

# Resource Economics

## Lecture 3

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Market structure

Political considerations

Behavioral aspects

# Market structure

- The previous models covered, all assumed a market with perfect competition (PC).
- Resource markets exhibit a variety of structures:
  - Monopoly or cartelization
  - One major producer and many fringe producers.
  - Open access.

# Monopoly or cartel

- E.g. OPEC on the oil market.
- Market power does not in general change the results of the Hotelling model to any substantial degree.
  - E.g. if no extraction costs and constant demand elasticity (Stiglitz) then a monopolist will follow exactly the same extraction path a PC market.
  - Intuition: Usually, a monopolist lowers supply in order to keep prices up. But with a given stock lowering supply today means increasing supply tomorrow (and getting lower price then). I.e. keeping prices up in all time periods is not possible.
  - More realistically demand elasticity increases with price. General trade-off is the same but the monopolist extracts slightly slower than a PC market. Hence price starts higher but rises slower. But it does rise.

# Monopoly + backstop

- If there is a monopolist is facing a known date where a backstop arrives then the monopolist may choose not to extract it all to keep price up.
- The resource constraint does not bind and the Hotelling result disappears.
- Can this explain oil data?
  - Known backstop assumption (fusion power) not realistic.

# (A useful parenthesis)

- Suppose there are many resource deposits differing in their extraction costs.
- E.g. oil extraction costs in Saudi Arabia are 3-6 \$/bbl and in Nigeria 15-30 \$/bbl.
- Theory predicts that the cheapest deposits should be extracted first and that this should take place sequentially (i.e. no overlap).
- In reality this does not hold.

# Monopolist + fringe

- The oil market is characterized by one large cartel (OPEC) but many small producers which are not part of it (the fringe, e.g. Norway).
- Typically OPEC has lower extraction costs (3-20 \$/bbl) than non-opec (20+ \$/bbl).
- The monopolist will then keep production low, driving price up so that the fringe produces at its maximum capacity. Meanwhile the monopolist makes some profits and, importantly, gradually drives out the fringe from the market (since they produce at full speed). This leaves the monopolist with substantial future market power.
- Reverse of the basic theory, the expensive deposits are extracted first.

	Reserves		Production		R/P
	Billion bbl	Share of world total	Thousand bbl/day	Share of world total	
<b>US</b>	30.9	1.9%	7841	<b>8.8%</b>	10.8
<b>Canada</b>	175.2	<b>10.6%</b>	3522	4.3%	>100
Mexico	11.4	0.7%	2938	3.6%	10.6
Argentina	2.5	0.2%	607	0.8%	11.4
Brazil	15.1	0.9%	2193	2.9%	18.8
Colombia	2.0	0.1%	930	1.2%	5.9
Ecuador	6.2	0.4%	509	0.7%	33.2
Peru	1.2	0.1%	153	0.2%	22.2
Trinidad & Tobago	0.8	0.1%	136	0.1%	16.7
<b>Venezuela</b>	296.5	<b>17.9%</b>	2720	3.5%	>100
<b>Norway</b>	6.9	0.4%	2039	2.3%	9.2
<b>Russian Federation</b>	88.2	<b>5.3%</b>	10280	<b>12.8%</b>	23.5
United Kingdom	2.8	0.2%	1100	1.3%	7.0
Iran	151.2	<b>9.1%</b>	4321	5.2%	95.8
Iraq	143.1	<b>8.7%</b>	2798	3.4%	>100
Kuwait	101.5	6.1%	2865	3.5%	97.0
Oman	5.5	0.3%	891	1.1%	16.9
Qatar	24.7	1.5%	1723	1.8%	39.3
<b>Saudi Arabia</b>	265.4	<b>16.1%</b>	11161	<b>13.2%</b>	65.2
Algeria	12.2	0.7%	1729	1.9%	19.3
Angola	13.5	0.8%	1746	2.1%	21.2
Libya	47.1	2.9%	479	0.6%	>100
Nigeria	37.2	2.3%	2457	2.9%	41.5
Brunei	1.1	0.1%	166	0.2%	18.2
China	14.7	0.9%	4090	5.1%	9.9
India	5.7	0.3%	858	1.0%	18.2
Indonesia	4.0	0.2%	942	1.1%	11.8
Malaysia	5.9	0.4%	573	0.7%	28.0
Total World	1652.6	100.0%	83576	100.0%	54.2
OPEC	1196.3	<b>72.4%</b>	35830	<b>42.4%</b>	<b>91.5</b>
Non-OPEC	329.4	<b>19.9%</b>	34258	<b>41.0%</b>	<b>26.3</b>

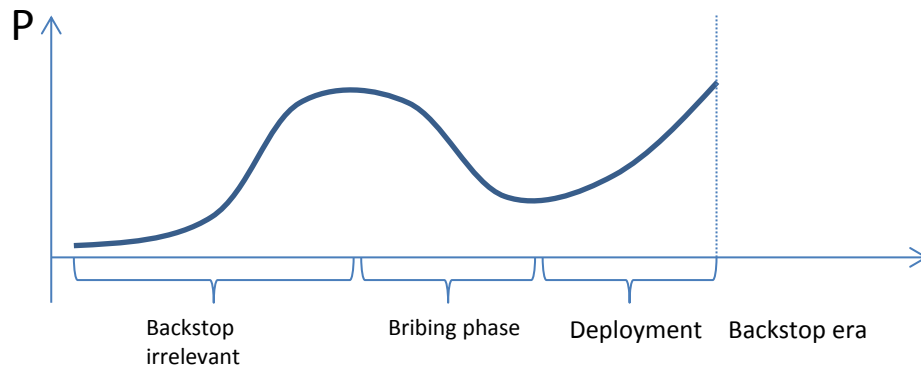
# Seller and buyer power combined

- Gerlagh & Liski (2011, not on list).
- Suppose there is a monopolistic seller (OPEC) and a monopsonistic buyer (EU/US).
- The buyer can choose to invest in a backstop at a cost (solar or fusion power). The backstop arrives with a delay.
- The seller wants to keep price up but still prevent the buyer from investing in the backstop.



# Results: Seller and buyer power

- When the stock is large, the extraction is high enough to make the backstop threat irrelevant → follow Hotelling-like path.
- When the stock becomes small enough the seller needs to “bribe” the buyer in order not to invest in the backstop. The backstop becomes more and more of a threat the smaller the stock is so the bribe needs to be bigger. Keeping extraction up is the bribe. So the extraction increases over time.
- At some point bribing does not work anymore and the seller invests in the backstop (the stock gradually runs out). After this the sellers clears the stock by following a Hotelling-like path.



- Can this explain the observed oil prices?
  - Fits the shape of the last 40 yrs of oil price
  - Maybe, but coordinated buyer power is questionable.
  - The rising price in the last 15 yrs should have been coupled with deployment of a backstop at a known date. Realistic?

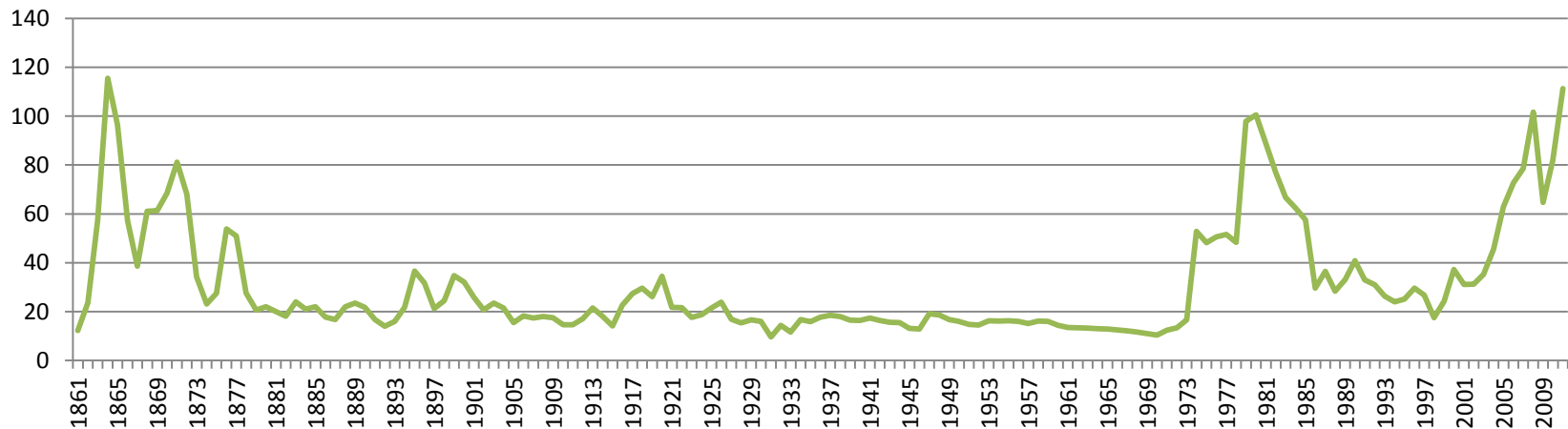
# Open access- diamonds



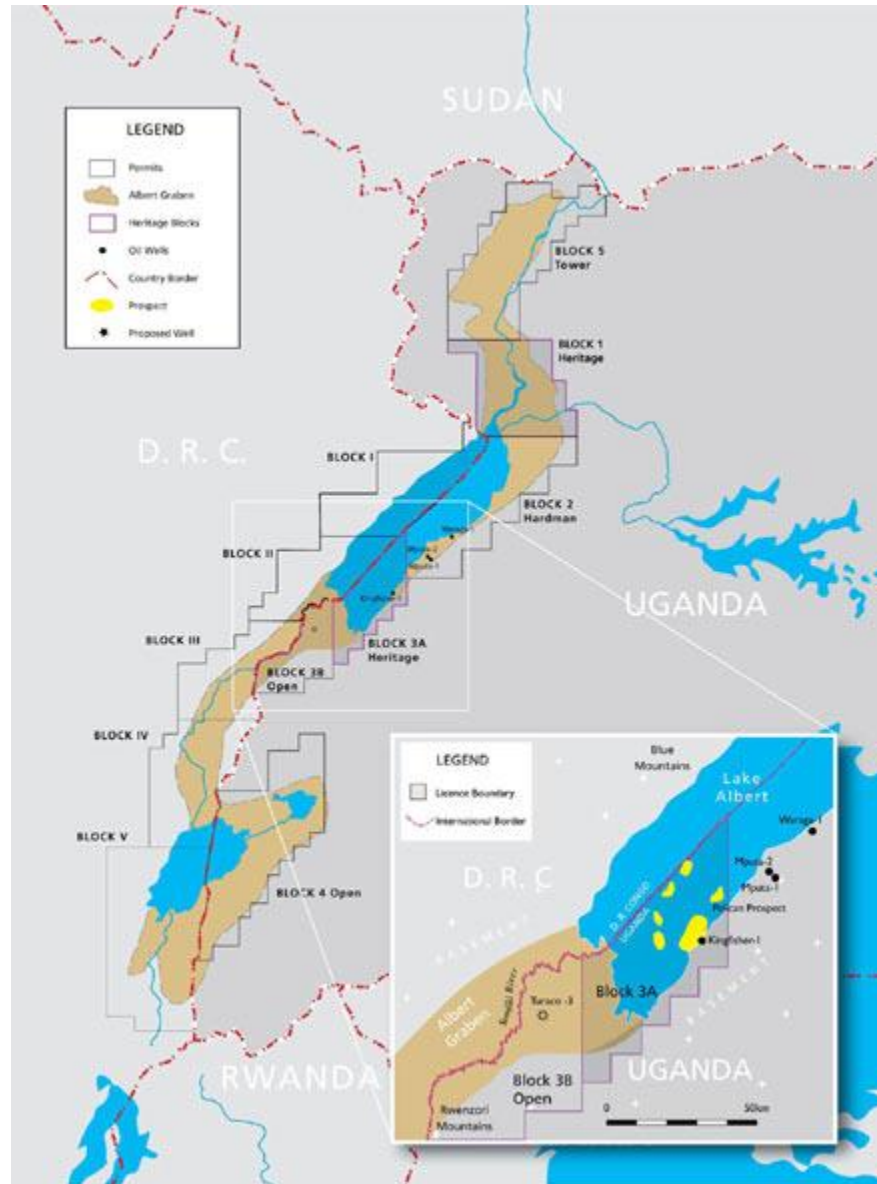
# Open access – oil US

- Property rights in the US were surface based. Deposits may be very wide but shallow – one field lies underneath many landowners' land.
- Early years of US extraction was essentially open access. (See work by Hamilton)
- Until price was regulated.

Real price (2011) \$/bbl



# Open access - Uganda



# Open access – economic effects

- What I don't extract someone else will.
- No point in leaving any resources for later.
- Extract so that my marginal costs of extraction equal price.
- No scarcity rent.

# Open access – political effects

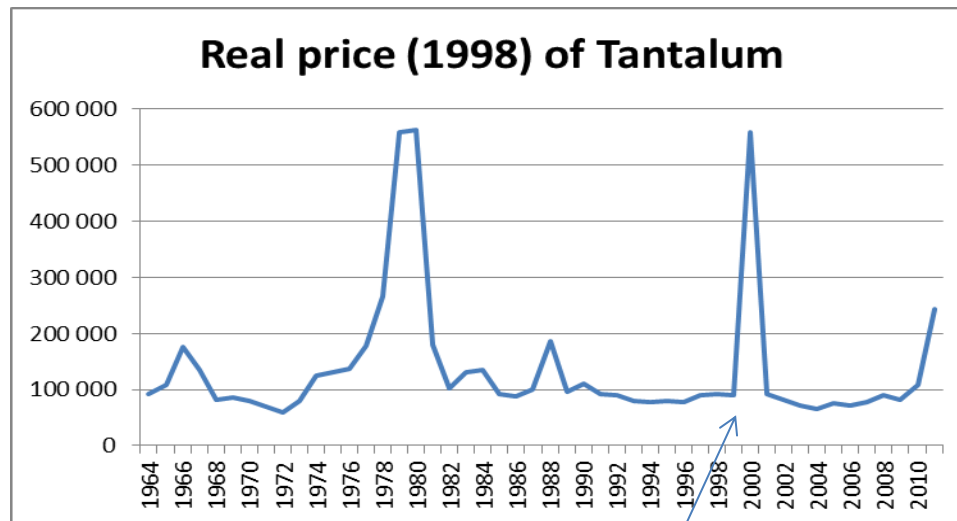
- Trade off between investing my time/effort in extraction or investing in preventing others from extracting. → Arms race and sometimes civil war.

# Political considerations

- Exploration, extraction and transport is controlled by governments.
- Resources affect politics (lecture 5).
- Politics affect resource markets (this lecture).
- Largely unexplored research area. The following slides “speculate” about possible effects.

# Tantalum and the D.R.C.

D.R.C has 70% of world deposits of Coltan which is a source of Tantalum (used in electronics).



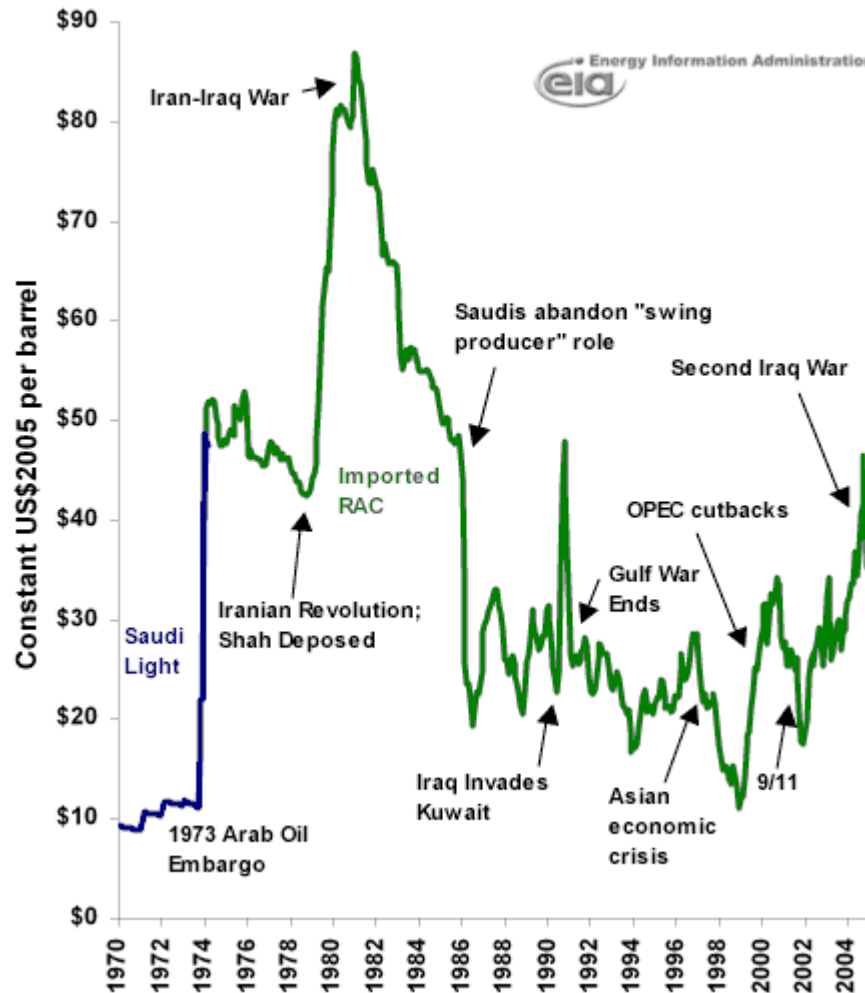
2<sup>nd</sup> Congolese civil war



# Middle east wars

## Major Events and Real World Oil Prices, 1970-2005

(Prices adjusted by CPI for all Urban Consumers, 2005)



# Resource wars

- See Acemoglu et al (2012, not on list).
- A resource rich but militarily weak country.
- A resource poor but militarily strong country can invade the resource rich country.
  
- In fear of invasion, extraction is performed at maximum speed.
- Since depletion is very fast, invasion takes place early.

# Resource extraction and re-election

- Robinson et al (2006)
- The government can use the resource income to be re-elected or to become rich.
- Low popularity incumbent leads to rapacious extraction since both the government needs to take opportunity to get rich and to bribe population into re-election.
- Data supports low re-election probabilities leads to faster extraction.
- Stable autocracies will be more conservative in extraction.
- Democratic and unstable autocracies will extract faster.
- Norway vs Saudi-Arabia.

# Nationalization

- Bohn & Deacon (2000).
- Nationalization of resources has takes place many times. Of oil in the 70's and recently of various resources in many Latin American countries.
- Risk of expropriation leads to
  - Lower investment due to shorter time for where the investment can be used.
  - Higher investments since needs to get resource out quickly.
- But extraction higher once the investment is made.

# Nationalization

- Current work by Spiro & Torvik.
- Private firms own resource in each country.
- Gov in each country may nationalize resource at a cost. For gov, profits of nationalizing need to surpass costs.
- In fear of losing the resource the firm extracts at full speed → flat price path and not scarcity rents → no nationalization of a single country since no profits.
- As time goes scarcity becomes apparent when stock goes down (although not reflected in price) → all gov's nationalize → price follows Hotelling path afterwards.

# Political business cycles in resources?

- A gov may have incentives to sell large amounts prior to re-election or when under threat of coup.
- Can this (partly) explain why resource prices are so volatile?
- Depends on sovereign wealth funds which is a more flexible tool for boosting the economy in the short run. But may be limits like in Norway.

# Political control of the resource

- In the previous lecture we learnt that exploration should not affect the long run price dynamics with forward looking markets.
- What about if a new entrant discovers a deposit?
- Implicit in the exploration argument is that resource owners can buy the new deposits and extract them when price is sufficiently high to cover it.
- Alternatively, exploration firms will not find it worthwhile to explore until the price is high enough.
- But is there really a market for buying not developed and not yet discovered deposits? Is it politically possible for a gov to postpone extraction once they have found a deposit? Is it politically possible to sell a deposit to someone else?
- If answer is “no” then
  - new discoveries will affect the price path if they are made in a “new” country! But not if in current producing country.
  - there will be parallel extraction from fields with different extraction costs.

# Behavioral aspects

- Norgaard (1990)
- Academics usually assume market participants know how scarce the resource is and hence conclude that the market price reflects scarcity correctly.
- But if this is true we could ask them about it, yet we don't do this.
- If they are not informed about it then market prices will not reflect scarcity.
- Bottom line: every market participant says she doesn't know the facts herself but assumes someone else knows something so that prices are correct.

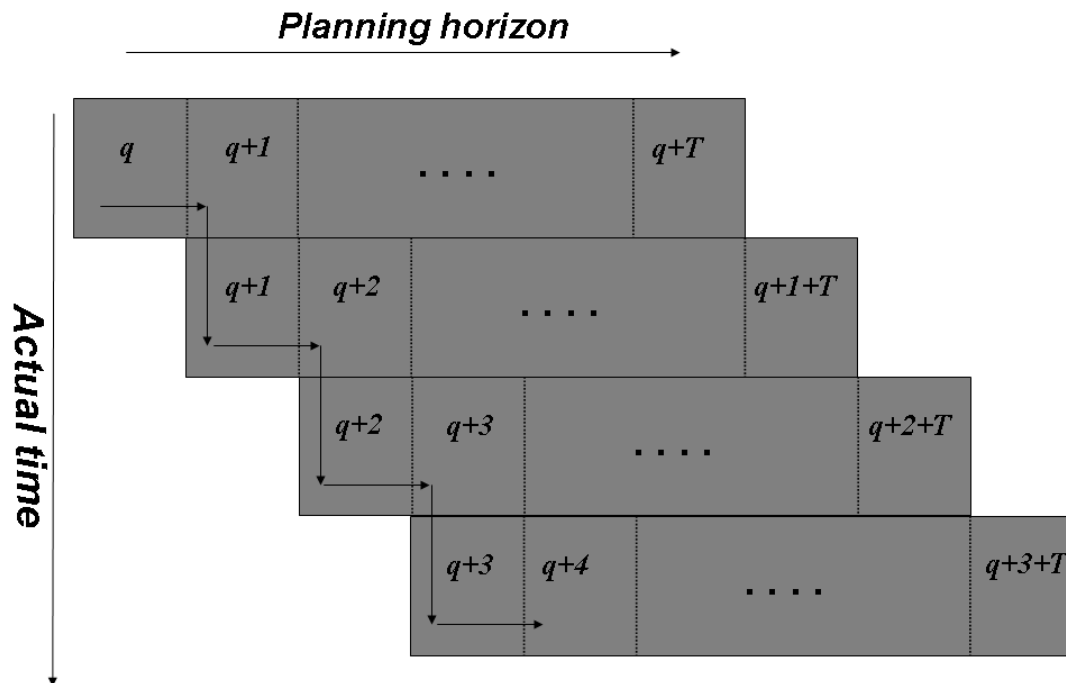


# Time horizon

- Spiro (2012).
- Hotelling model with extraction costs in finite time ( $T$ ).
- With convex or linear extraction costs it would not be optimal to extract it all within  $T$  yrs if the stock is large.
- The total stock is not binding and hence extraction is constant and so is the price. No scarcity rent.

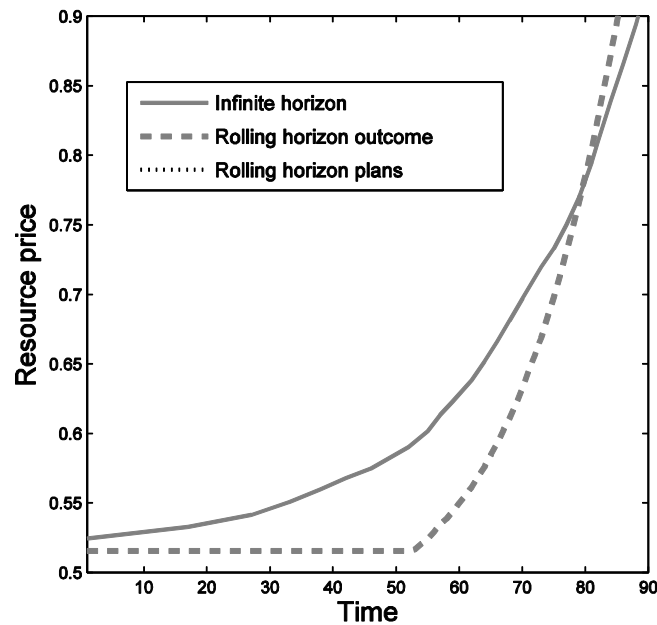
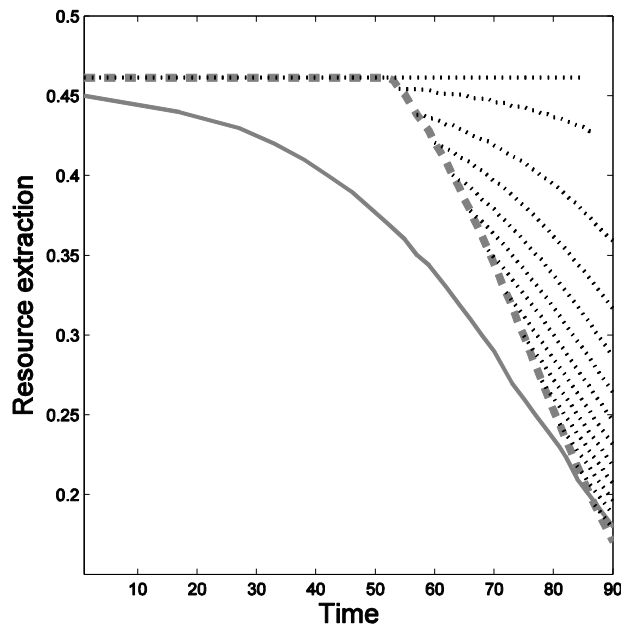
# Time horizon

- Suppose market agents have a rolling horizon
- Plan for  $T$  yrs, implement first yr and then plan again for  $T$  yrs...



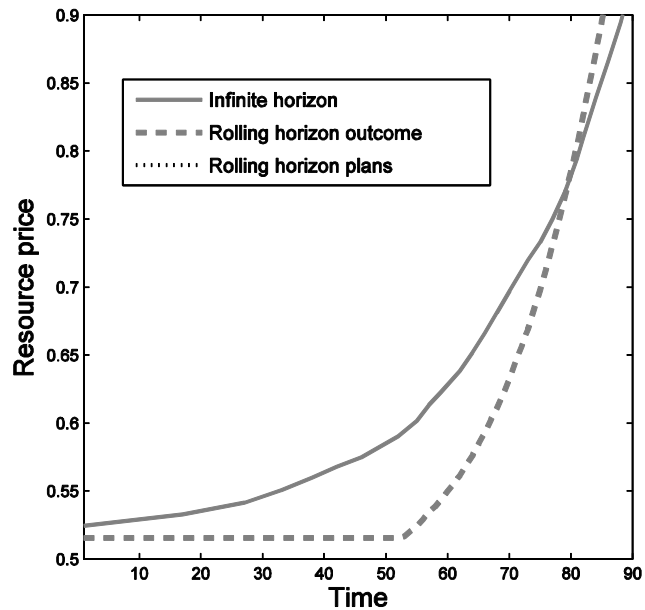
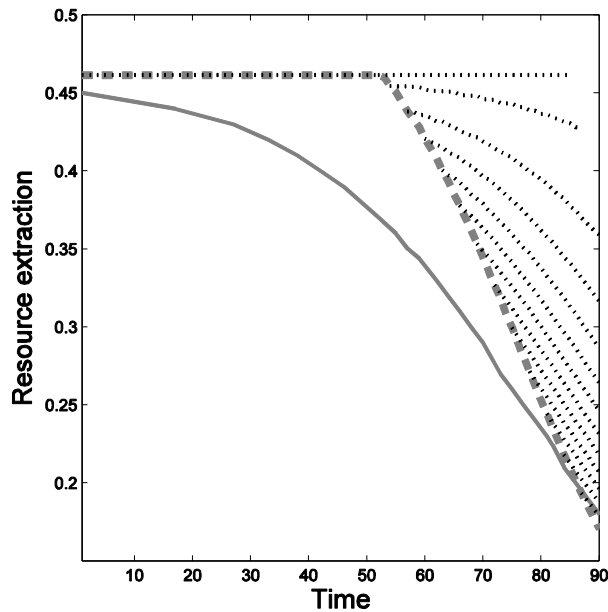
# Results: Time horizon

- In first period non binding resource constraint, plan to extract at max speed. Implement one yr.
- In second period non-binding resource constraint, plan to extract at max speed. Implement one yr.
- Etc...



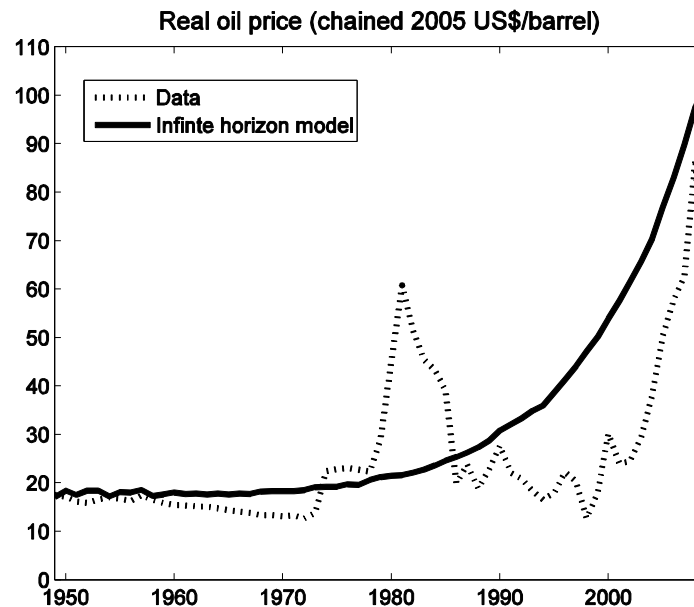
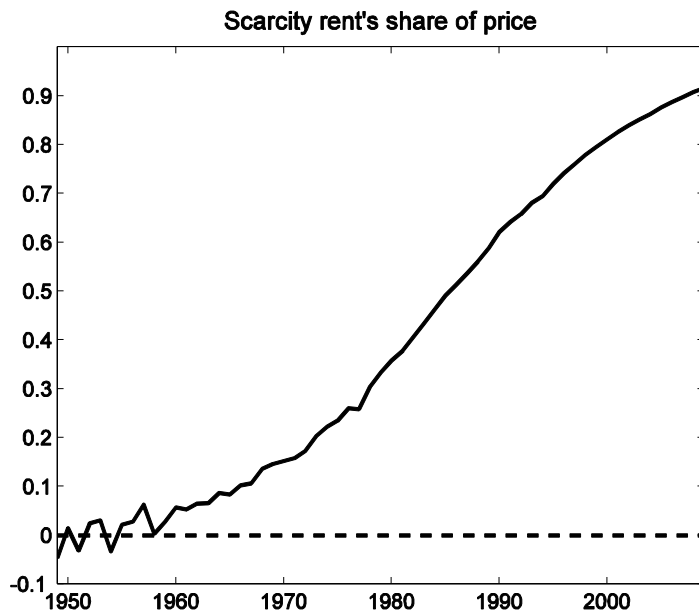
# Results: time horizon

- Constant extraction.
- Constant price
- No connection between price growth and interest
- Time consistency.



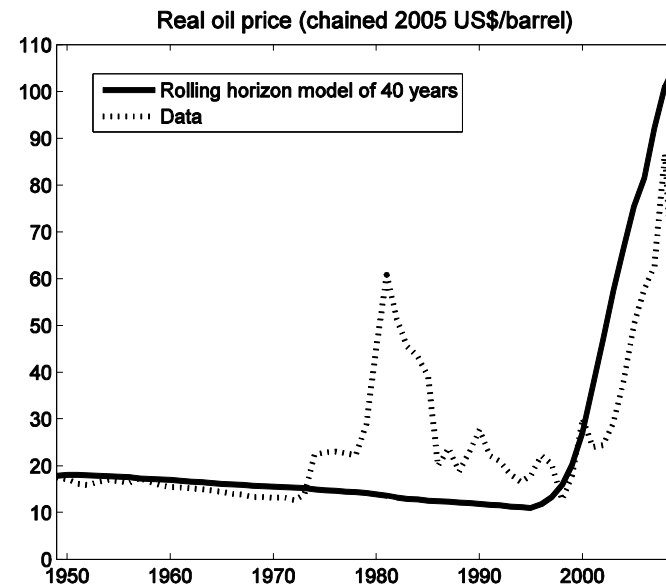
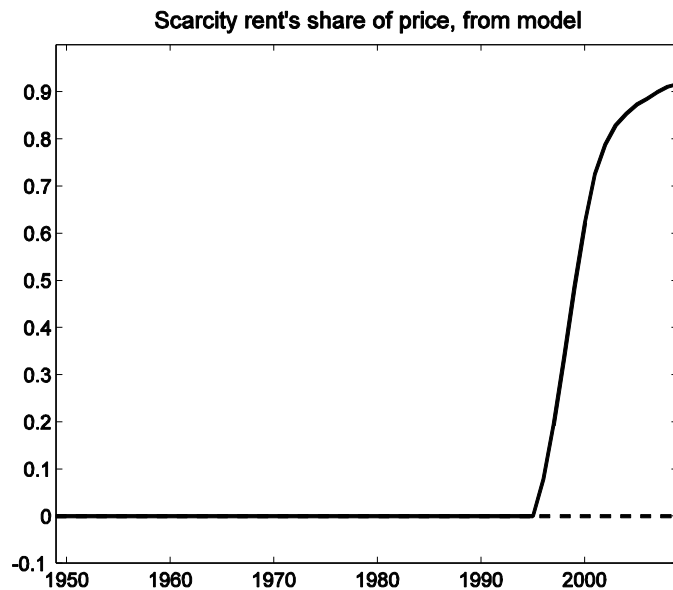
# Calibration - Hotelling

- Can a combination of technology, labor, substitutes, capital etc explain the observed oil price?
- Build a large model, let the model's (Hotelling) agents determine their extraction of oil taking data of technology, labor, capital, extraction costs, total stock, other energy sources as given.



# Calibration – Hotelling with rolling horizon

- Use the same numbers but assume a 40 yr rolling horizon (taken from data).



# The bet

- In 1980, Julian Simon (economist) and Paul Ehrlich (biologist) bet on whether 5 resource prices would rise over the following 10 yrs. Simon won since prices did not rise.
- The conclusion of Simon was that since prices have not risen historically scarcity has not been an issue. Hence scarcity will not be an issue in the future either.
- But if prices are expected to be low then each agent will extract at full capacity since the returns of keep the resource under ground is low. This will in itself lead to non-increasing prices – self-fulfilling beliefs.
- If prices are expected to stay down there will be no point in investing in exploration or technology and hence scarcity can become severe without prices indicating it.
- So even if technology can deal with scarcity, it can become a grave problem before anyone invests in solutions. This is also a problem if the time horizon is not infinite.