



University of Sussex

Energy Consumption Takes Time

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“An Inch of Time cannot be bought by an Inch of Gold”

Chinese Proverb

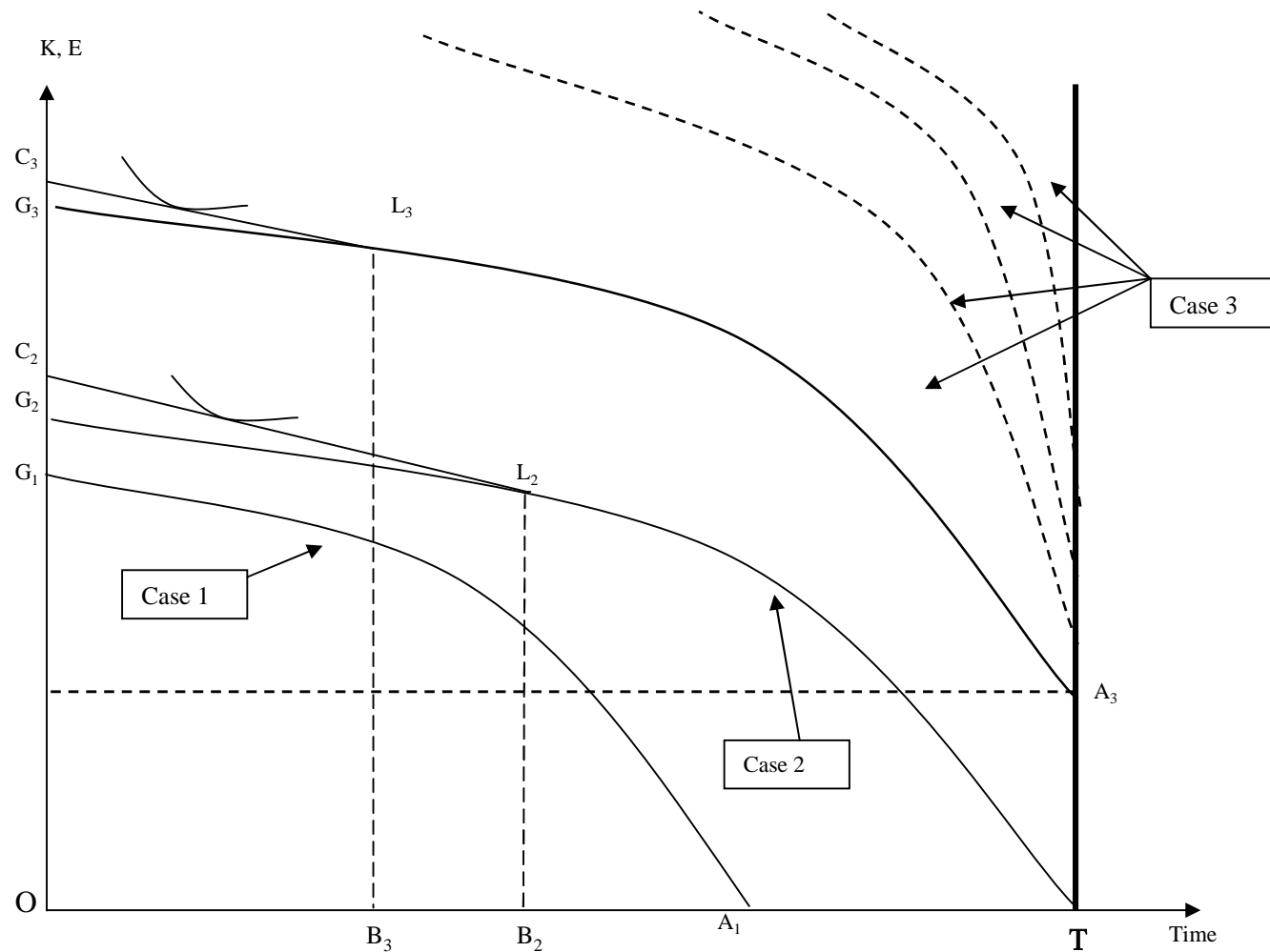
- 1 Household Production, Energy Consumption and Time Allocation**
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Time Allocation and Energy Consumption

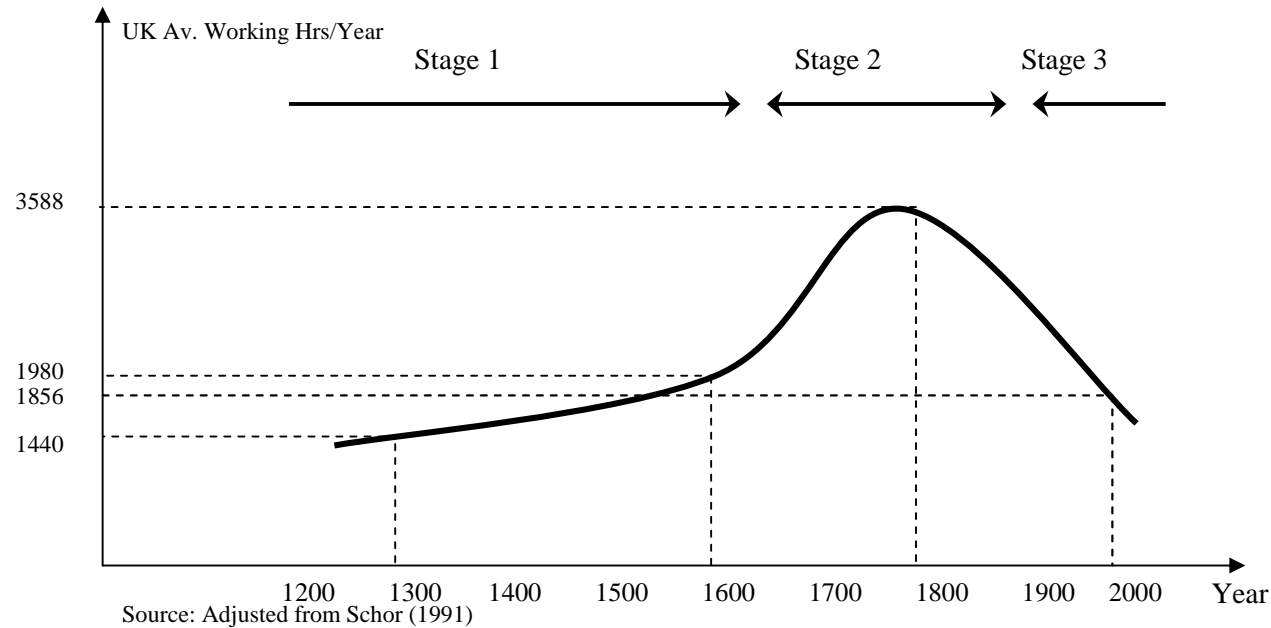
- Description of Income and Time Allocation within Household Production
- Time can buy income but not necessarily the opposite
- Augmented the traditional economic problem of resource allocation by a time constraint (cardinal)
- A two-fold optimisation decision
- Derived K-T conditions for the non-linear programming problem
- Aggregated over consumers and stretched over history

- Solutions from Household Production non-linear framework fit real data on time allocation
- Three out of four solutions describe historically observed stages of economic development:
 1. Agrarian Economies: *Income Constraint Binding; Time Constraint Slack*
 2. Developing Economies: *Both Constraints Binding*
 3. Industrial Economies: *Income Constraint Slack; Time Constraint Binding*
- Fourth solution: both constraints slack-towards a 35 hour week? Transition to this stage not yet observed

Expanding Production Frontier: 2-D Graph



The UK Experience

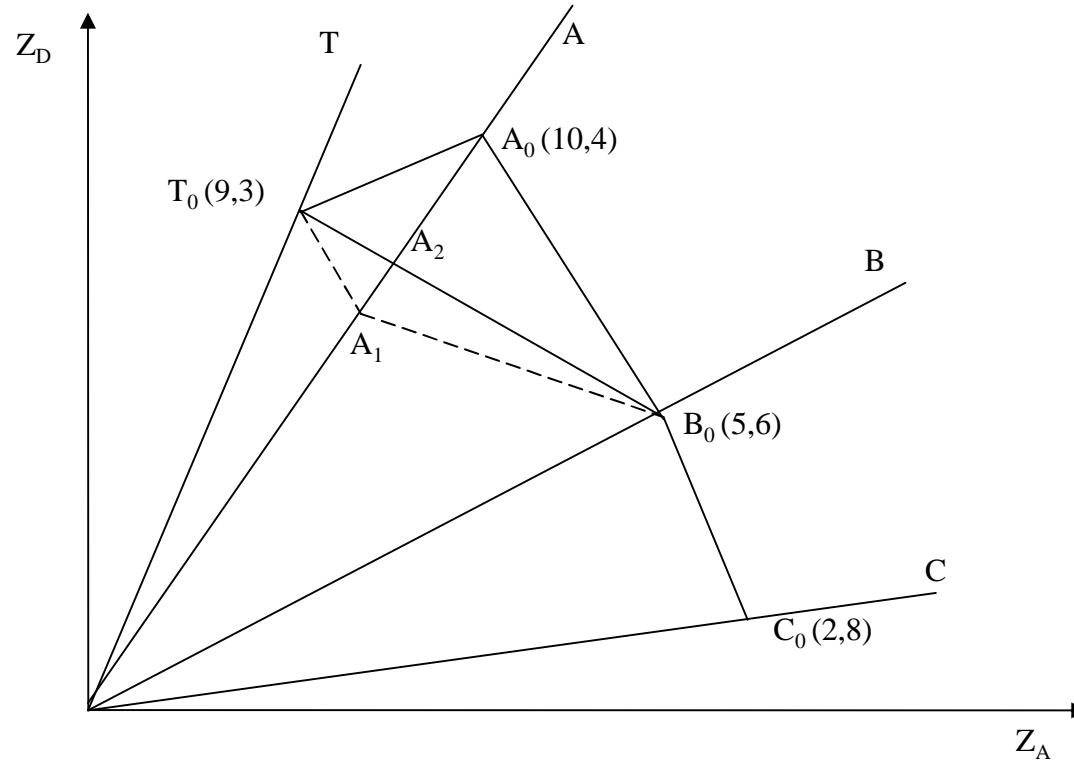


- Historical Transition to Industrialisation went through a phase of increased labour time intensity. Similar for US and other European countries.
- Cheap and unskilled labour supports production in early stages of development: very long working hours
- Stage 3 marks the beginning of energy penetration and increasing leisure, supported by capital accumulation and increasing income
- Parallels to Environmental Kuznets curve?

'New' Demand Theory: What can be learned?

- Lancaster's Demand Theory: "Characteristics" in goods and services provide utility: comfort, aesthetics, nutrition
- Parallel to Becker's household production? Not exactly
- Analysis in characteristics space describes preferences: an example with transport
- Two characteristics: Duration and Affordability
- Four Goods: Train, Bus, Bicycle and Automobile
- With income constraint slack and time constraint binding (Stage 3), the fastest of the three goods will always be preferred even if it's not the most affordable

Analysis in Characteristics Space



- Point A_0 in highest preference for duration, but not affordability
- Demand imposed from binding time constraint
- With income constraint slack, energy efficiency cannot change preference

- Changes in engineering efficiency in energy are likely to affect multiple aspects of economic efficiency
- These can be described as *indirect effects*
- The net result is ambiguous
- Implications for rebound effect from energy efficiency improvements: hard to isolate from looking only at energy cost reduction

Conclusions

1. Although time is not a material input, it can still affect energy demand in production and consumption
2. This is evident from early stages in economic development
3. Energy, combined with capital, can substitute for labour time in production
4. With increasing income, energy can substitute for time in consumption
5. Scarce time can impose preferences in energy demand, that oppose traditional income allocation decisions
6. Welfare gains associated with time scarcity are likely to be energy intensive