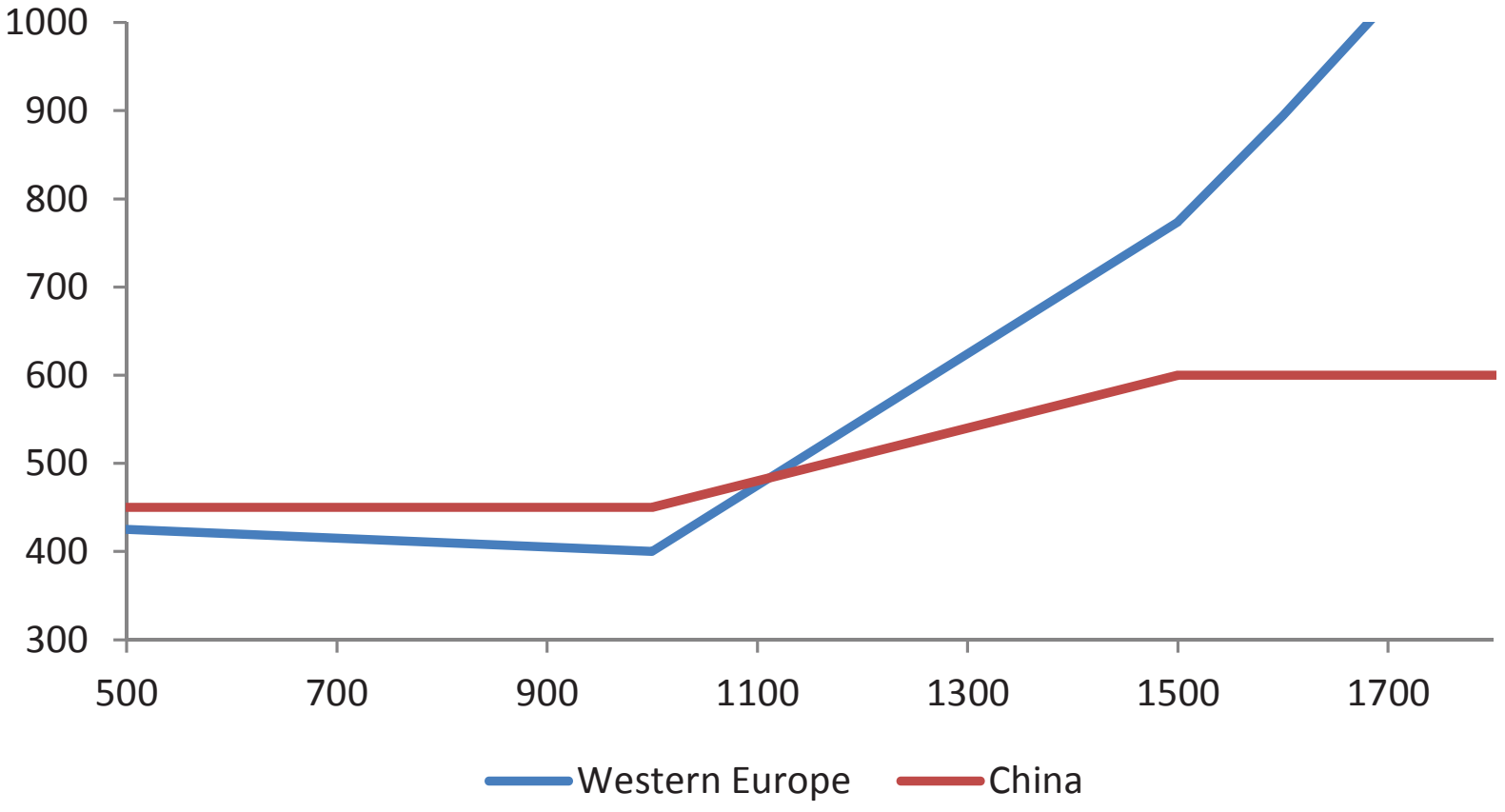
# Outline

Build model where children learn from elders, and adopt the best ideas they have been exposed to. Model exhibits moral-hazard problem in master-apprentice relationship.

Equilibrium depends on institution that deals with moral hazard problem. Distinguish family (early Europe), clan (elsewhere), and guilds and markets (later Europe).

Argue that adoption of superior institutions explains dissemination of knowledge and faster technological progress in Europe.

# Outline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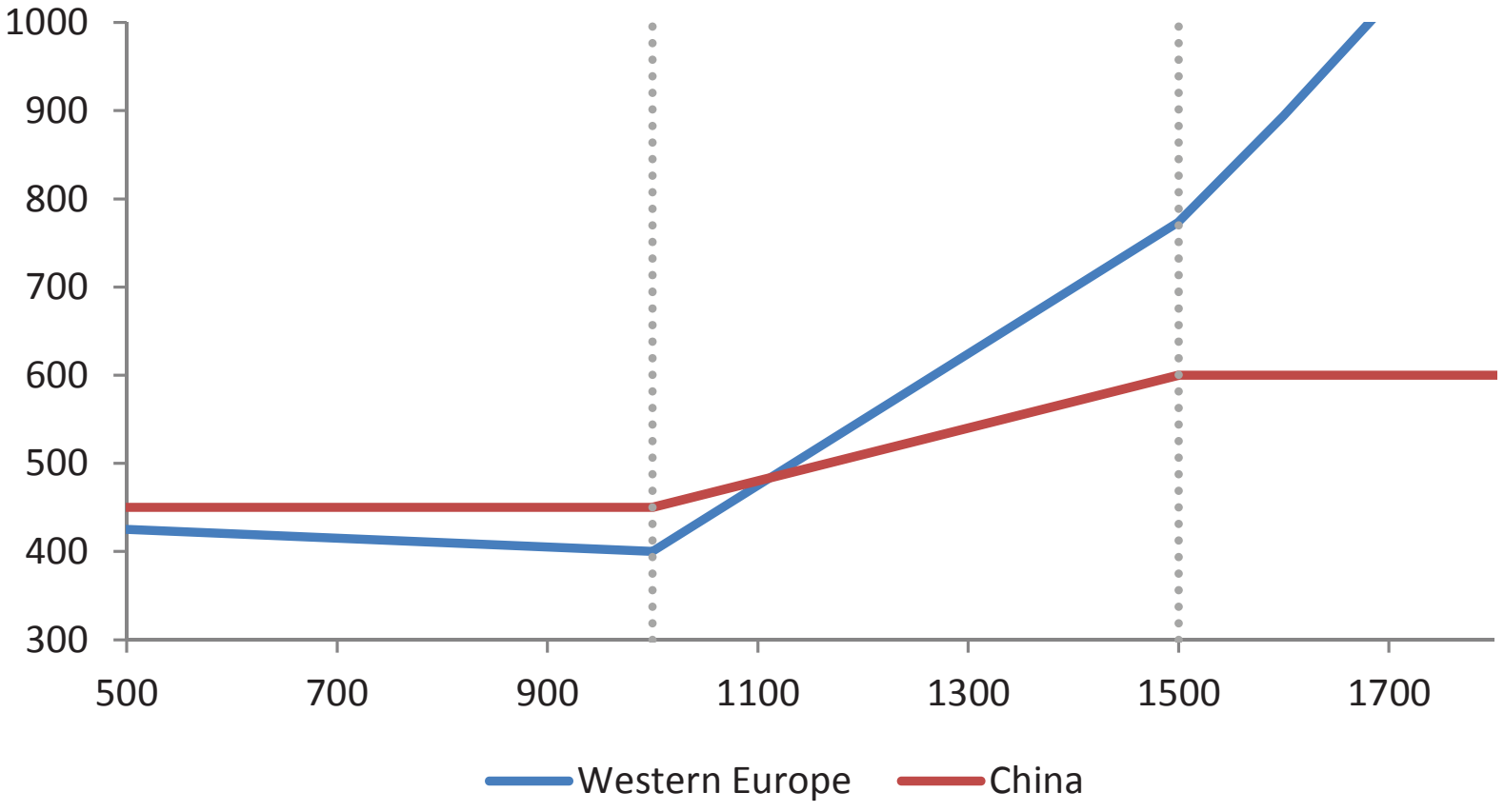
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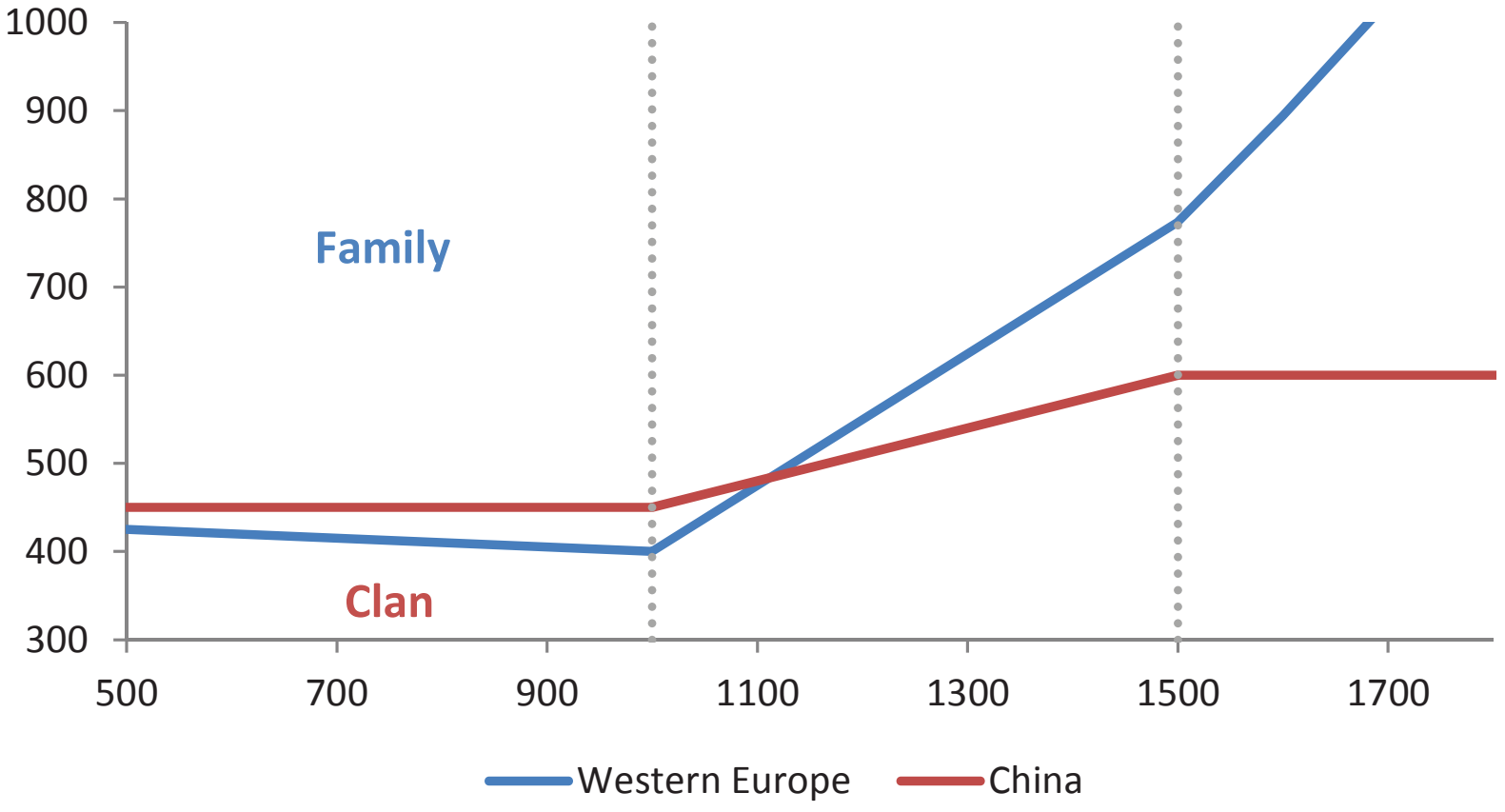
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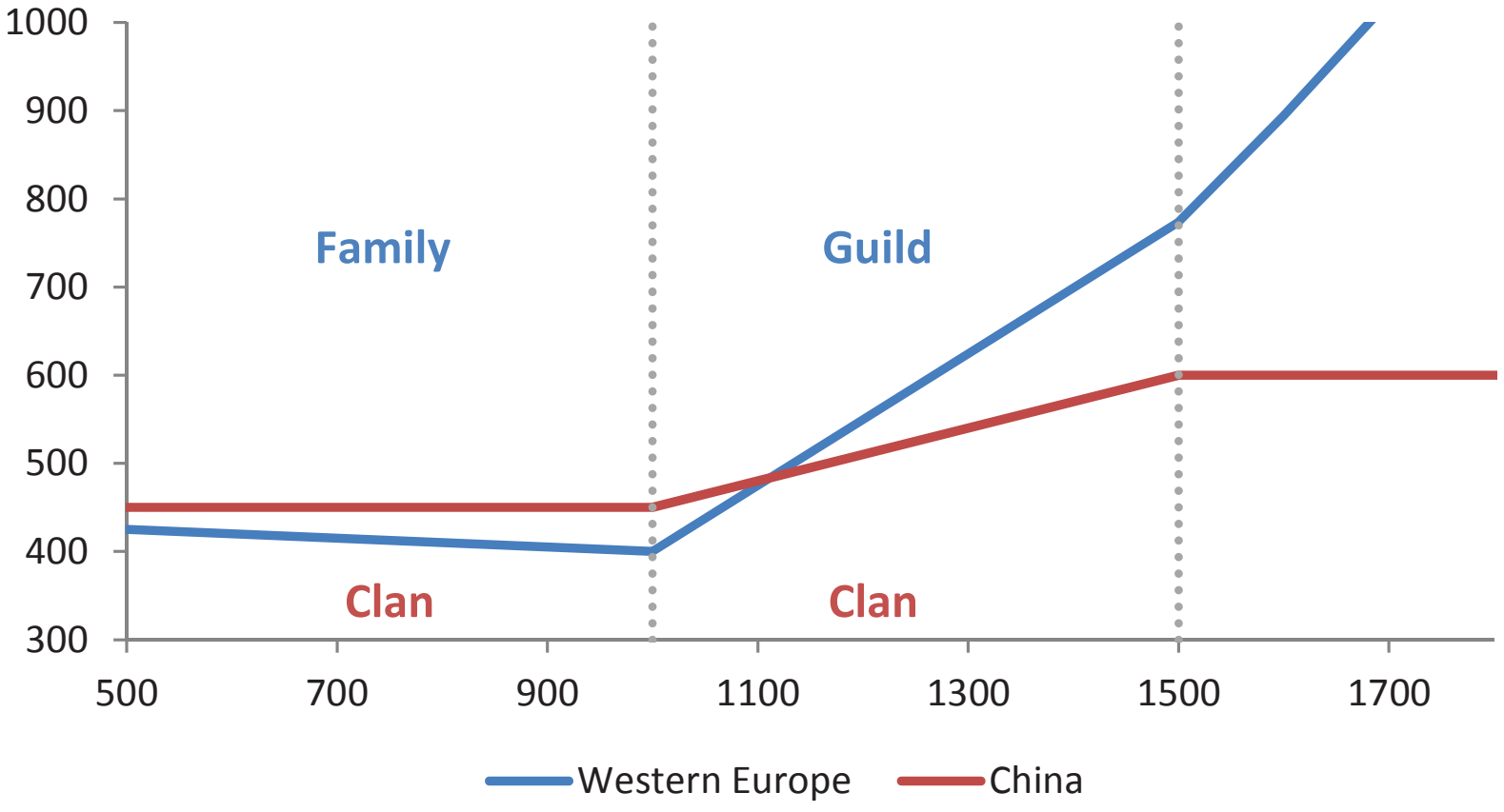
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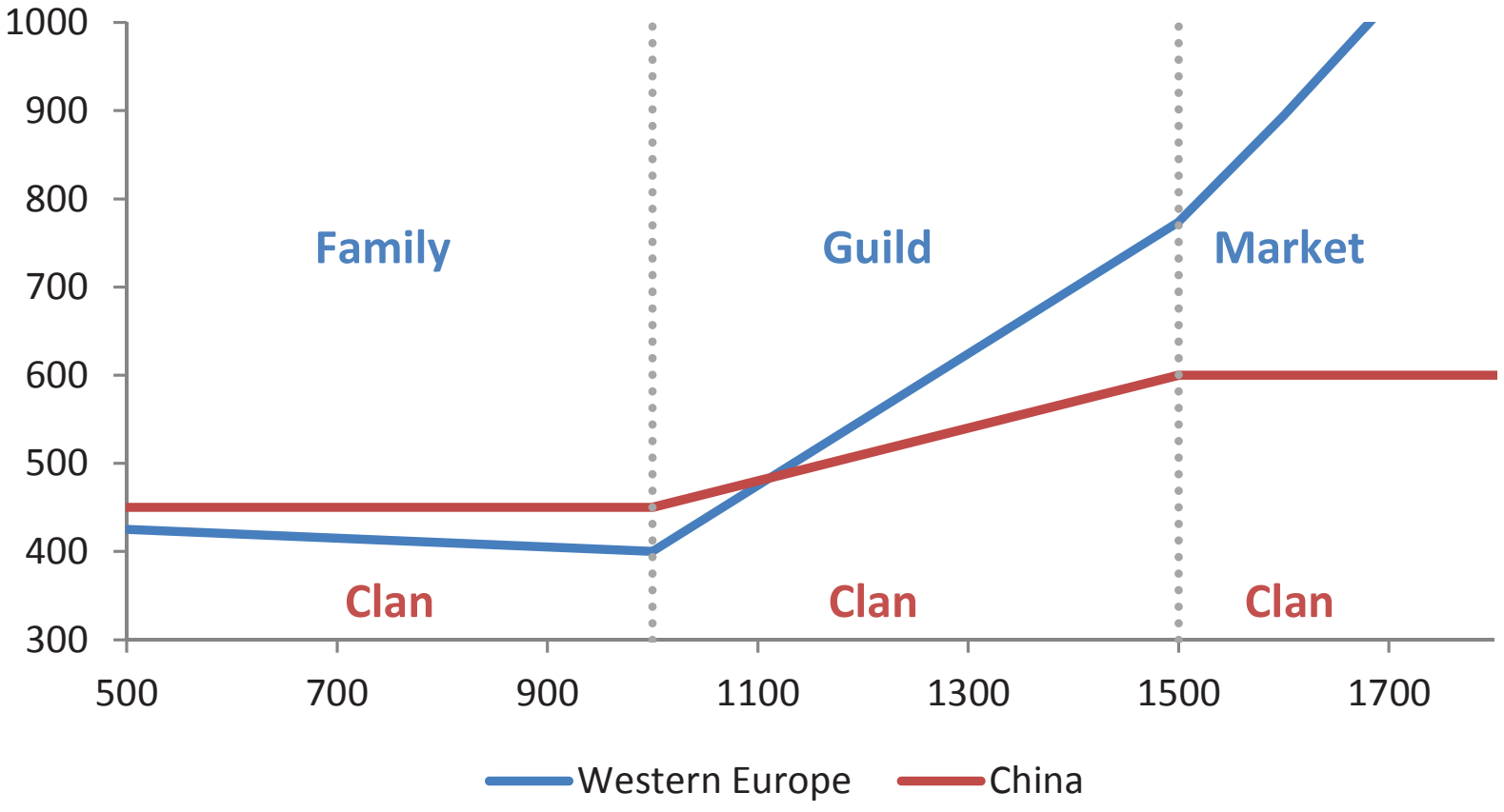
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# Typical Contract in Europe

Marseilles (c. 1250 CE)

April the ninth. I, Peter Borre, in good faith and without guile, place with you, Peter Feissac, weaver, my son Stephen, for the purpose of learning the trade or craft of weaving, to live at your house, and to do work for you from the feast of Easter next for four continuous years, promising you by this agreement to take care that my son does the said work, and that he will be faithful and trustworthy in all that he does, and that he will neither steal nor take anything away from you, nor flee nor depart from you for any reason, until he has completed his apprenticeship. And I, the said Peter Feissac, promise you, Peter Borre, that I will teach your son faithfully and will provide food and clothing for him. Done at Marseilles, near the tables of the money-changers. Witnesses, etc.

# Typical (Incomplete) Contract in Europe

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# Clan versus the Nuclear Family

- China:
  - Confucianism considers moral obligations among kin as the basis for social order (Greif and Tabellini, 2010).
  - Kinship system emphasizes patrilineality.
  - Example: Tang penal code of 624.
    - Hit a paternal grandparent: decapitation.
    - Hit a random person: 40 blows with the stick.
- Europe:
  - Church discouraged practices sustaining kinship groups.
  - By the ninth century, the nuclear family predominated.
    - Distinction between paternal and maternal relatives disappears from Romance language by 600.
    - Spiritual kinships analogous to blood kinships (Mitterauer, 2010).

# Different Apprenticeship Systems

"In China, training was provided by relatives, and hence a narrow group of experts, instead of the much wider training opportunities provided by many European guilds." (Prak and van Zanden, 2013)

"In China, guilds were organized along lines of a common origin, rather than a citizenship in the place where the guild was based as in Europe." (Moll-Murata, 2013)

In Europe, few apprentices were trained by relatives (estimated in London to be 7–28 percent)

# Guilds

Two views:

- Guild-critical: set of rent-seeking clubs, hostile to innovation, limiting membership (Ogilvie).
- Guild rehabilitationist: enforced contracts (Epstein).

Rembrandt (1662) - Governors of the Drapers' Guild

# The Model

Overlapping generations of people.

Output produced using land $X = 1$ and effective craftsmen's labor $L$:

$$Y = L^{1-\alpha} X^{\alpha}.$$

$L$ is an aggregate of labor supplied in different trades:

$$L = \left( \int_0^1 (L_i)^{\frac{1}{\lambda}} \, di \right)^{\lambda}.$$

Craftsmen heterogeneous in knowledge.

Existing knowledge of craftsmen embodied in adult generation.
Future craftsmen acquire knowledge by learning from elders.

# Preferences

Adults make all decisions.

Adult preferences given by utility function:

$$c + \gamma I',$$

where $c$ is consumption and $I'$ is the income of the children.

# Population Growth

Every adult gives birth to $\bar{n} > 0$ children; $n$ survive.

Child survival depends on aggregate output per adult $Y/N$.

Fraction of surviving children is $sY/N$:

$$n = \bar{n} \ \min \left\{ 1, s\frac{Y}{N} \right\}.$$

# Acquiring Knowledge

Consider apprentice who learns from $m$ elders. Efficiency of elder measured by cost parameter $h_i$; labor supply is $h_i^{-\theta}$, generating income:

$$y_i = h_i^{-\theta} \ (1-\alpha) \ \frac{Y}{L}.$$

Apprentice adopts knowledge of most efficient elder visited:

$$h_L = \min \left\{ h_1, h_2, \ldots, h_m \right\}.$$

# New Ideas

On reaching adulthood, apprentice also generates new idea with cost parameter $h_N$.

Final efficiency level is:

$$h' = \min\{h_L, h_N\}.$$

# Distribution of Knowledge and Efficiency

Distribution of craftsmen's cost parameter is exponential:

$$h_i \sim \text{Exp}(k).$$

Distribution parameter $k$ measures average efficiency:

$$\text{E}[h_i] = \frac{1}{k}.$$

Distribution of new idea is also exponential, and quality of new ideas depends on average knowledge:

$$h_N \sim \text{Exp}(\nu k).$$

Parameter $\nu$ measures relative importance of transmitted knowledge and new ideas.

# Evolution of Knowledge

Learning process preserves shape of knowledge distribution over time. With $m$ independent draws, we have:

$$h_L = \min\{h_1, h_2, \ldots, h_m\} \sim \text{Exp}(mk),$$
$$h' = \min\{h_L, h_N\} \sim \text{Exp}(mk + \nu k).$$

Hence, knowledge $k$ evolves according to:

$$k' = (m + \nu)k.$$

# Costs and Benefits of Teaching

When working with an elder, apprentice produces $\kappa$.

Elder who teaches $a$ apprentices incurs cost $\delta(a)$ (increasing, convex).

Moral hazard problem: Elder can take on apprentices, keep production $\kappa a$, but not actually teach, saving cost $\delta(a)$.

# Institutions for Dealing with Moral Hazard

Aggregate state variables $k$ and $N$ pin down income of craftsmen, average income, and evolution of population.

To be determined: Who learns from whom, and resulting growth in knowledge.

Apprenticeship requires institution to resolve moral hazard.

Consider informal and formal institutions.

# Formal versus Informal Institutions

Informal institutions: Mutual punishment strategy in network of people who can communicate.

- Family.
- Clan.

Formal institutions: Contracts are enforced through courts or similar setups.

- Market.
- Guild.

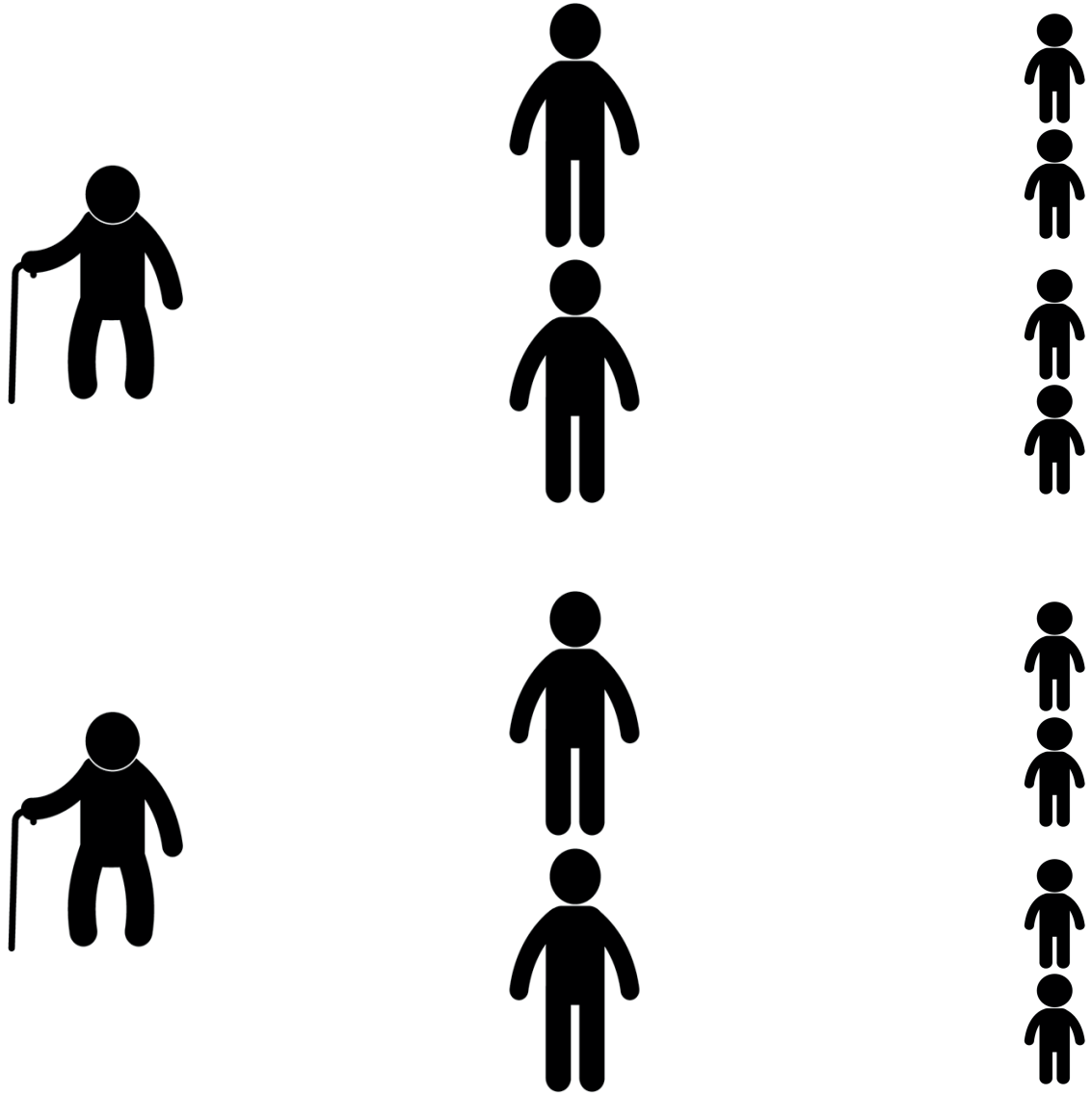
# The Family Equilibrium

Only train your own children. Moral hazard resolved because you like them.

Productivity growth only due to new ideas, but no dissemination of existing ideas.

Income per capita is constant, and population grows at rate that makes this so.

# Knowledge Transmission in Family Equilibrium



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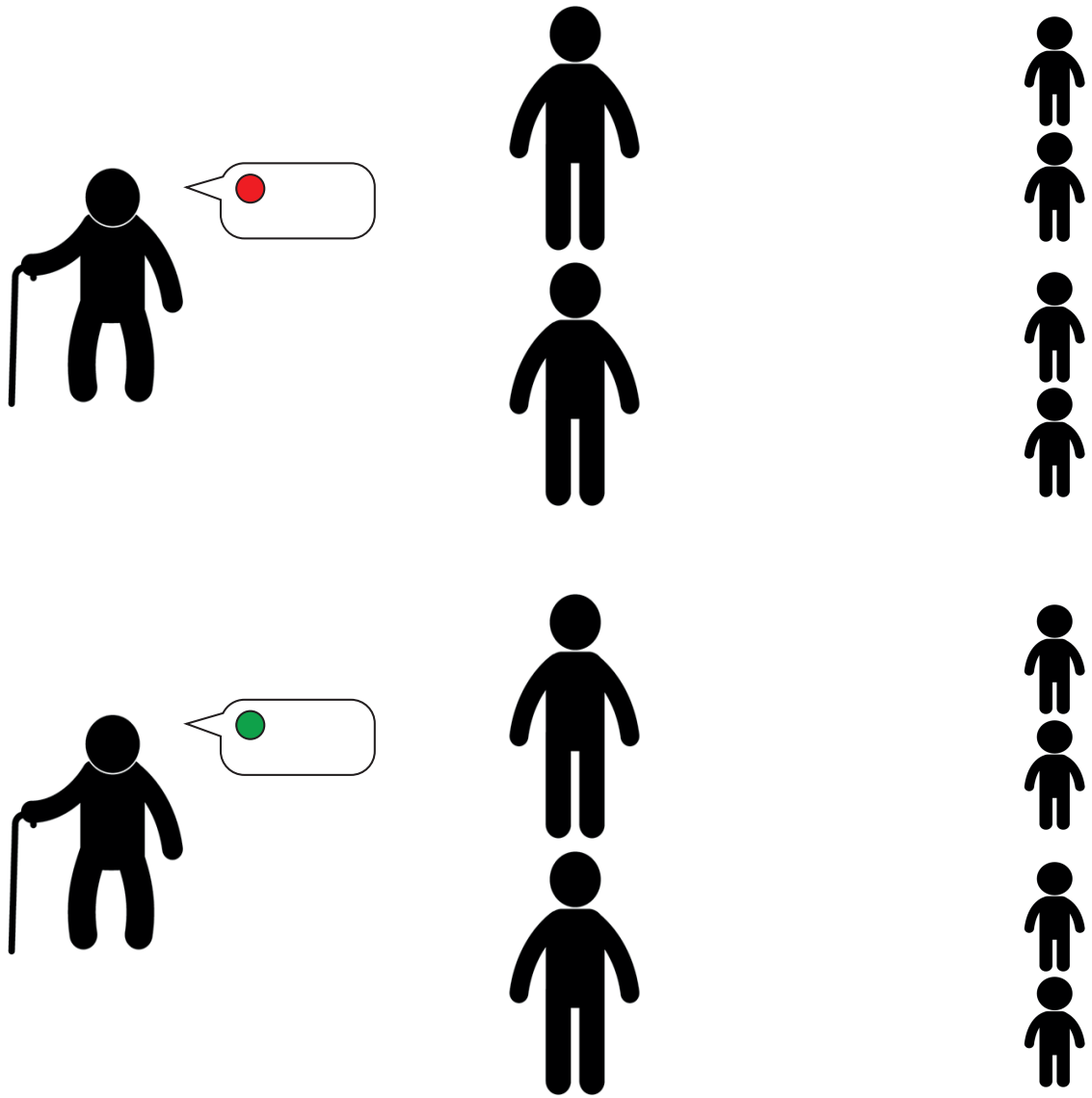

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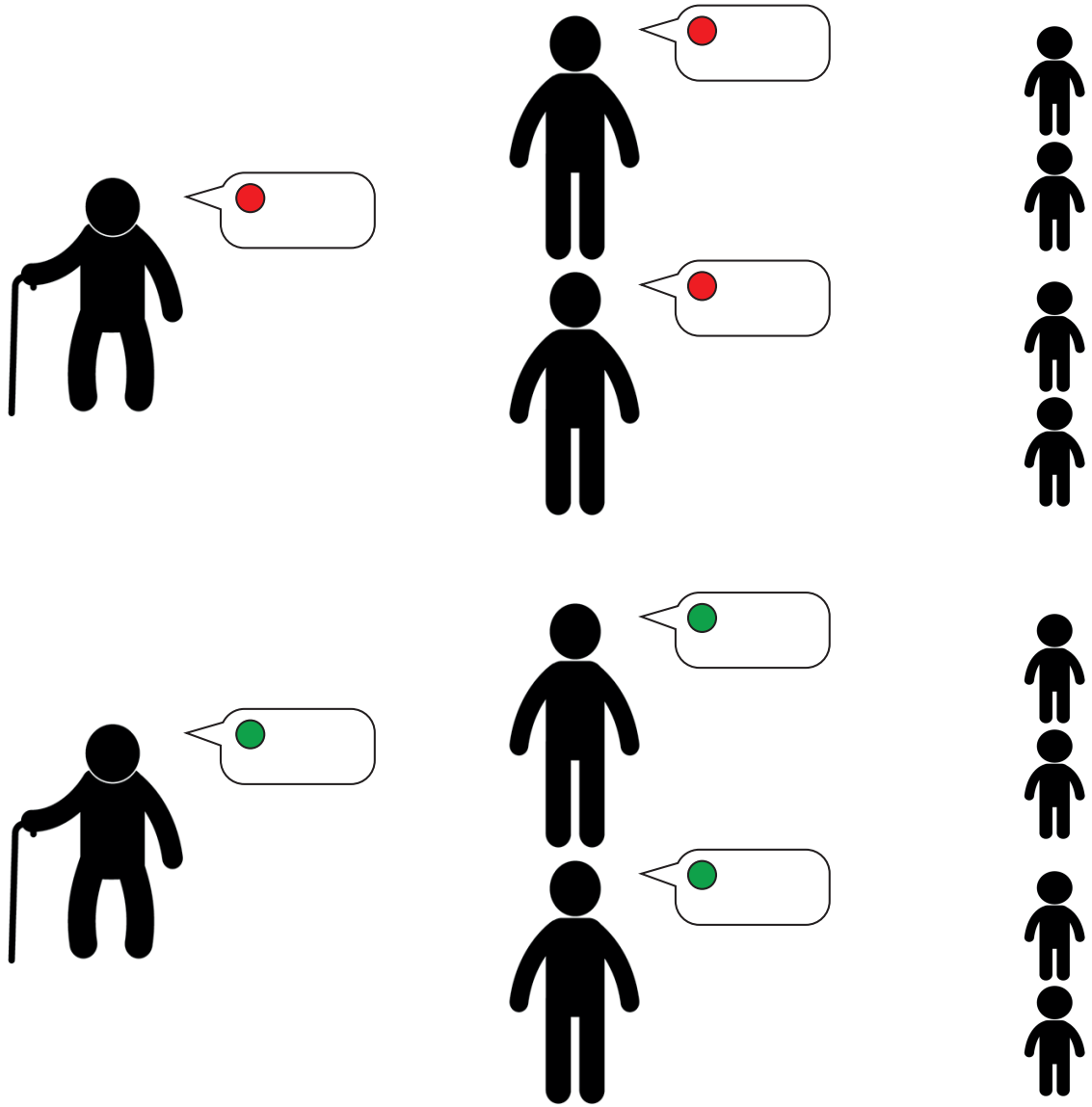

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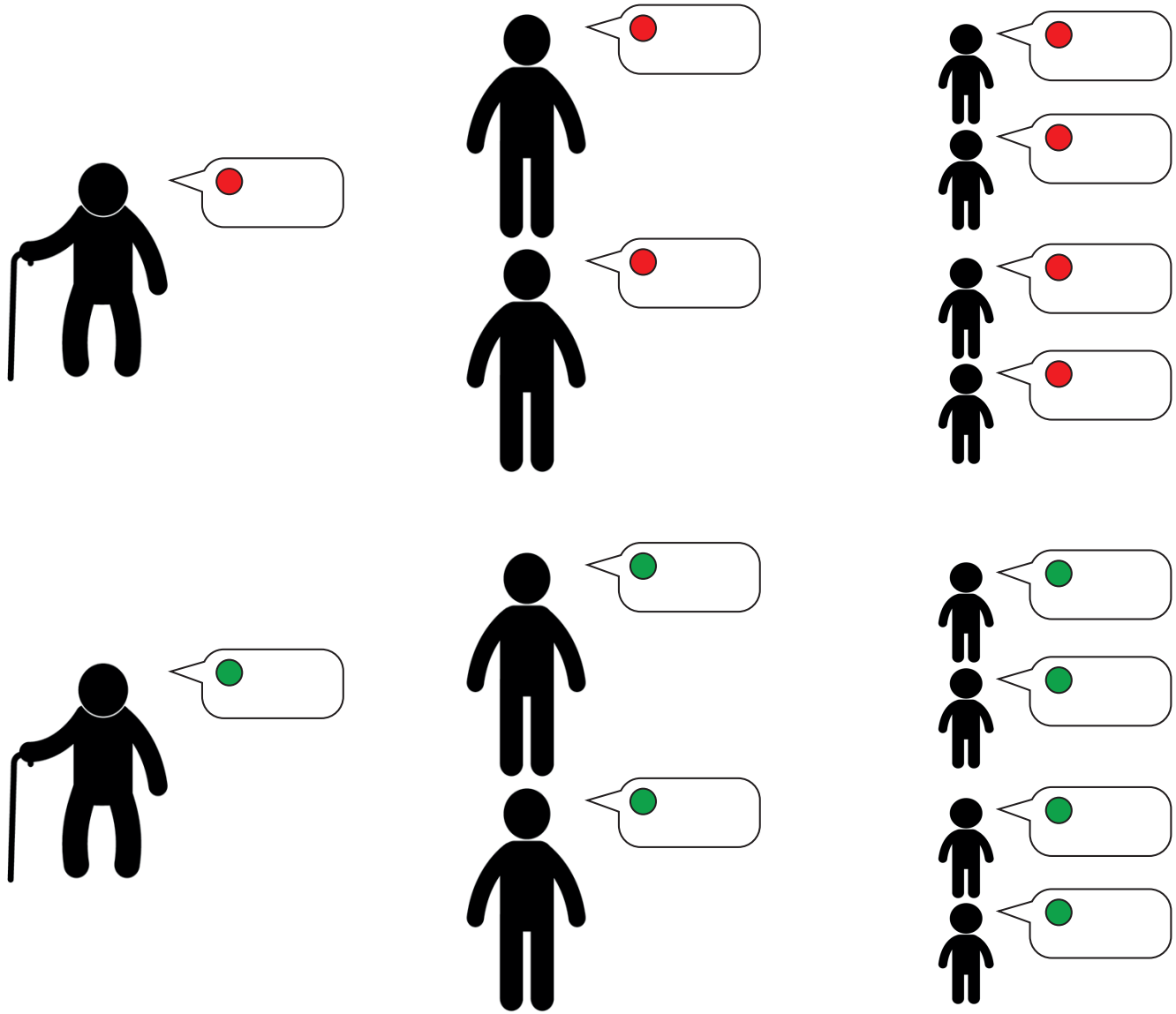

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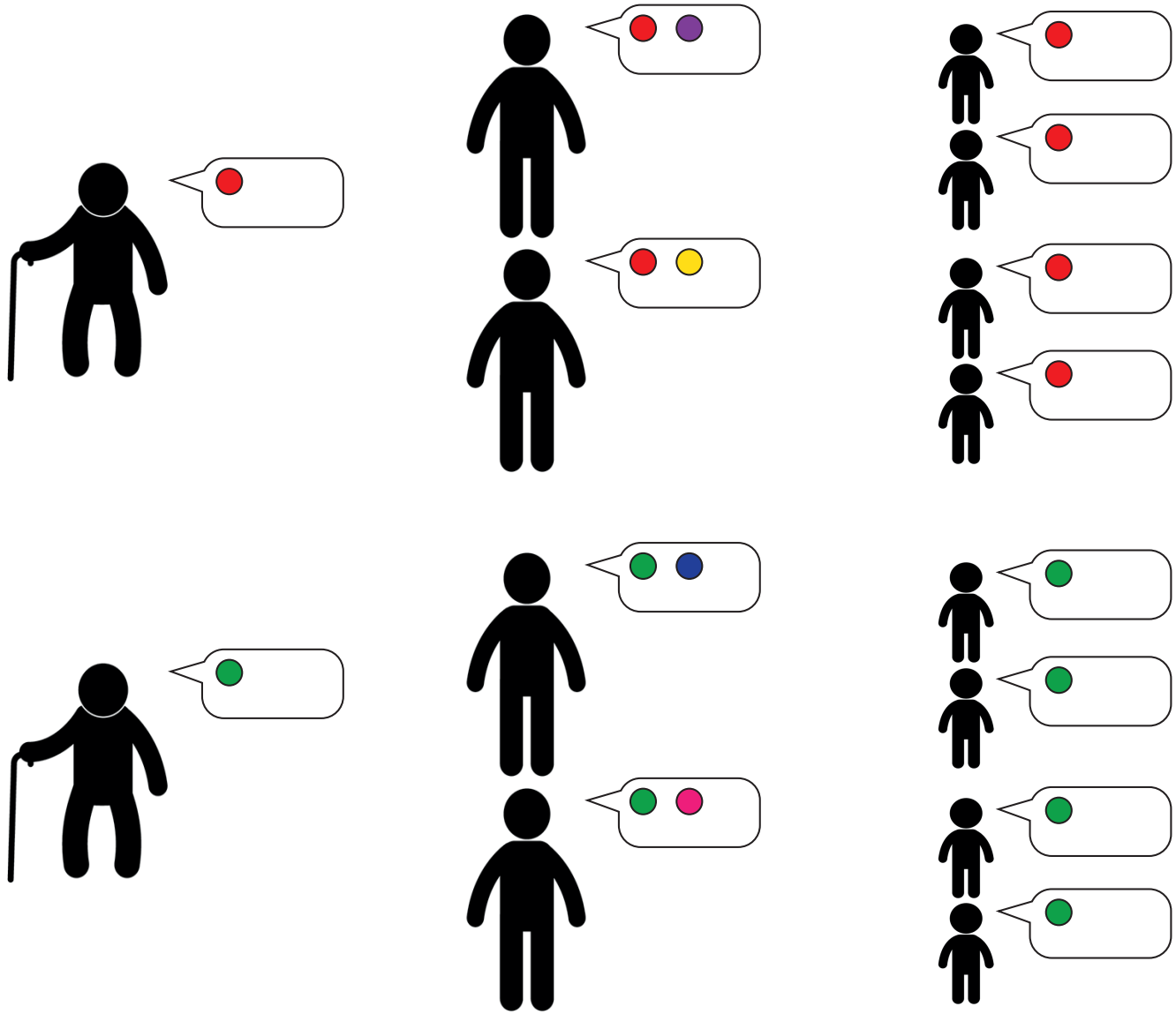

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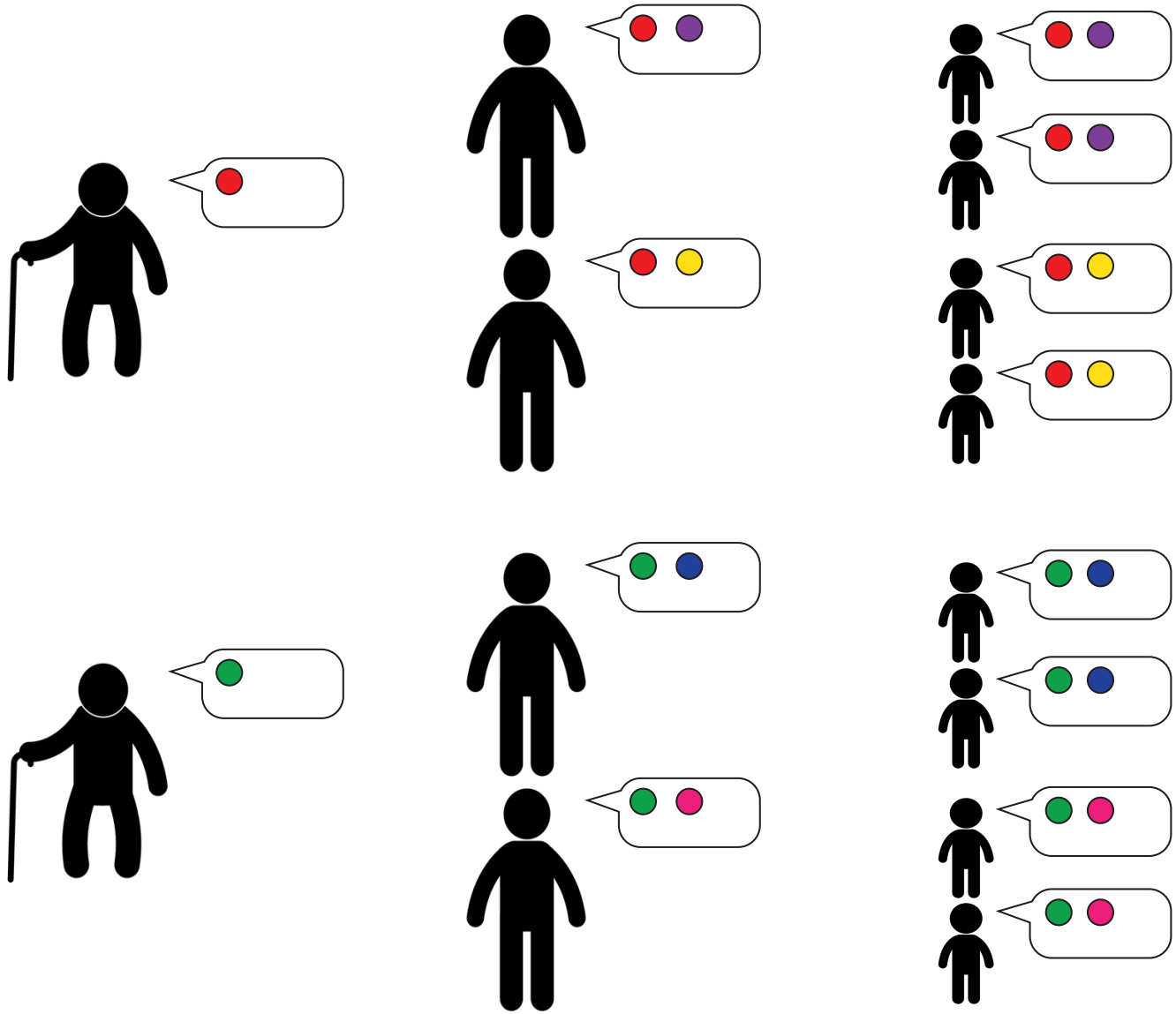


# Balanced Growth in Family Equilibrium

Since each child trains only with own parent, $m = 1$.

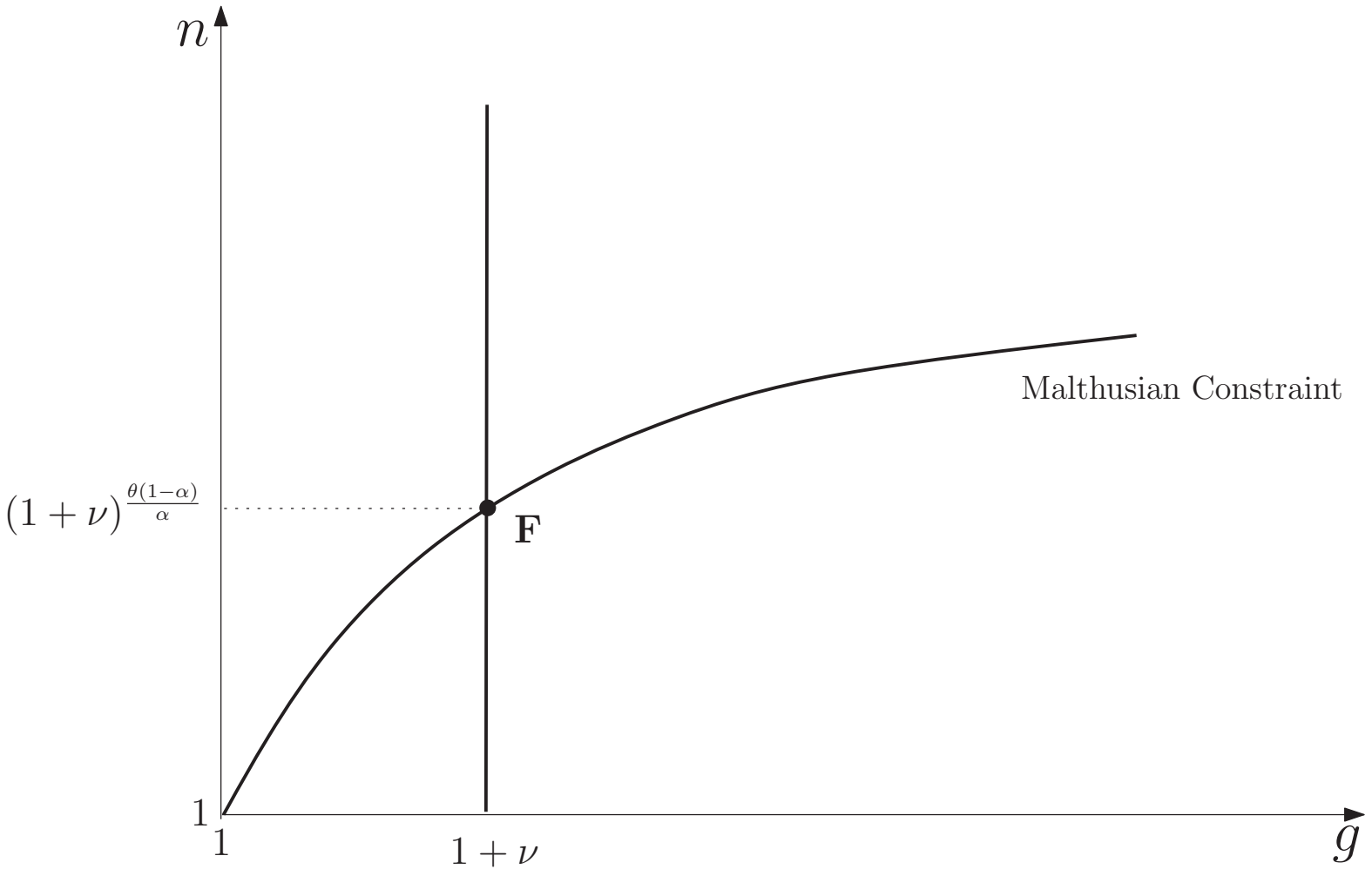
Knowledge $k$ grows at rate $1 + \nu$.

Population $N$ grows at rate $(1 + \nu)^{\frac{(1-\alpha)\theta}{\alpha}}$.

Income per capita is constant and satisfies:

$$\frac{Y}{N} = \frac{(1 + \nu)^{\frac{(1-\alpha)\theta}{\alpha}}}{\bar{n}s}.$$

# Balanced Growth in Family Equilibrium



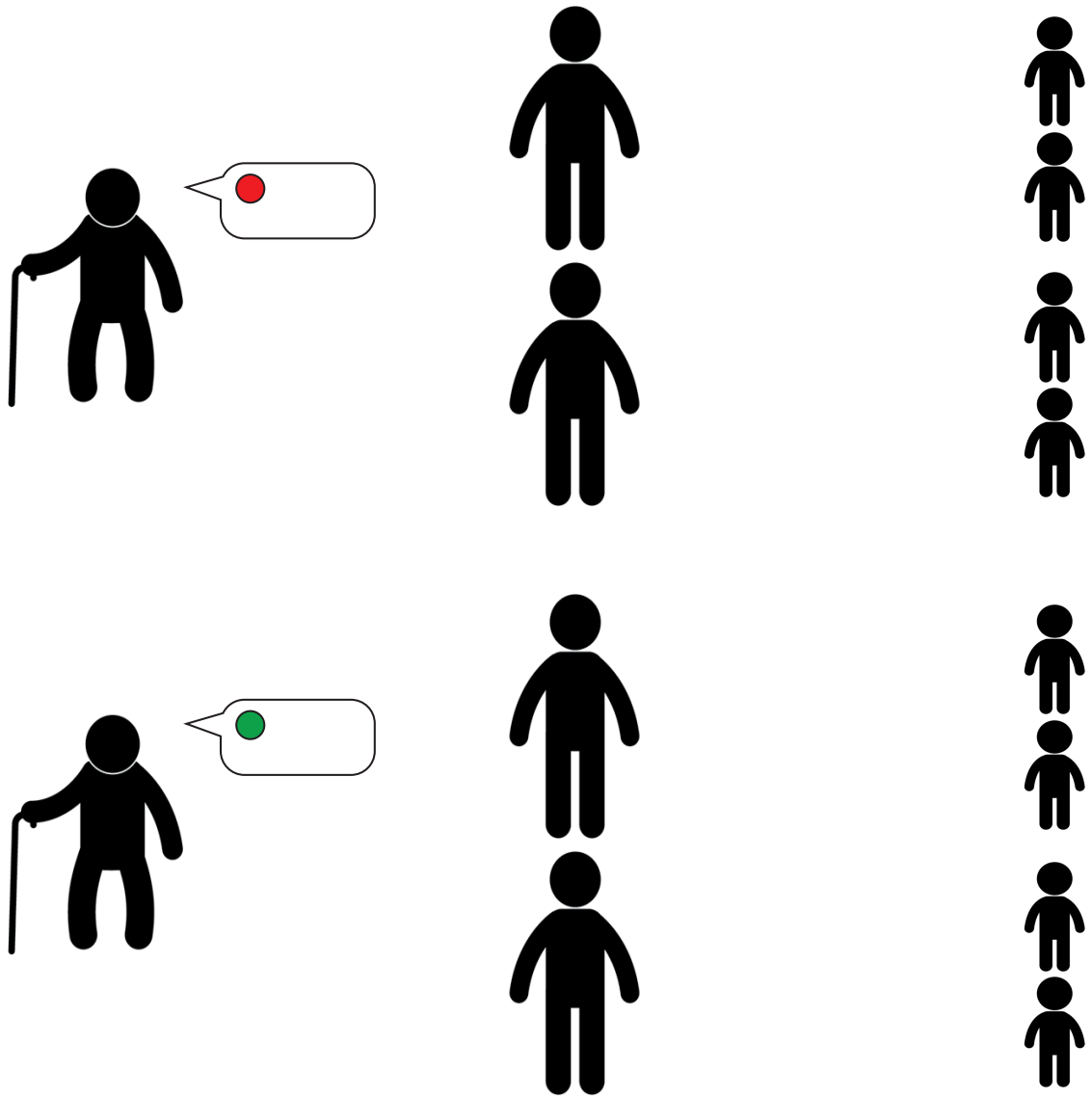
# Clan Equilibrium

All members of a dynasty who share an ancestor $o$ generations back engage in a mutual enforcement mechanism.

All craftsmen send their children to be trained by all current members of the dynasty.

Knowledge growth and income higher compared to family equilibrium, but no dissemination of knowledge across clans.

# Knowledge Transmission in Clan Equilibrium



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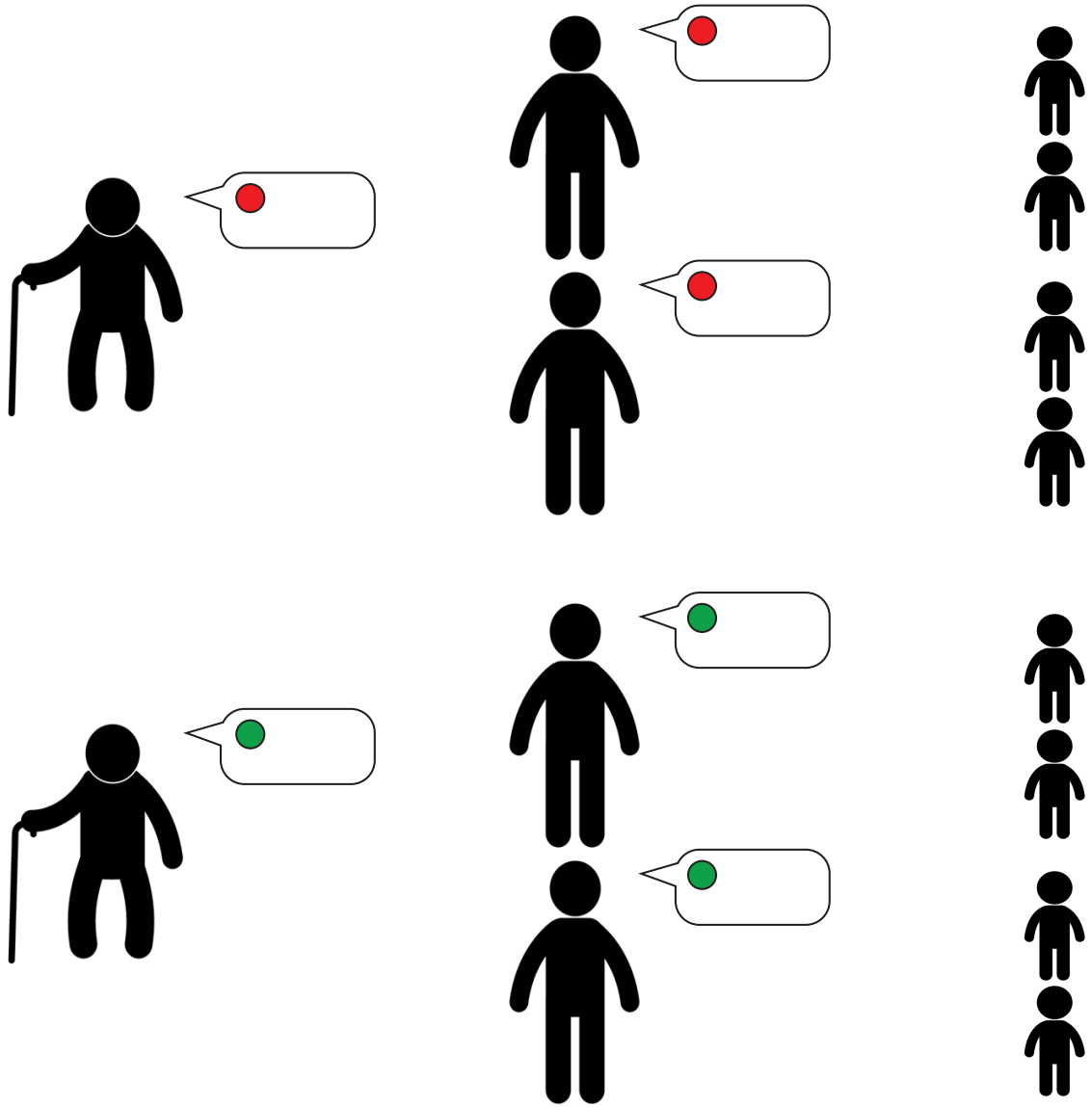

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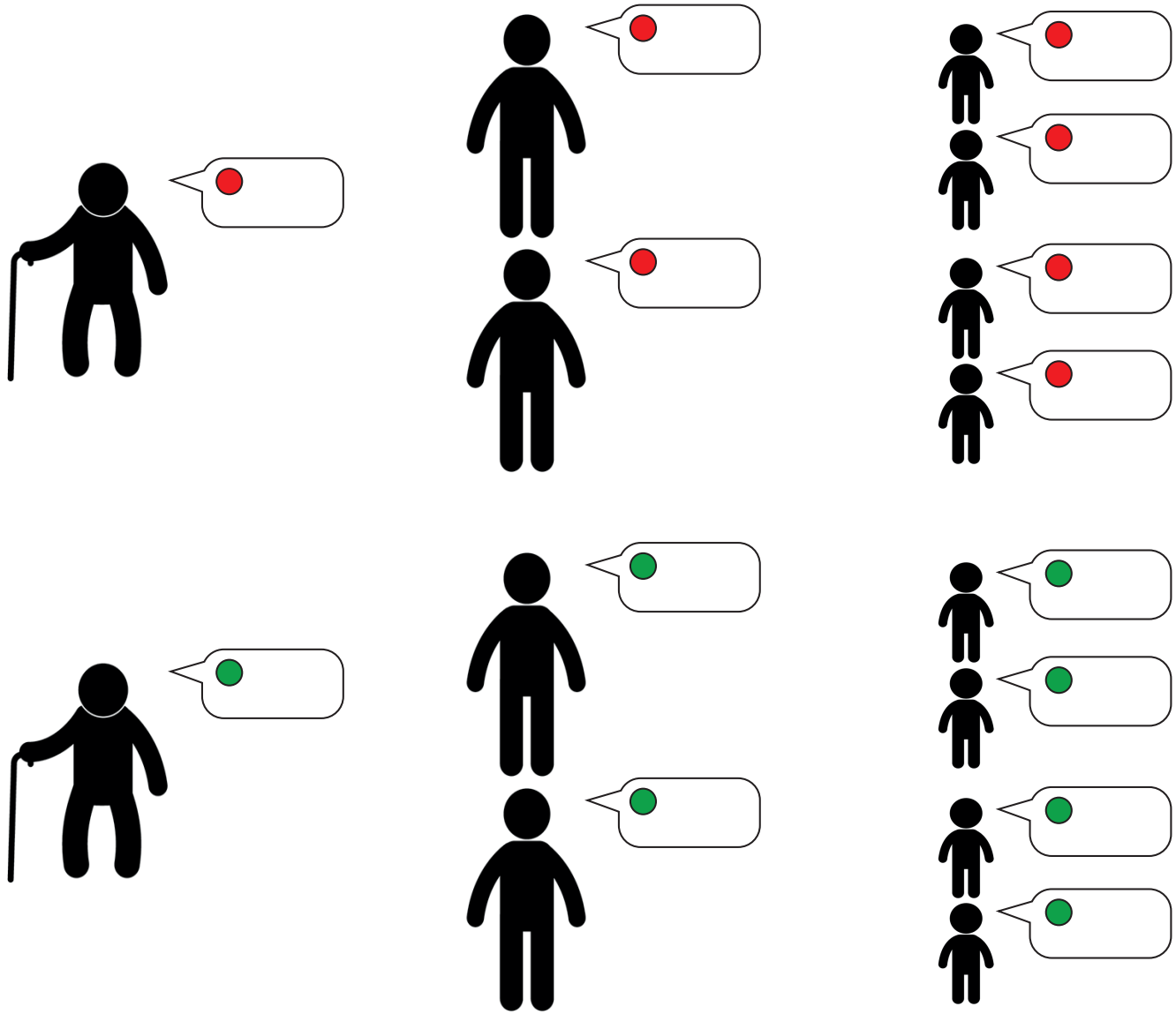

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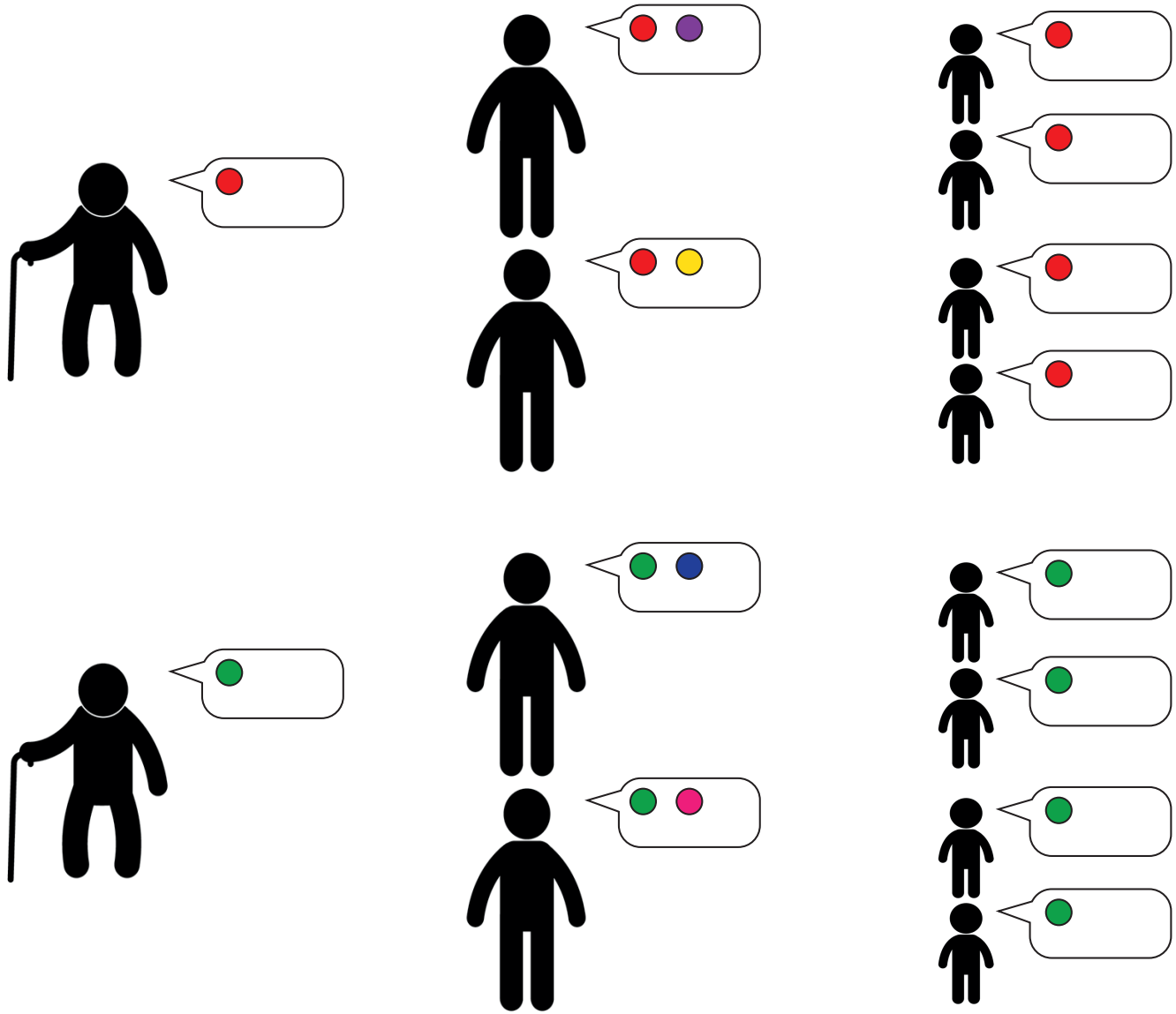

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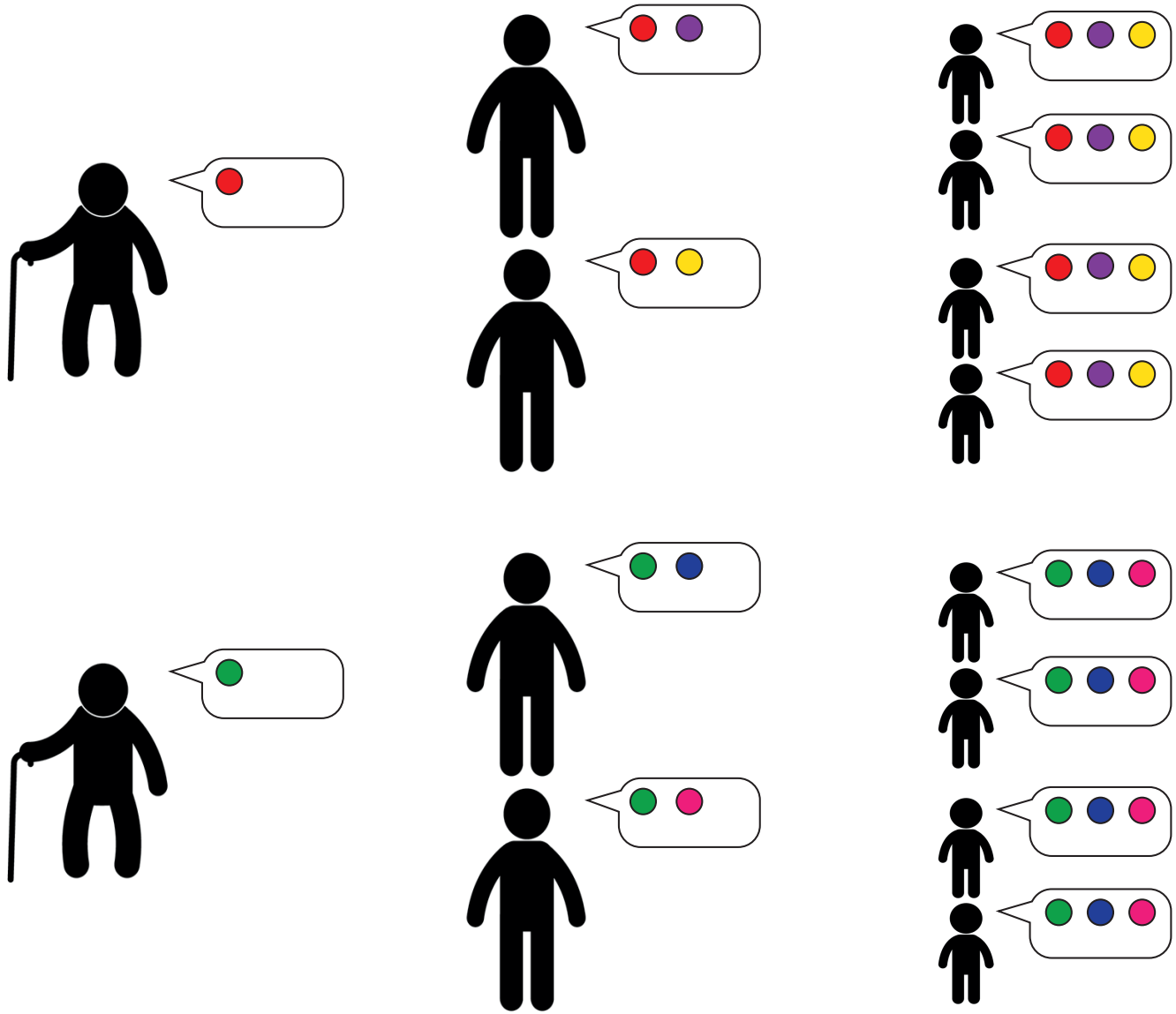


# Balanced Growth in Clan Equilibrium

Growth rate of knowledge $k$, growth rate of population $N$, and income per capita given by:

$$g_{\text{clan}} = 1 + \frac{\nu \left(n_{\text{clan}}\right)^{o}}{g_{\text{clan}} - \nu} < m_{\text{clan}} + \nu,$$

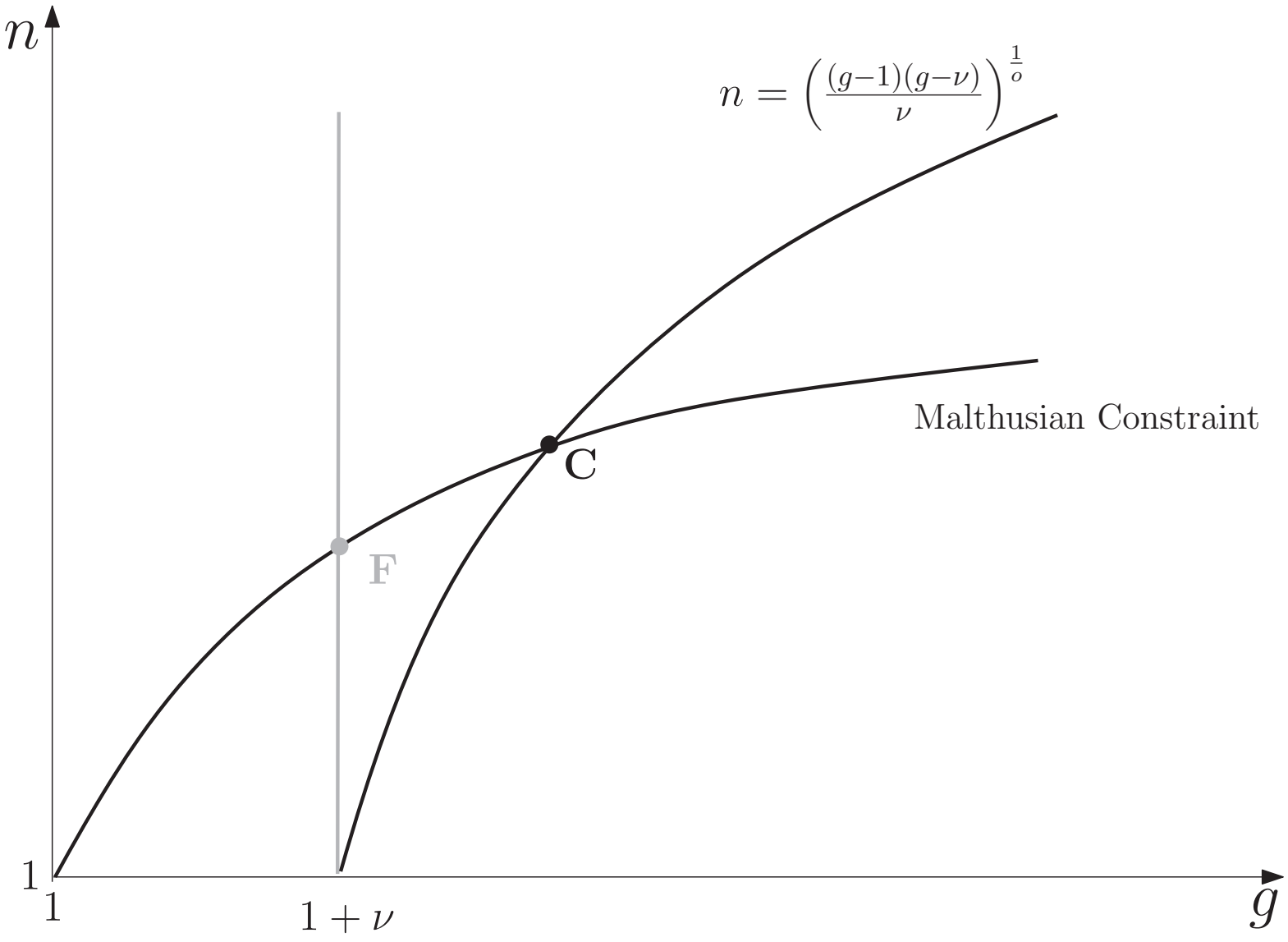
$$n_{\text{clan}} = \left(g_{\text{clan}}\right)^{\frac{(1-\alpha)\theta}{\alpha}},$$

$$\frac{Y}{N} = \frac{\left(g_{\text{clan}}\right)^{\frac{(1-\alpha)\theta}{\alpha}}}{\bar{n}s}.$$

Knowledge growth and income higher compared to family equilibrium.

Population growth and knowledge growth are mutually interdependent.

# Balanced Growth in Clan Equilibrium



# An Apprenticeship Market

Consider outcomes in economy with formal contract enforcement where masters cannot cheat.

Parents decide how many masters $m$ their child will visit at price $p$.

Masters decide how many apprentices to accept given price $p$.

Price paid by parents to masters clears the apprenticeship market.

# Masters' Decision to Accept Apprentices

Given $p$, accept apprentices to maximize profits:

$$\max_{a} \{pa + \kappa a - \delta(a)\}.$$

Price satisfies:

$$p = \delta'(a) - \kappa.$$

# Parents' Decision to Apprentice Children

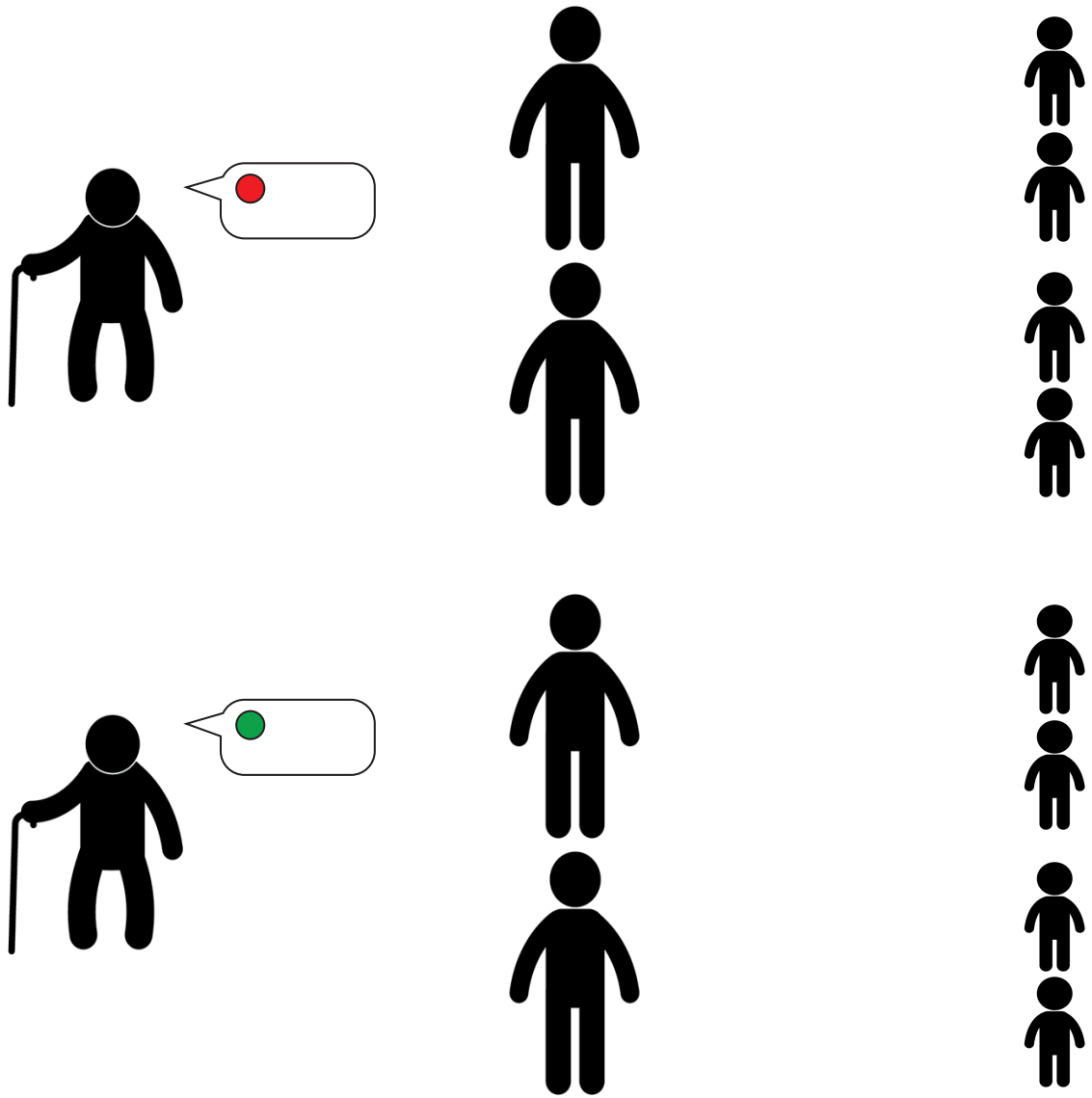
Given $p$, choose number of masters to maximize utility:

$$\max_m \mathrm{E}\left\{-pm + \gamma y'_{\mathrm{M}}\right\}.$$

First-order condition:

$$\underbrace{p}_{\text{marginal cost}} = \underbrace{\gamma \frac{\partial \mathrm{E}[q']}{\partial m}(1-\alpha)\frac{Y'}{L'}}_{\text{marginal benefit}}.$$

# Knowledge Transmission in Market Equilibrium



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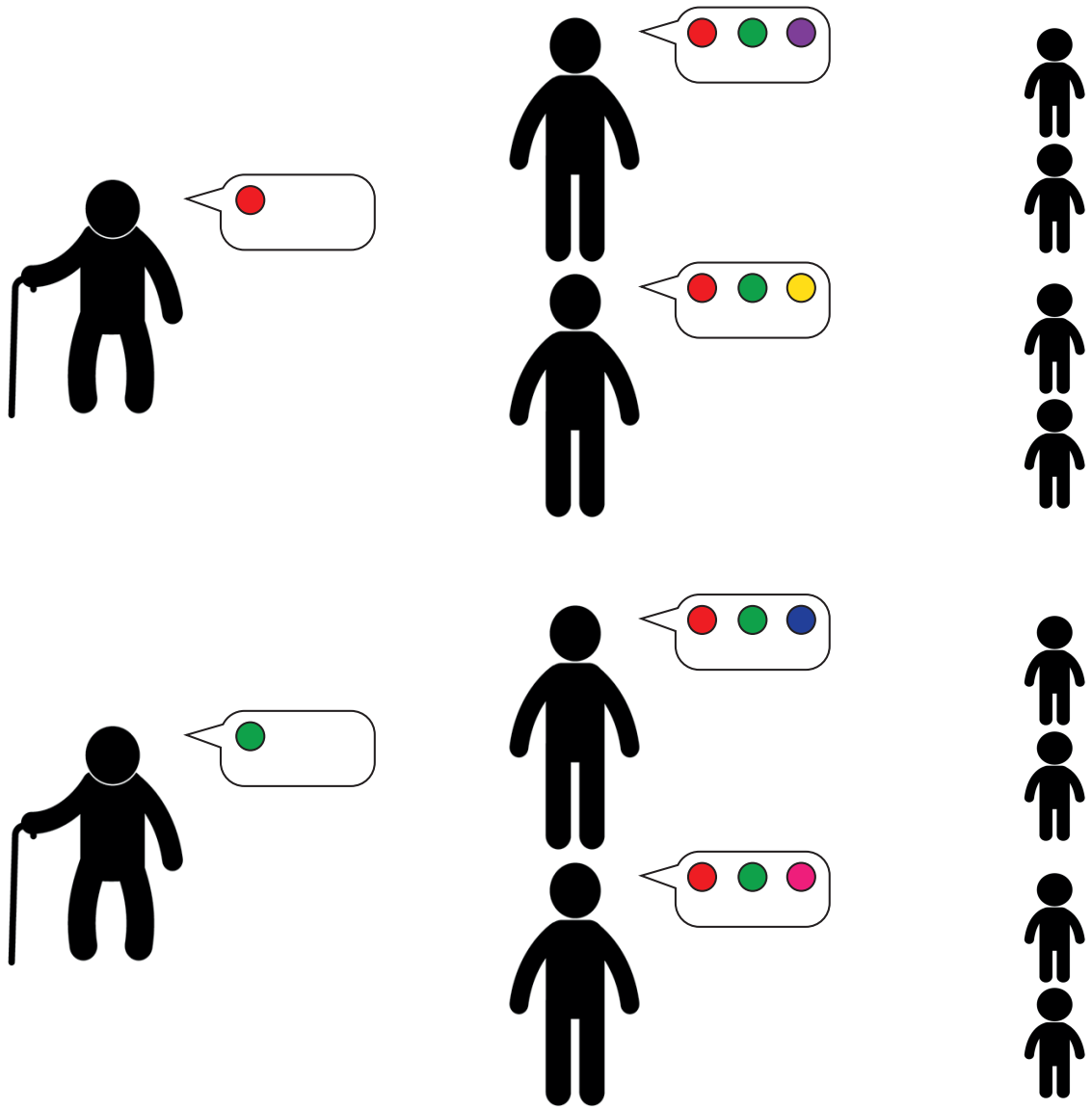

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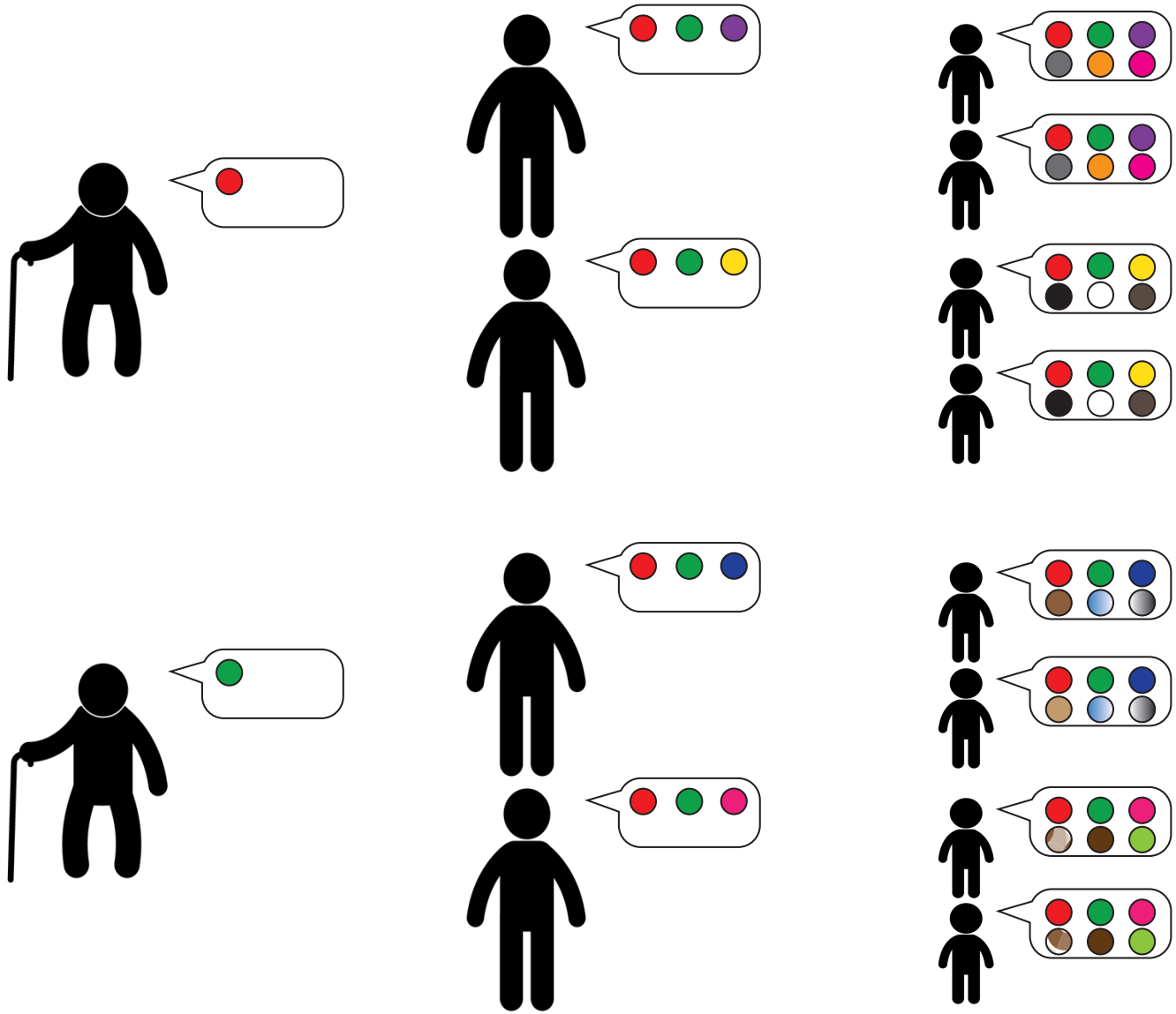


# Balanced Growth in Market Equilibrium

Equilibrium in Apprenticeship Market:

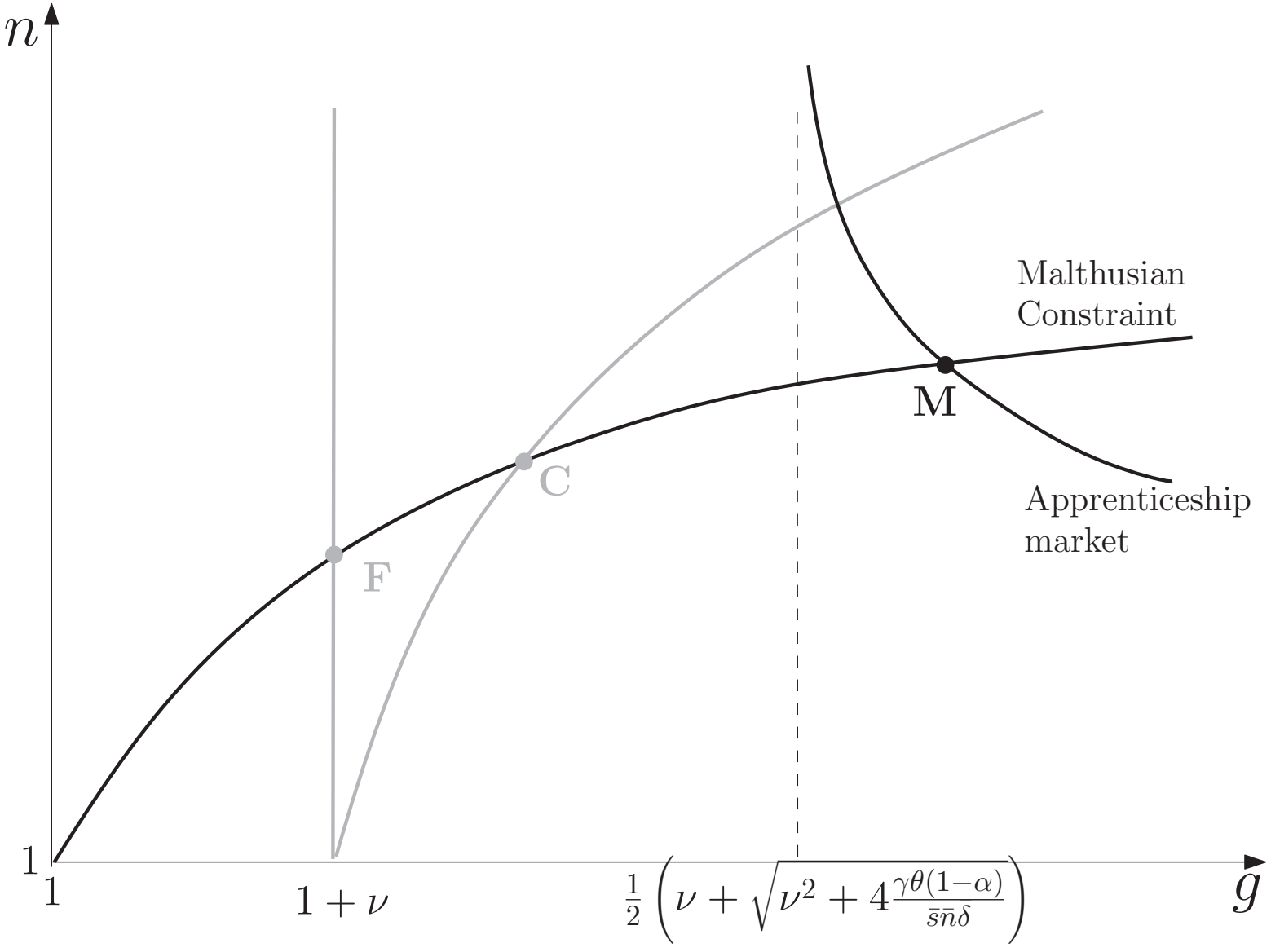
$$a = m\, n_{\text{market}}.$$

Growth rate of knowledge $k$, growth rate of population $N$, and income per capita given by:

$$\begin{aligned} g_{\text{market}} &= m_{\text{market}} + \nu, \\ n_{\text{market}} &= \left(g_{\text{market}}\right)^{\frac{(1-\alpha)\theta}{\alpha}}, \\ \frac{Y}{N} &= \frac{\left(g_{\text{market}}\right)^{\frac{(1-\alpha)\theta}{\alpha}}}{\bar{n}s}. \end{aligned}$$

Growth higher than in clan equilibrium.

# Balanced Growth in Market Equilibrium



# The Guild

Long historical debate on the merits, or lack thereof, of guilds.

Guilds' role for apprenticeship:

- Regulate entry of masters.
- Regulate apprenticeship contract.
- Enforce the rules.

# The Guild

Positive channel: Need institution that enforces apprenticeship contract. Guilds provided such an institution when government-provided enforcement was less effective.

Negative channel: By restricting access to and raising price of apprenticeship, guilds lower rate of knowledge growth.

# Guild Equilibrium

Coalition of all masters in a given trade.

Guild sets the price for apprenticeship $p$ and the maximum number of apprentices per master $a$.

In guild equilibrium, number of apprentices per master $a$, number of masters per child $m$, knowledge growth, and income per capita lower compared to market equilibrium.

However, guild equilibrium may still generate higher growth than clan equilibrium.

# Guild Equilibrium

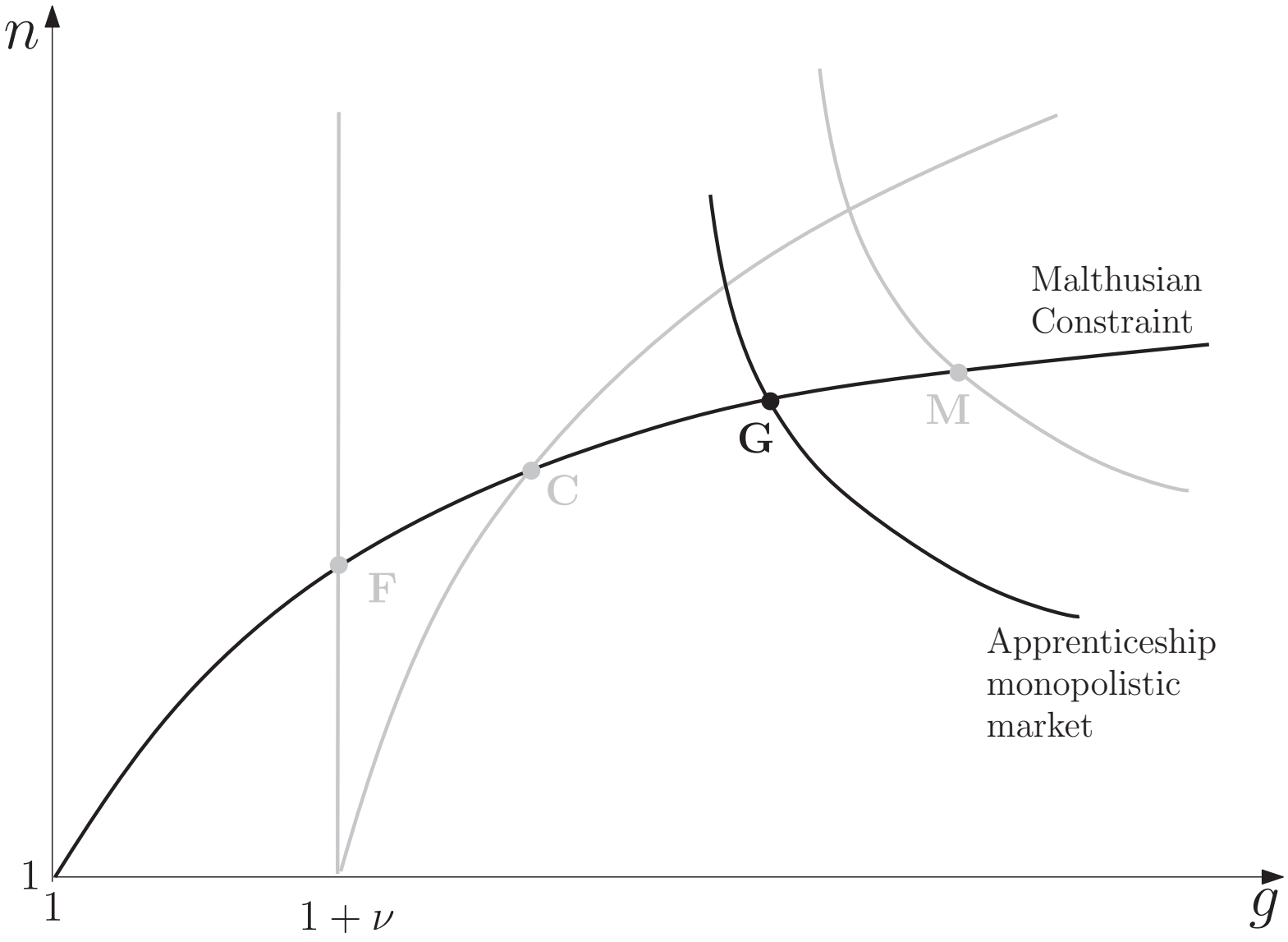
Guild restricts access to entrepreneurship, but still supports choosing masters in optimal (random) manner: otherwise market price for apprenticeship falls.

Hence, guild beneficial for dissemination of knowledge across ancestral lines.

For given number of masters $m$, growth in guild equilibrium always higher than in clan equilibrium.

Guilds were beneficial for knowledge growth, but only as long as there was a lack of alternative, market-based enforcement institutions.

# Balanced Growth in Guild Equilibrium



# The Rise of Europe

Consider possibility of adopting guild system (and, later, the market) at fixed cost $\mu$ (e.g., cost of moving to city with enforcement institutions).

Gain from adoption larger when initial equilibrium is worse.

Thus, Europe (family equilibrium) more likely to adopt institution compared to regions in clan equilibrium.

# The Rise of Europe

Complementary channels:

- Absence of clans led to creation of a variety of impersonal institutions (cities, corporations, monasteries, universities, . . . ). May have facilitated creation of guilds.
- European cities were dense, facilitating creation of institutions that cut across family lines.
- Control by elders in clan-based system.

# Summary

Explicit model of technological progress in pre-industrial times, based on master-apprentice transmission.

Compare alternative institutions to deal with moral hazard problem in master-apprentice relationship.

Useful for understanding the Rise of Europe.

Useful for understanding the role of guilds for pre-industrial growth.