

Energy Price Uncertainty and Global Land Use

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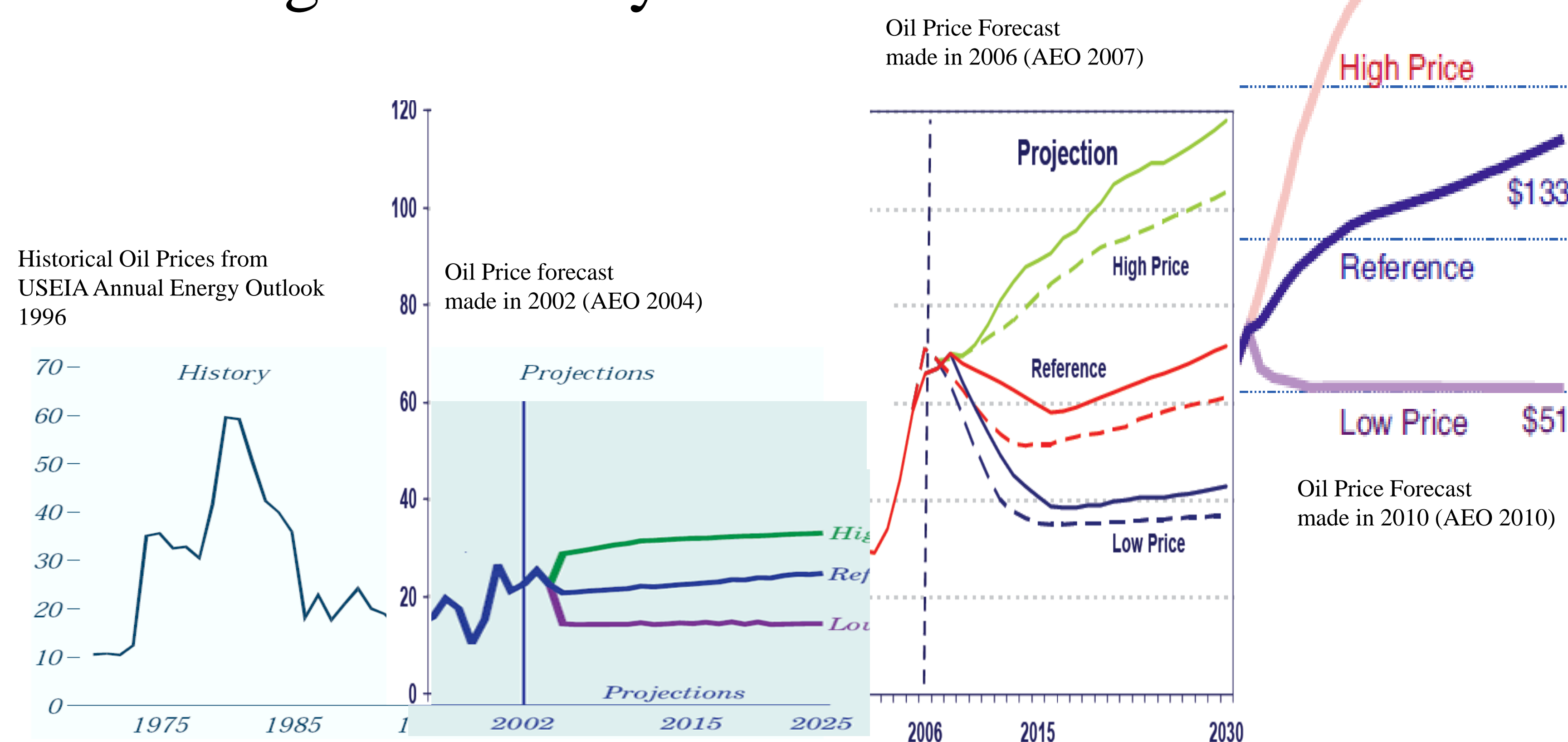
Motivation

- Petroleum and natural gas prices are key factors affecting competitiveness of biofuels and cost of fertilizer
- Rising energy prices put significant pressure on global land supply and greenhouse gas emissions from terrestrial systems
- The effect of uncertainty in energy prices on global land use dominates the effects of (1) uncertainty in energy and climate mitigation policies and (2) uncertainty in climate impacts (Steinbuks and Hertel 2013)
- Uncertainty in energy prices has received relatively little attention in the literature concerning land use

Characterizing uncertainty in energy prices

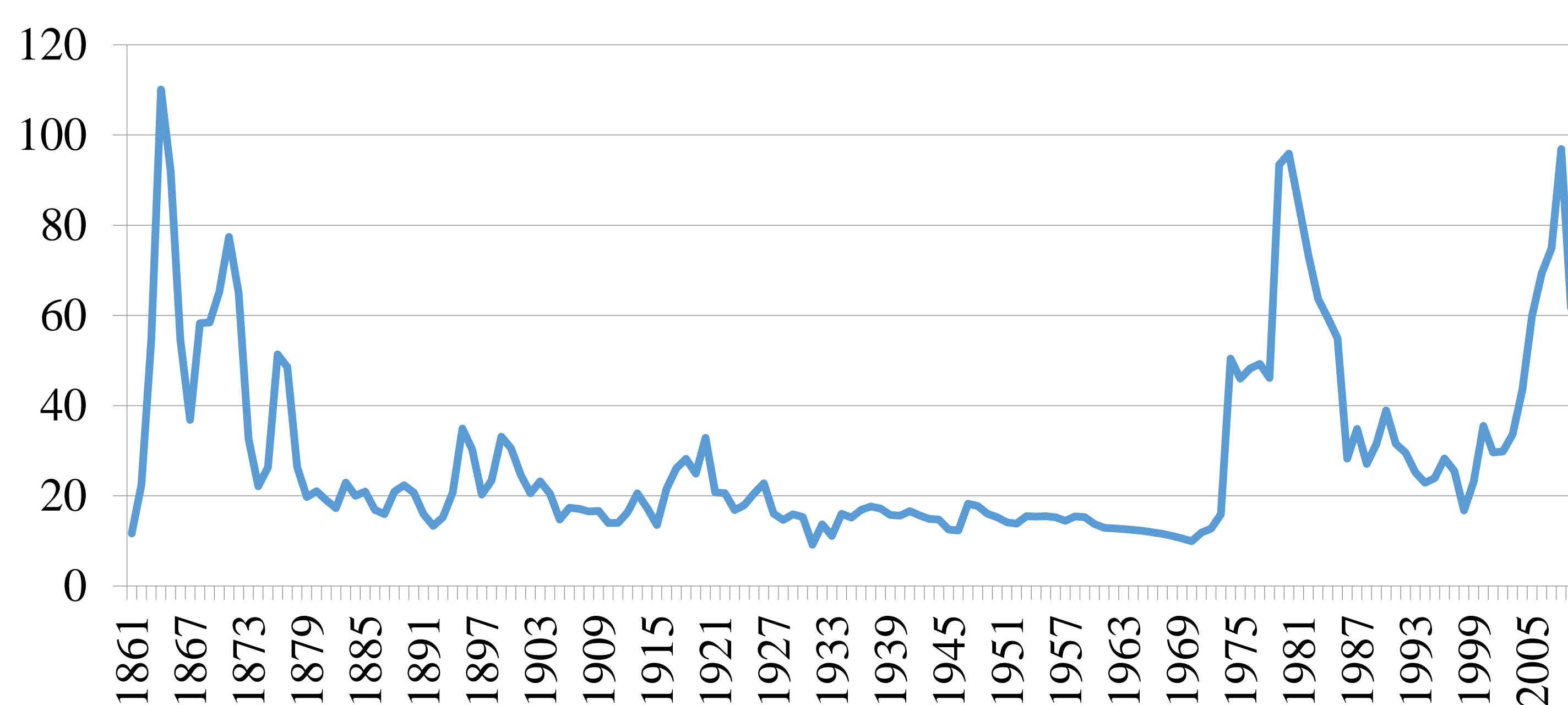
- Sources of uncertainty
 - Technology and discovery
 - Economics and behavior of oil producers and consumers
- Available information
 - U.S. EIA Annual Energy Outlook includes alternative oil price cases from 2010 to 2040
 - History

Increasing uncertainty in EIA forecast



Source: Steinbuks 2013

Historical crude oil prices, 2009 \$US/barrel

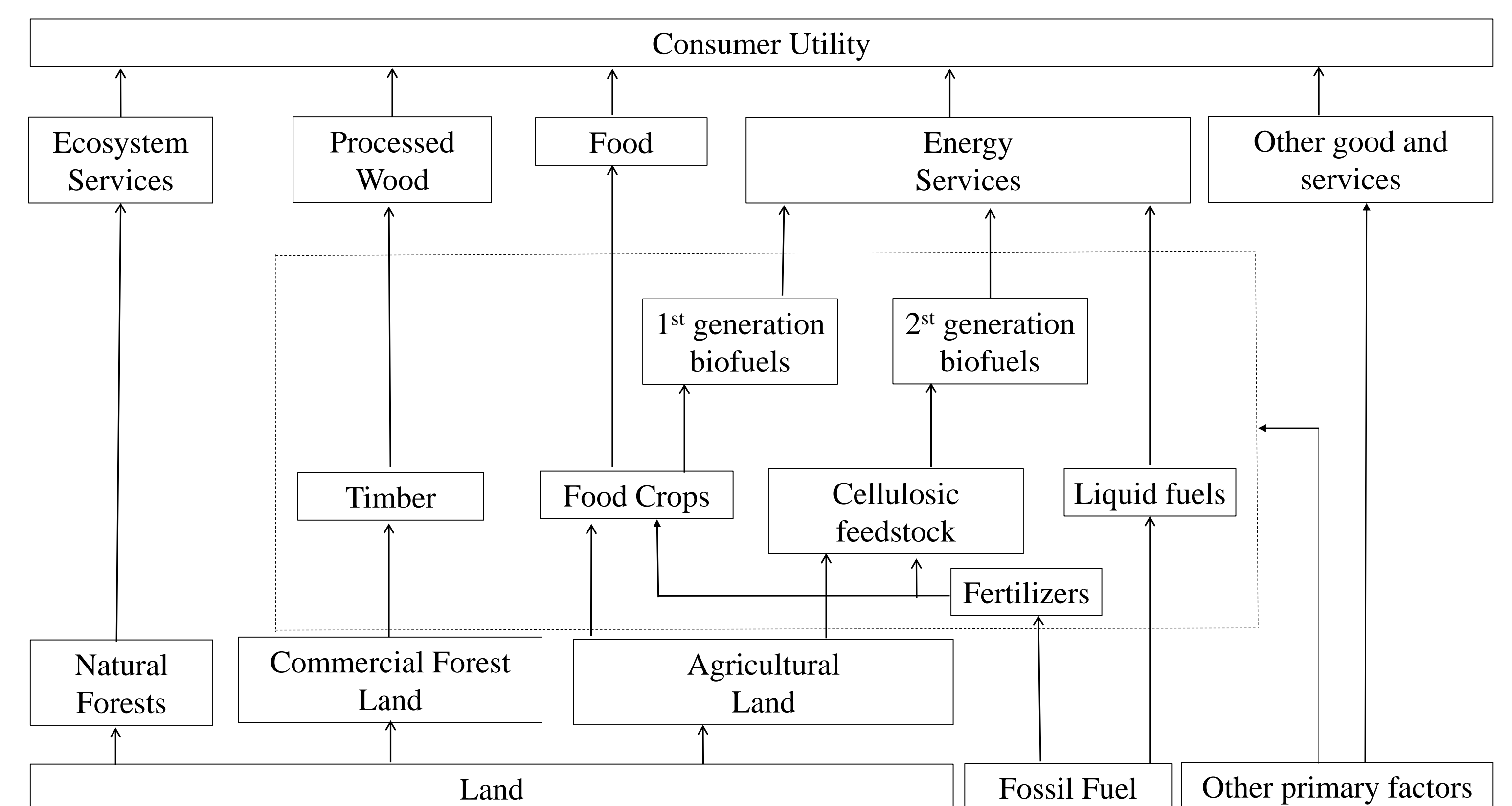


ChartsBin statistics collector team 2014, *Historical Crude Oil prices, 1861 to Present*, ChartsBin.com, viewed 14th February, 2014, <<http://chartsbin.com/view/0au>>.

$$AR(1) \text{ model: } \ln(p^*_t) = \rho \ln(p^*_{t-1}) + \varepsilon_t, \rho = 0.772,$$

$$p\text{-value} \leq 0.05, p^* \text{ is normalized price (Pindyck 1999)}$$

A Global PE Model of Land Use (FABLE)



Model description

- Economy representation similar to FABLE model (Cai et al. 2014)
- Stochastic dynamic
- Energy price is exogenous
- Vintage Representation of Forestry Sector
- Intensification in crops and cellulosic feedstock production
- 1st and 2nd Generation Biofuels
- Calibrated to 2004 data (FAO, GTAP)

Implementation

- Dynamic programming method
- Energy price follows AR(1) with exogenous jump process
- Solve maximization problem

$$V(X, p) = \max_C \{U(C) + \beta E[V(X^+, p^+) | p]\}$$

$$E[V(X^+, p^+) | p] = \int_0^\infty V(X^+, p^+) f(p^+ | p) dp^+$$
- Replace the continuous-valued Markov chain with a finitely-many-discrete-valued Markov chain (Tauchen 1986)
- The values of Markov chain are chosen using the scheme described in Cai et al. (2014a)
- Find value function and policy rules for deterministic problems
- Employ the stochastic dynamic programming structure described in Cai and Judd (2014) and its parallel algorithms described in Cai et al. (2014c) to determine impact of uncertainty on optimal path of land use

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