Technology and Institutions Appropriability and Inequality

Michele Boldrin

WUStL, Ca' Foscari, INSE-PKU, CEPR

5th INSE Symposium, PKU, December 2019.

Introduction

- Economic growth is driven by technology and institutions

Introduction

- Economic growth is driven by technology and institutions
- Economic growth changes level and distribution of income *simultaneously*

Introduction

- Economic growth is driven by technology and institutions
- Economic growth changes level and distribution of income *simultaneously*
- This happens through interaction between technology and institutions

Introduction

- Economic growth is driven by technology and institutions
- Economic growth changes level and distribution of income *simultaneously*
- This happens through interaction between technology and institutions
- Which comes "first"?

Introduction

- Economic growth is driven by technology and institutions
- Economic growth changes level and distribution of income *simultaneously*
- This happens through interaction between technology and institutions
- Which comes "first"?
- This a difficult dynamic question

Introduction

- Economic growth is driven by technology and institutions
- Economic growth changes level and distribution of income *simultaneously*
- This happens through interaction between technology and institutions
- Which comes "first"?
- This a difficult dynamic question
- Marx, among other, had an answer ...

Defining the Analytical Framework

1. Higher appropriability $=>$ more incentive for innovator (monopoly/inequality)

Defining the Analytical Framework

1. Higher appropriability => more incentive for innovator (monopoly/inequality)
2. Broader appropriability => larger set of potential innovators (competition/equality)

Defining the Analytical Framework

1. Higher appropriability => more incentive for innovator (monopoly/inequality)
2. Broader appropriability => larger set of potential innovators (competition/equality)
3. Tradeoff or reinforcement between competition and innovation?

Defining the Analytical Framework

1. Higher appropriability => more incentive for innovator (monopoly/inequality)
2. Broader appropriability => larger set of potential innovators (competition/equality)
3. Tradeoff or reinforcement between competition and innovation?
4. Tradeoff or reinforcement between inequality and growth?

Defining the Analytical Framework

1. Higher appropriability => more incentive for innovator (monopoly/inequality)
2. Broader appropriability => larger set of potential innovators (competition/equality)
3. Tradeoff or reinforcement between competition and innovation?
4. Tradeoff or reinforcement between inequality and growth?
5. Not all institutions work the same for all technologies, and viceversa

Example - Superstars (I)

- Single period, two goods: $u(c) + m$

Example - Superstars (I)

- Single period, two goods: $u(c) + m$
- Two kinds of labor, A and B, each with one unit. Equally skilled at producing m, one to one basis

Example - Superstars (I)

- Single period, two goods: $u(c) + m$
- Two kinds of labor, A and B, each with one unit. Equally skilled at producing m, one to one basis
- One unit of A produces $(1 + \varepsilon)\beta$ units of c, one unit of B produces β units of it

Example - Superstars (I)

- Single period, two goods: $u(c) + m$
- Two kinds of labor, A and B, each with one unit. Equally skilled at producing m, one to one basis
- One unit of A produces $(1 + \varepsilon)\beta$ units of c, one unit of B produces β units of it
- Price of A is $1 + \varepsilon$ times the price of B as long as both goods are perfectly divisible

Example - Superstars (I)

- Single period, two goods: $u(c) + m$
- Two kinds of labor, A and B, each with one unit. Equally skilled at producing m, one to one basis
- One unit of A produces $(1 + \varepsilon)\beta$ units of c, one unit of B produces β units of it
- Price of A is $1 + \varepsilon$ times the price of B as long as both goods are perfectly divisible
- Comparative advantage: agent B produces c only after $(1 + \varepsilon)\beta$ units are produced by A

Example - Superstars (I)

- Single period, two goods: $u(c) + m$
- Two kinds of labor, A and B, each with one unit. Equally skilled at producing m, one to one basis
- One unit of A produces $(1+\varepsilon)\beta$ units of c, one unit of B produces β units of it
- Price of A is $1+\varepsilon$ times the price of B as long as both goods are perfectly divisible
- Comparative advantage: agent B produces c only after $(1+\varepsilon)\beta$ units are produced by A
- Let ℓ_2 be amount of type B labor in the c sector. Then $\beta u'[\beta(1+\varepsilon) + \beta\ell_2] = 1$ holds

Example - Superstars (II)

- Technological change increases the productivity parameter β

Example - Superstars (II)

- Technological change increases the productivity parameter β
- If $u'(c)$ is eventually inelastic, then ℓ_2 falls as β rises, and B is forced out of c

Example - Superstars (II)

- Technological change increases the productivity parameter β
- If $u'(c)$ is eventually inelastic, then ℓ_2 falls as β rises, and B is forced out of c
- However it will always be the case that B will earn 1 and A will earn $1 + \varepsilon$

Example - Superstars (II)

- Technological change increases the productivity parameter β
- If $u'(c)$ is eventually inelastic, then ℓ_2 falls as β rises, and B is forced out of c
- However it will always be the case that B will earn 1 and A will earn $1 + \varepsilon$
- This technological change does NOT increase inequality and benefits both agents

Example - Superstars (III)

- With an indivisibility the situation is different

Example - Superstars (III)

- With an indivisibility the situation is different
- It costs a fixed amount C to produce c at all

Example - Superstars (III)

- With an indivisibility the situation is different
- It costs a fixed amount C to produce c at all
- When ℓ_2 falls below C producer B drops out of c entirely

Example - Superstars (III)

- With an indivisibility the situation is different
- It costs a fixed amount C to produce c at all
- When ℓ_2 falls below C producer B drops out of c entirely
- This occurs at $\beta u'[\beta(1+\varepsilon)+\beta C]=1$. Producer B's income drop to 1

Example - Superstars (III)

- With an indivisibility the situation is different
- It costs a fixed amount C to produce c at all
- When ℓ_2 falls below C producer B drops out of c entirely
- This occurs at $\beta u'[\beta(1+\varepsilon)+\beta C]=1$. Producer B's income drop to 1
- However, price of c now jumps to $\beta u'(\beta(1+\varepsilon))$.

Example - Superstars (III)

- With an indivisibility the situation is different
- It costs a fixed amount C to produce c at all
- When ℓ_2 falls below C producer B drops out of c entirely
- This occurs at $\beta u'[\beta(1+\varepsilon)+\beta C]=1$. Producer B's income drop to 1
- However, price of c now jumps to $\beta u'(\beta(1+\varepsilon))$.
- Producer A now earns $\beta u'[\beta(1+\varepsilon)](1+\varepsilon)$, lot larger than $1+\varepsilon$.

Example - Superstars (IV)

- The argument generalizes to a dynamic setting with capital, endogenous labor, etc

Example - Superstars (IV)

- The argument generalizes to a dynamic setting with capital, endogenous labor, etc
- BUT *it depends on property rights*: agent B cannot imitate A AFTER c is introduced

Example - Superstars (IV)

- The argument generalizes to a dynamic setting with capital, endogenous labor, etc
- BUT *it depends on property rights*: agent B cannot imitate A AFTER c is introduced
- Assume imitation is possible. Then if $\beta u'[\beta(1+\varepsilon)] > 1$ agent B enters the c market

Example - Superstars (IV)

- The argument generalizes to a dynamic setting with capital, endogenous labor, etc
- BUT *it depends on property rights*: agent B cannot imitate A AFTER c is introduced
- Assume imitation is possible. Then if $\beta u'[\beta(1+\varepsilon)] > 1$ agent B enters the c market
- At the *equilibrium with imitation* $\beta u'[\beta(1+\varepsilon)+\beta\ell_2] = 1$

Example - Superstars (IV)

- The argument generalizes to a dynamic setting with capital, endogenous labor, etc
- BUT *it depends on property rights*: agent B cannot imitate A AFTER c is introduced
- Assume imitation is possible. Then if $\beta u'[\beta(1+\varepsilon)] > 1$ agent B enters the c market
- At the *equilibrium with imitation* $\beta u'[\beta(1+\varepsilon)+\beta\ell_2] = 1$
- Income of agent A is $\beta u'[\beta(1+\varepsilon)+\beta\ell_2](1+\varepsilon)$

Example - Superstars (IV)

- The argument generalizes to a dynamic setting with capital, endogenous labor, etc
- BUT *it depends on property rights*: agent B cannot imitate A AFTER c is introduced
- Assume imitation is possible. Then if $\beta u'[\beta(1+\varepsilon)] > 1$ agent B enters the c market
- At the *equilibrium with imitation* $\beta u'[\beta(1+\varepsilon)+\beta\ell_2] = 1$
- Income of agent A is $\beta u'[\beta(1+\varepsilon)+\beta\ell_2](1+\varepsilon)$
- Income of agent B is $\beta u'[\beta(1+\varepsilon)+\beta\ell_2]\ell_2 + (1-\ell_2)$

Example - Superstars (IV)

- The argument generalizes to a dynamic setting with capital, endogenous labor, etc
- BUT *it depends on property rights*: agent B cannot imitate A AFTER c is introduced
- Assume imitation is possible. Then if $\beta u'[\beta(1+\varepsilon)] > 1$ agent B enters the c market
- At the *equilibrium with imitation* $\beta u'[\beta(1+\varepsilon)+\beta\ell_2] = 1$
- Income of agent A is $\beta u'[\beta(1+\varepsilon)+\beta\ell_2](1+\varepsilon)$
- Income of agent B is $\beta u'[\beta(1+\varepsilon)+\beta\ell_2]\ell_2 + (1-\ell_2)$
- This example can be generalized along almost any relevant dimension.

Back to the General Theory

- Inequality depends on BOTH technology and institutions

Back to the General Theory

- Inequality depends on BOTH technology and institutions
- Right to adopt/imitate at center stage.

Back to the General Theory

- Inequality depends on BOTH technology and institutions
- Right to adopt/imitate at center stage.
- **Embodiment** determines the pace of technological progress and imitation

Back to the General Theory

- Inequality depends on BOTH technology and institutions
- Right to adopt/imitate at center stage.
- **Embodiment** determines the pace of technological progress and imitation
- Historically, this is the main cause of inequality across nations and individuals

Back to the General Theory

- Inequality depends on BOTH technology and institutions
- Right to adopt/imitate at center stage.
- **Embodiment** determines the pace of technological progress and imitation
- Historically, this is the main cause of inequality across nations and individuals
- Do not ask *Why in country X the "available" technology Z is not used*?

Back to the General Theory

- Inequality depends on BOTH technology and institutions
- Right to adopt/imitate at center stage.
- **Embodiment** determines the pace of technological progress and imitation
- Historically, this is the main cause of inequality across nations and individuals
- Do not ask *Why in country X the "available" technology Z is not used*?
- Ask: *how could country/agent X acquire the embodiment of Z?*

Embodiment

- This is a key feature of technological progress ignored in established theory

Embodiment

- This is a key feature of technological progress ignored in established theory
- It allows us understand why *certain innovations*, in *certain institutional settings*, may increase inequality

Embodiment

- This is a key feature of technological progress ignored in established theory
- It allows us understand why *certain innovations*, in *certain institutional settings*, may increase inequality
- For most people imitating the leader is the ONLY available way to economic development

Embodiment

- This is a key feature of technological progress ignored in established theory
- It allows us understand why *certain innovations*, in *certain institutional settings*, may increase inequality
- For most people imitating the leader is the ONLY available way to economic development
- What is true for countries is true for individuals within a country

Embodiment and Inequality (I)

- Consider two dimensions of inequality: across and within trade areas

Embodiment and Inequality (I)

- Consider two dimensions of inequality: across and within trade areas
- Inequality has decreased among countries and increased within countries

Embodiment and Inequality (I)

- Consider two dimensions of inequality: across and within trade areas
- Inequality has decreased among countries and increased within countries
- Due to the same process: *human capital embodies diverging levels of knowledge*

Embodiment and Inequality (I)

- Consider two dimensions of inequality: across and within trade areas
- Inequality has decreased among countries and increased within countries
- Due to the same process: *human capital embodies diverging levels of knowledge*
- Still we continue to think at the inequality issue with the filter of K vs L

Embodiment and Inequality (II)

- Facts show that it is not K vs L but $K(j) - L(j)$ for $j = 1, 2, 3, ...$

Embodiment and Inequality (II)

- Facts show that it is not K vs L but $K(j) - L(j)$ for $j = 1, 2, 3, ...$
- Two factors: "natural" ability to imitate/use, institutional opportunities to imitate/use

Embodiment and Inequality (II)

- Facts show that it is not K vs L but $K(j) - L(j)$ for $j = 1, 2, 3, ...$
- Two factors: "natural" ability to imitate/use, institutional opportunities to imitate/use
- The political issue is: *when we say "free trade" what is it that we are allowing to be traded?*

Embodiment and Inequality (II)

- Facts show that it is not K vs L but $K(j) - L(j)$ for $j = 1, 2, 3, ...$
- Two factors: "natural" ability to imitate/use, institutional opportunities to imitate/use
- The political issue is: *when we say "free trade" what is it that we are allowing to be traded?*
- To reduce inequality within a country we need more imitation/use of knowledge

Embodiment and Inequality (II)

- Facts show that it is not K vs L but $K(j) - L(j)$ for $j = 1, 2, 3, ...$
- Two factors: "natural" ability to imitate/use, institutional opportunities to imitate/use
- The political issue is: *when we say "free trade" what is it that we are allowing to be traded?*
- To reduce inequality within a country we need more imitation/use of knowledge
- To reduce inequality across countries we need more replicas of knowledge

Embodiment and Inequality (II)

- Facts show that it is not K vs L but $K(j) - L(j)$ for $j = 1, 2, 3, ...$
- Two factors: "natural" ability to imitate/use, institutional opportunities to imitate/use
- The political issue is: *when we say "free trade" what is it that we are allowing to be traded?*
- To reduce inequality within a country we need more imitation/use of knowledge
- To reduce inequality across countries we need more replicas of knowledge
- The obstacles are: *institutions and embodiment of knowledge*

Embodiment and Inequality (III)

- Worldwide, competitive access to embodied knowledge is being restricted $=>$ monopoly power

Embodiment and Inequality (III)

- Worldwide, competitive access to embodied knowledge is being restricted $=>$ monopoly power
- If more countries join the globalization process owners of embodied knowledge earn large capital gains $=>$ inequality

Embodiment and Inequality (III)

- Worldwide, competitive access to embodied knowledge is being restricted => monopoly power
- If more countries join the globalization process owners of embodied knowledge earn large capital gains => inequality
- Without imitation the "less lucky" must play the "innovation cum IP" game

Embodiment and Inequality (III)

- Worldwide, competitive access to embodied knowledge is being restricted => monopoly power
- If more countries join the globalization process owners of embodied knowledge earn large capital gains => inequality
- Without imitation the "less lucky" must play the "innovation cum IP" game
- This is potentially wasteful, but no matter. Problem is that it is hardly feasible

Embodiment and Inequality (III)

- Worldwide, competitive access to embodied knowledge is being restricted => monopoly power
- If more countries join the globalization process owners of embodied knowledge earn large capital gains => inequality
- Without imitation the "less lucky" must play the "innovation cum IP" game
- This is potentially wasteful, but no matter. Problem is that it is hardly feasible
- Innovating at the frontier, because of embodiment, requires inputs available only to a minority

The Global Political Problem (I)

- This process has just started. There are billions of poor people waiting to be matched.

The Global Political Problem (I)

- This process has just started. There are billions of poor people waiting to be matched.
- The speed at which it will spread depends on two factors: "imitative" productive capacity, monopolistic barriers to imitation and free trade

The Global Political Problem (I)

- This process has just started. There are billions of poor people waiting to be matched.
- The speed at which it will spread depends on two factors: "imitative" productive capacity, monopolistic barriers to imitation and free trade
- In advanced countries barriers to free trade are growing because free trade is a source of inequality.

The Global Political Problem (I)

- This process has just started. There are billions of poor people waiting to be matched.
- The speed at which it will spread depends on two factors: "imitative" productive capacity, monopolistic barriers to imitation and free trade
- In advanced countries barriers to free trade are growing because free trade is a source of inequality.
- The political question: *how do you keep free trade going while containing its negative effects on inequality?*

The Global Political Problem (I)

- This process has just started. There are billions of poor people waiting to be matched.
- The speed at which it will spread depends on two factors: "imitative" productive capacity, monopolistic barriers to imitation and free trade
- In advanced countries barriers to free trade are growing because free trade is a source of inequality.
- The political question: *how do you keep free trade going while containing its negative effects on inequality?*
- To reduce inequality within advanced country X we need to allow more imitation, hence less monopoly power

The Global Political Problem (I)

- This process has just started. There are billions of poor people waiting to be matched.
- The speed at which it will spread depends on two factors: "imitative" productive capacity, monopolistic barriers to imitation and free trade
- In advanced countries barriers to free trade are growing because free trade is a source of inequality.
- The political question: *how do you keep free trade going while containing its negative effects on inequality?*
- To reduce inequality within advanced country X we need to allow more imitation, hence less monopoly power
- Innovating at the frontier requires (i) *knowledge* and (ii) *cognitive skills*

The Global Political Problem (II)

- *The frontier has shifted in such a way that the chances of being an innovator are slim for most people*

The Global Political Problem (II)

- *The frontier has shifted in such a way that the chances of being an innovator are slim for most people*
- This we can hardly overcome with more "education", this strategy faces natural limits

The Global Political Problem (II)

- *The frontier has shifted in such a way that the chances of being an innovator are slim for most people*
- This we can hardly overcome with more "education", this strategy faces natural limits
- This is generating powerful forces opposing globalization and increasing social tensions

The Global Political Problem (II)

- *The frontier has shifted in such a way that the chances of being an innovator are slim for most people*
- This we can hardly overcome with more "education", this strategy faces natural limits
- This is generating powerful forces opposing globalization and increasing social tensions
- *Global free trade and imitation across countries is not compatible with monopoly power and prevention of imitation*