What do you humans want?

Dr. Kumar Aniket
University College London

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Anxiety about Technology

“What worries many job experts more is that automation may prevent the economy from creating enough new jobs…”


“The basic fact is that technology eliminates jobs, not work.”

QUESTION ABOUT FOOD FROM 1950s PERSPECTIVE.
QUESTION ABOUT FOOD FROM 1950s PERSPECTIVE.

A consumer can perceive goods to be substitutes or complement.

Choosing between goods:

*Substitutes:* very sensitive to price

*Complements:* less sensitive to price change
**Substitutes and Complements**

Choosing between goods:

*Substitutes*: very sensitive to price

*Complements*: less sensitive to price change

Can bundle *substitutes* into a category, but not *complements*.

*Do consumers perceive automated goods to be substitutes or complements?*

Does price and market power matter?
UK Expenditure Data 2016

Average UK household expenditure, 2016

- Transport
- Housing & fuel
- Recreation
- Food & drinks
- Restaurants
- Goods & services
- Health & Education
- Clothing & footwear
- Communication
- Misc
- Others
UK Expenditure Data 2016

Average UK household expenditure, 2016

- Transport
- Housing & fuel
- Recreation
- Food & drinks
- Restaurants
- Miscellaneous
- Others
UK Expenditure Data 2016
Sector-wise relative wage in UK, 2000-2018

Ratio of sector's median wage (stayers) and UK median wage (2000−18)
**Production: Machines versus Humans**

<table>
<thead>
<tr>
<th>Machines</th>
<th>Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive tasks</td>
<td>Copycats</td>
</tr>
<tr>
<td>Require explicit pathways</td>
<td>Contrarians</td>
</tr>
<tr>
<td>Problem interfacing humans</td>
<td></td>
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</tbody>
</table>

substitutes or complements

does skill-adjusted wage play a role
Kasparov versus IBM’s Deep Blue
Kissinger’s Constructive ambiguity
<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1820</td>
<td>The first <em>mass-produced calculator</em> invented by Charles Xavier Thomas</td>
</tr>
<tr>
<td>1822</td>
<td>Charles Babbage designs his first <em>mechanical computer</em></td>
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<tr>
<td>1835</td>
<td><em>Morse code</em> invented by Samuel Morse</td>
</tr>
<tr>
<td>1837</td>
<td><em>Electric telegraph</em> invented by Charles Wheatstone &amp; Samuel Morse</td>
</tr>
<tr>
<td>1873</td>
<td>Christopher Sholes invents the Remington <em>typewriter</em></td>
</tr>
<tr>
<td>1877</td>
<td><em>Microphone</em> invented by Emile Berliner</td>
</tr>
<tr>
<td>1888</td>
<td>Hertz produces <em>radio waves</em></td>
</tr>
<tr>
<td>1893</td>
<td><em>Wireless communication</em> invented by Nikola Tesla</td>
</tr>
<tr>
<td>1895</td>
<td>Radio signals were invented by Guglielmo Marconi</td>
</tr>
<tr>
<td>1919</td>
<td>James Smathers develops the first <em>electric typewriter</em></td>
</tr>
<tr>
<td>1923</td>
<td><em>Sound film</em> invented by Lee DeForest</td>
</tr>
<tr>
<td>1924</td>
<td>Electro Mechanical <em>television</em> system invented by John Logie Baird</td>
</tr>
<tr>
<td>1927</td>
<td>Philo Farnsworth invents <em>video camera tube</em></td>
</tr>
<tr>
<td>1937</td>
<td><em>Alan Turing</em> develops the concept of a <em>theoretical computing machine</em></td>
</tr>
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<td>1971</td>
<td><em>E-mail</em> invented by Ray Tomlinson</td>
</tr>
<tr>
<td>1973</td>
<td><em>Ethernet</em> invented by Bob Metcalfe and David Boggs</td>
</tr>
<tr>
<td>1973</td>
<td><em>Personal computer</em> invented by Xerox PARC</td>
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</table>
Dynamic complementarities: when complementarities between inputs span across time
realising the full benefits from one invention relies on other seemingly unrelated invention

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1877 Microphone invented by Emile Berliner
1919 James Smathers develops the first electric typewriter
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1927 Philo Farnsworth invents video camera tube
1937 Alan Turing develops the concept of a theoretical computing machine
1971 E-mail invented by Ray Tomlinson
1973 Personal computer invented by Xerox PARC
1990 World Wide Web invented by Tim Berners-Lee
Honing the human capital

Chetty (2014)

Duflo (2001)

Heckman and Cunha’s framework:

Self-productivity channel

Dynamic complementarity

Early broad based education allows workers to be more flexible to move across jobs.
OUTPUT PER WORKER AND WAGE

Data source: Core Econ, Unit 17
Output per worker and wage, UK

- Accommodation + Food
- Agriculture
- Arts + Recreation
- Construction
- Education
- Information + Communication
- Manufacturing
- Professional + Scientific
- Service
- TOTAL INDUSTRIES
- Transportation and Storage
- Wholesale + Motor

UK: Output per worker, Wage
**Markup over wage**

A measure to capture the role *human labour* plays in the production process.

$$\text{Markup over wage} = \frac{\text{Output per worker} - \text{wage}}{\text{wage}}$$

Easier to compute if firm level data is not available.
MARKUP OVER WAGE FOR UK

Output per worker as a markup on wage
OUTPUT PER WORKER AND WAGE, US
**Mark up over wage for US**

- Accommodation + Food
- Agriculture
- Arts + Recreation
- Construction
- Education
- Information + Communication
- Manufacturing
- Scientific + Technical Admin
- Service
- TOTAL INDUSTRIES
- Transportation and Storage
- Wholesale + Motor

US Output per worker as a markup on wage
MARKUP OVER WAGE: US versus UK

Output per worker as a markup on wage: UK vs. US

Graphs showing the markup over wage for various industries in the US and UK from 1995 to 2015.
**Markup over wage: US versus France**

Output per worker as a markup on wage
- **FR**
- **US**
**MARKUP OVER WAGE: US VERSUS EURO AREA**

Output per worker as a markup on wage  
- **EA**  
- **US**
MARKUP OVER WAGE: US VERSUS SWEDEN

Output per worker as a markup on wage

- Accommodation + Food
- Agriculture
- Arts + Recreation
- Construction
- Education
- Information + Communication
- Manufacturing
- Scientific + Technical Admin
- Service
- TOTAL INDUSTRIES
- Transportation and Storage
- Wholesale + Motor

Output per worker as a markup on wage SE US
MARKUP OVER WAGE: US VERSUS PORTUGAL

Output per worker as a markup on wage

- Accommodation + Food
- Agriculture
- Arts + Recreation
- Construction
- Education
- Information + Communication
- Manufacturing
- Scientific + Technical Admin
- Service
- TOTAL INDUSTRIES
- Transportation and Storage
- Wholesale + Motor

MARKUP OVER WAGE: WORLD

Output per worker as a markup on wage
- DE
- DK
- EA
- FR
- PT
- SE
- UK
- US
MARKUP OVER WAGE: WORLD

Output per worker as a markup on wage

DE  DK  EA  FR  PT  SE  UK  US
MARKUP OVER WAGE: WORLD

Output per worker as a markup on wage

Technological progress comes in waves through micro and macro innovations and build into crescendos.

Technology leaders acquire market power in period of accelerated change.

Human skills and their self-learning capacity are set in stone through early education.

Consumers choose between human and machine intensive goods.

Multiple equilibria in the economy.