Gaël Giraud

0. Background on neo-classical models

. The Demand ide

The supply side

III. Matching demand and supply

Some Criteria for Economic Models in view of the Energy Shift

Gaël Giraud¹

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> Houches Feb. 2014.

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0. Background on neo-classical models

• Households maximize an exogenously given utility function

$$\max u_i(x_0^i, L_0^i; x_1^i, L_1^i; ...$$

subject to the budget constraint $p_t \cdot x_t^i \leq w_t L_t^i \quad \forall t \geq 0.$

 w_t = wages at time t , x_t^i = consumption at t ; L_t^i = labor at t.

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Some Criteria for Economic Models

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0. Background on neo-classical models

. The Demand ide

II. The supply side

III. Matching demand and supply

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 w_t = wages at time t , x'_t = consumption at t ; L'_t = labor at t.

• Example:

$$u_i(x_0^i, x_1^i, \ldots) = \mathbb{E}^{\pi} \Big[\sum_t \frac{1}{\Delta^t} \big(\ln(x_t^i) - \frac{1}{2} \sqrt{L_t^i} \big) \Big].$$

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 $\Delta \in (0,1) = discount factor.$

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0. Background on neo-classical models

. The Demand ide

II. The supply side

III. Matching demand and supply

0. Background on neo-classical models

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 $\Delta \in (0,1) = discount factor.$

• Remark on the Inada conditions: $\lim_{x\to 0^+} Du_t^i(x) = +\infty$.

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0. Background on neo-classical models

. The Demand ide

II. The supply side

III. Matching demand and supply

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• The firm *j* maximizes its discounted profit:

$$\max \sum_{t \ge 0} \frac{1}{\beta^t} p_t \cdot (y_t^j - x_t^j)$$

subject to $y_t^j \leq f^j(x_t^j)$.

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 $f^{j}(\cdot) = \text{production function.}$ $x_{t}^{j} = \text{input at time } t$ $y_{t}^{j} = \text{output at time } t.$ Some Criteria for Economic Models

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0. Background on neo-classical models

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subject to $y_t^j \leq f^j(x_t^j)$.

$$f^{j}(\cdot) = \text{production function.}$$

 $x_{t}^{j} = \text{input at time } t$
 $y_{t}^{j} = \text{output at time } t.$

• Example: Cobb-Douglas production function.

$$\begin{split} f^{j}(\mathcal{K}_{t}^{j},\mathcal{L}_{t}^{j},\mathcal{E}_{t}^{j}) &:= \mathcal{A}(\mathcal{K}_{t}^{j})^{\alpha}(\mathcal{L}_{t}^{j})^{\beta}(\mathcal{E}_{t}^{j})^{\gamma}\\ \mathcal{K}_{t}^{j} &= \mathsf{capital}, \quad \mathcal{L}_{t}^{j} = \mathsf{labor}, \quad \mathcal{E}_{t}^{j} = \mathsf{energy}.\\ \alpha + \beta + \gamma \leq 1. \quad \mathcal{A} > \mathsf{0} = \mathsf{Total} \mathsf{\ Productivity} \mathsf{\ Factor}. \end{split}$$

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand side

II. The supply side

III. Matching demand and supply

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0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

Cobb-Douglas, CES, etc.

• Smooth functions

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Cobb-Douglas, CES, etc.

- Smooth functions
- Substitutability across production factors.

Some Criteria for Economic Models

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0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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Cobb-Douglas, CES, etc.

- Smooth functions
- Substitutability across production factors.
- $\circ~$ No path-dependence of the production.

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0. Background on neo-classical models

I. The Demand

II. The supply side

III. Matching demand and supply

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Cobb-Douglas, CES, etc.

- Smooth functions
- Substitutability across production factors.
- No path-dependence of the production.
- Decreasing returns to scale.

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0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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0. Background on neo-classical models

. The Demand

I. The supply side

III. Matching demand and supply

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• Perfect foresight ?

Rational Expectations.

Performativity of economics ?

Alternatives : Temporary equilibrium (Grandmont, 80s').

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0. Background on neo-classical models

. The Demand

I. The supply side

III. Matching demand and supply

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- Perfect foresight ?
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 Alternatives : Temporary equilibrium (Grandmont, 80s').
- Equilibrium is a fixed point. Impulse Response Function. A static theory where Past= present= future. No uncertainty on prices. Caution: Risk≠ Uncertainty.

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0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

- Perfect foresight ? Rational Expectations. Performativity of economics ? Alternatives : Temporary equilibrium (Grandmont, 80s').
- Equilibrium is a fixed point. Impulse Response Function. A static theory where Past= present= future. No uncertainty on prices. Caution: Risk≠ Uncertainty.
- The budget constraint is 0-homogeneous:

$$p_t \cdot x_t^i \leq w_t L_t^i \quad \forall t \geq 0.$$

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 $e_t^i = \text{initial endowment of household } i \text{ at time } t.$ \Rightarrow No money.

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0. Background on neo-classical models

. The Demand ide

The supply side

III. Matching demand and supply

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• Believe it, or not , this is the core of mainstream economic

theory !

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0. Background on neo-classical models

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II. The supply side

 Matching demand and supply

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• Believe it, or not , this is the core of mainstream economic theory !

• Roots:

Jevons, Menger, Walras (\approx 1870) Marshall (1890)

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0. Background on neo-classical models

. The Demand ide

II. The supply side

 Matching demand and supply

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Jevons, Menger, Walras (\approx 1870) Marshall (1890)

Keynes (1936) : Deep revolution...
 ...rapidly forgotten: Hicks (1937, 1981)

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0. Background on neo-classical models

. The Demand ide

II. The supply side

III. Matching demand and supply

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Jevons, Menger, Walras (\approx 1870) Marshall (1890)

- Keynes (1936) : Deep revolution...
 ...rapidly forgotten: Hicks (1937, 1981)
- Real business cycles: Kydland & Prescott (1982) Rational Expectations: Lucas (1972).

 "The most visible outcomes of this new approach are the dynamic stochastic general equilibrium (DSGE) models. They are models derived from micro foundations—that is, utility maximization by consumers-workers; value maximization by firms; rational expectations; and a full specification of imperfections, from nominal rigidities to some of the imperfections discussed above—and typically estimated by Bavesian methods."

Blanchard 2009, p. 223.

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Gaël Giraud

0. Background on neo-classical models

. The Demand

I. The supply side

III. Matching demand and supply "The most visible outcomes of this new approach are the dynamic stochastic general equilibrium (DSGE) models. They are models derived from micro foundations—that is, utility maximization by consumers-workers; value maximization by firms; rational expectations; and a full specification of imperfections, from nominal rigidities to some of the imperfections discussed above—and typically estimated by Bayesian methods."

Blanchard 2009, p. 223.

• "The state of macro is good."

Blanchard 2009, p. 210.

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Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand ide

I. The supply side

III. Matching demand and supply

Gaël Giraud

0. Background on neo-classical models

I. The Demand

I. The supply side

II. Matching demand and supply

 "Identifying the flaws of existing policy is (relatively) easy. Defining a new macroeconomic policy framework is much harder... It is important to start by stating the obvious, namely, that the baby should not be thrown out with the bathwater. Most of the elements of the pre-crisis consensus, including the major conclusions from macroeconomic theory, still hold." Blanchard, Dell'Ariccia et al. 2010, p. 207.

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Gaël Giraud

0. Background on neo-classical models

I. The Demand

I. The supply side

II. Matching demand and supply

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I.1. The law of Demand

• Often: A single representative household. No distribution issue... !

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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I.1. The law of Demand

- Often: A single representative household. No distribution issue... !
- Sonnenschein-Mantel-Debreu (1975).
 The aggregate demand = any C⁰ vector field on the unit sphere with boundary conditions.

The "law of demand" need not be satisfied in general. Scale transition.

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

I. The supply side

 Matching lemand and supply

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- Sonnenschein-Mantel-Debreu (1975). The aggregate demand = any \mathcal{C}^0 vector field on the unit sphere with boundary conditions. The "law of demand" need not be satisfied in general. Scale transition.
- Incomplete markets ?
 Strong inefficiency of equilibrium allocations... (Geanakoplos & Polemarchakis (1986).)

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0. Background on neo-classical models

I. The Demand side

I. The supply side

 Matching lemand and supply

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 - Incomplete markets ?
 Strong inefficiency of equilibrium allocations... (Geanakoplos & Polemarchakis (1986).)
 - Private debts ? Bénassy-Quéré, Fontagné et al. (2012).
 Krugman, Eggertson (2012)... but still barter economy !

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0. Background on neo-classical models

I. The Demand side

I. The supply side

 Matching lemand and supply



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Gaël Giraud

). Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

A ' 'good'' economic model should:

• Involve heterogenous households, so that wealth and energy distribution matters. $P_1, P_2, P_3...$

Gaël Giraud

). Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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- A ' 'good'' economic model should:
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- Enable private households to have private debts.

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0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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- A ' 'good'' economic model should:
- Involve heterogenous households, so that wealth and energy distribution matters. P₁, P₂, P₃...
- Involve incomplete financial markets.
- Enable private households to have private debts.
- Not involve the law of demand at the aggregate level.

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Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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• Take an explicit account of money.

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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0. Background on neo-classical models

I. The Demand side

I. The supply side

III. Matching demand and supply

How can we check for the presence of money in a model ?

Non-homogeneity with respect to prices.
 Dubey & Geanakoplos (2003), Drèze & Polemarchakis (2003),
 Giraud & Tsomocos (2010), etc.

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Gaël Giraud

0. Background on neo-classical models

I. The Demand side

I. The supply side

III. Matching demand and supply

How can we check for the presence of money in a model ?

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 Dubey & Geanakoplos (2003), Drèze & Polemarchakis (2003), Giraud & Tsomocos (2010), etc.
- Money should not be neutral in the short-run.
 What about the long-run ? (Keynes: "in the long-run, we are all dead")
 E.g. Piketty (2013).

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Gaël Giraud

0. Background on neo-classical models

I. The Demand side

I. The supply side

III. Matching demand and supply

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- Money should not be neutral in the short-run.
 What about the long-run ? (Keynes: "in the long-run, we are all dead")
 E.g. Piketty (2013).
- The model should not involve the money multiplier. Holmes (1969) ; Moore (1979) ; Moore (1988) ; Kydland and Prescott (1990).

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$\circ~$ Banking credit:

$$I \neq S$$
.

$$I = S + c$$
 where $c =$ credit.

Contrary to IS-LM mode, and almost all models.

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0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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• Banking credit:

$$I \neq S$$
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 where $c =$ credit.

Contrary to IS-LM mode, and almost all models.

• Deflation should be possible. (\neq Aghion, Acemoglu, etc.) Schumpeter (1927) ; Schumpeter (1934) ; Fisher (1933), Keynes (1936), Minsky (1975, 1977, 1982, 1993), Krugman & Eggertson (2012). Some Criteria for Economic Models

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0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply
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0. Background on neo-classical models

I. The Demand side

I. The supply side

 Matching lemand and supply



Sources : IMF International Financial Statistics, IMF World Economic Outlook

Croissance, chômage et taux d'intérêts au Japon

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Sources : Eurostat, Ministères des Affaires Intérieures et des Communications - Japon

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0. Background on neo-classical models

I. The Demand side

II. The supply side

II. Matching demand and supply





Sources : Bank of Japan; Ministry of Finance, Japan

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0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

• On financial markets, Speculative bubbles should be possible.

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0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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- On financial markets, Speculative bubbles should be possible.
- Crashes should be possible. Zame (1990)... Giraud & Pottier (2012).



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Gaël Giraud

0. Background on neo-classical models



II. The supply side

III. Matching demand and supply

Prix de l'immobilier - États-Unis



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). Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

• Very controversial :

The marginal productivity doctrine should not be used. Keen (2000), Fr. transl. forthcoming.

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). Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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• If there is a micro-foundation, rationality should be bounded:

No perfect foresight

If there is a micro-foundation, rationality should be bounded: No perfect foresight

 Satisficing (Simon (1976)) or gradient-maximization (Cornet (1990), Bottazzi (1994), Giraud-Tsomocos (2010)) else Moore machines (game theory with automata).

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

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• Uncertainty (Schmeidler (1983), et alii.)

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Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

If there is a micro-foundation, rationality should be bounded: No perfect foresight

- Satisficing (Simon (1976)) or gradient-maximization (Cornet (1990), Bottazzi (1994), Giraud-Tsomocos (2010)) else Moore machines (game theory with automata).
- Uncertainty (Schmeidler (1983), et alii.)
- Evolutionary game theory.
 Klaus Ritzberger, Jorgen Weibull, Stefano Demichelis...

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Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

 Are global returns to scale decreasing in the industrial sector ? Blinder (1998)...
 Be careful: econometric estimations are accounting tautologies (Brown (1957), Simon (1979), Simon & Levy (1963))

ション ふゆ ア キョン キョン ヨー もくの

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand ide

II. The supply side

III. Matching demand and supply

- Are global returns to scale decreasing in the industrial sector ? Blinder (1998)...
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- With respect to energy: decreasing returns for physical reasons.

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Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

- Are global returns to scale decreasing in the industrial sector ? Blinder (1998)...
 Be careful: econometric estimations are accounting tautologies (Brown (1957), Simon (1979), Simon & Levy (1963))
- With respect to energy: decreasing returns for physical reasons.
- Why do most economists favor global decreasing returns ? Profit maximization may not have any solution ⇒ Public management ? (Drèze, Mas-Colell, Cornet, Bonnisseau, etc.) Solow macro-economic workhorse growth model has no stationary point.

くしゃ 本面 そうせん ほう うめんろ

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand side

II. The supply side

II. Matching demand and supply

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- Why do most economists favor global decreasing returns ? Profit maximization may not have any solution ⇒ Public management ? (Drèze, Mas-Colell, Cornet, Bonnisseau, etc.) Solow macro-economic workhorse growth model has no stationary point.
- If returns are constant: zero profit. Realistic ?
 If returns are strictly decreasing, the feasible set is compact. (Hurwicz (1978)).
 No growth.

Hence, the trick of exogenous growth.

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

II. Matching demand and supply

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

 $\circ\,$ What should be the output elasticity of energy ?

$$\alpha_{e} := \frac{\partial Y_{t}^{j}}{Y_{t}^{j}} \times \frac{E_{t}^{j}}{\partial E_{t}^{j}}.$$

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Gaël Giraud

0. Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply

• What should be the output elasticity of energy ?

$$\alpha_{e} := \frac{\partial Y_{t}^{j}}{Y_{t}^{j}} \times \frac{E_{t}^{j}}{\partial E_{t}^{j}}.$$

• cost share "theorem" : at equilibrium,

 $\alpha_e = \text{cost share of energy in output}$

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E.g., Blanchard & Galí(2008).

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0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply



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- Kümmel, Lindenberger et al. (2008) The cost share "theorem" assumes no constraints. Adding constraints induces shadow prices
 - \Rightarrow decoupling between $\alpha_{\textit{E}}$ and the cost share.

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0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

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- Kümmel, Lindenberger et al. (2008) The cost share "theorem" assumes no constraints. Adding constraints induces shadow prices
 ⇒ decoupling between α_E and the cost share.
- Kahraman & Giraud (2013) Error correction model :

 $\Delta \ln \text{GDP}_t \simeq 0.6 \Delta \ln \text{E}_t + 0.2 \Delta \ln \text{K}_t + ... + \varepsilon_t$

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A robust relationship over 50 OECD countries (1970-2011). Kümmel, Ayres, Benjamin... David Stern (2010). Granger causality test: unequivocal. Energy \Rightarrow GDP. Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand

II. The supply side

III. Matching demand and supply

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A robust relationship over 50 OECD countries (1970-2011). Kümmel, Ayres, Benjamin... David Stern (2010). Granger causality test: unequivocal. Energy \Rightarrow GDP.

- Why do so many economists stick to the cost share "theorem" ? Capital accumulation is **not** the predominant root of growth. \neq Marxian economists.
 - \neq Neo-classical economists.

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand

II. The supply side

III. Matching demand and supply

Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

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 A "good" model should not rely on the cost share theorem. Most probably, a high output elasticity of energy.

Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

- A "good" model should not rely on the cost share theorem. Most probably, a high output elasticity of energy.
- More studies on increasing/decreasing returns to scale in industry.
 Prefer the industrial truth to the (possible) political discomfort.

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Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

II. Matching demand and supply

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 $\circ\,$ Add physical constraints to the production function. $\Rightarrow\,$ LinEx production function (Kümmel, Lindenberger).

Gaël Giraud

0. Background on neo-classical models

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II. The supply side

II. Matching demand and supply

- A "good" model should not rely on the cost share theorem. Most probably, a high output elasticity of energy.
- More studies on increasing/decreasing returns to scale in industry.
 Prefer the industrial truth to the (possible) political discomfort.
- Add physical constraints to the production function. \Rightarrow LinEx production function (Kümmel, Lindenberger).
- It should also not rely, at least no heavily, on the marginal productivity of factor doctrine.
 Does oil price reflect its marginal productivity ?

Substitutability among factors is also an issue.
 How does a factory work with no (or little) electricity ?

Gaël Giraud

0. Background on neo-classical models

I. The Demand

II. The supply side

III. Matching demand and supply

- Substitutability among factors is also an issue.
 How does a factory work with no (or little) electricity ?
- Capital is not substitutable to energy or labor, at least ex post.

Gaël Giraud

0. Background on neo-classical models

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II. The supply side

III. Matching demand and supply

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- Substitutability among factors is also an issue.
 How does a factory work with no (or little) electricity ?
- Capital is not substitutable to energy or labor, at least ex post.
- The production function as a state function is path-independent. What about the stock of past capital ? The whole energy transition problem deals with the choice of the *path*.

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Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

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- Substitutability among factors is also an issue.
 How does a factory work with no (or little) electricity ?
- Capital is not substitutable to energy or labor, at least ex post.
- The production function as a state function is path-independent. What about the stock of past capital ? The whole energy transition problem deals with the choice of the *path*.
- Putty-Clay technology: factors are weakly substitutable ex ante, and non-substitutable ex post.

Generations of capital (infrastructures, etc.). Path-dependence.

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

II. Matching demand and supply

Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

• My personal viewpoint on technological progress: conservative.

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0. Background on neo-classical models

. The Demand

II. The supply side

II. Matching demand and supply

- My personal viewpoint on technological progress: conservative.
- Exogenous technological progress (Harrod, Domar, Solow...) was "invented" to fill the gap of the Solow residual and to provide increasing returns to scale within a system of private poverty.

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Gaël Giraud

0. Background on neo-classical models

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II. The supply side

II. Matching demand and supply

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- Endogenous growth (Aghion, Howitt, Acemoglu, etc.) is not more convincing.

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Gaël Giraud

0. Background on neo-classical models

. The Demand

II. The supply side

III. Matching demand and supply

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- Endogenous growth (Aghion, Howitt, Acemoglu, etc.) is not more convincing.
- The model should be able to cope with no growth or even degrowth.

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III. Matching demand and supply III.1. Monetary cycles

 The model should be able to exhibit cycles. Leverage cycle on financial markets (Geanakoplos (2013)). Monetary (not real) Business cycles in the "real economy".

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Some Criteria for Economic Models

Gaël Giraud

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I. The Demand

I. The supply side

III. Matching demand and supply III.1. Monetary cycles

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くしゃ 本面 そうせん ほう うめんろ

 The model should cope with medium-run dynamics. Out-of-equilibrium dynamics. Not just short-run Impulse Response Functions.

Some Criteria for Economic Models

Gaël Giraud

). Background on neo-classical nodels

. The Demand

I. The supply side

III. Matching demand and supply III.1. Monetary cycles

- The model should be able to exhibit cycles. Leverage cycle on financial markets (Geanakoplos (2013)). Monetary (not real) Business cycles in the "real economy".
- The model should cope with medium-run dynamics. Out-of-equilibrium dynamics. Not just short-run Impulse Response Functions.
- On the medium run, the velocity of money should not be constant.

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Some Criteria for Economic Models

Gaël Giraud

). Background on neo-classical nodels

. The Demand side

I. The supply side

Gaël Giraud

). Background on neo-classical nodels

. The Demand

II. The supply side

III. Matching demand and supply



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Gaël Giraud

). Background on neo-classical models

I. The Demand side

I. The supply side

III. Matching demand and supply

• A "good" model should allow for underemployment.



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). Background on neo-classical nodels

I. The Demand

I. The supply side

III. Matching demand and supply

- A "good" model should allow for underemployment.
- Where does underemployment come from ? Only rigidities on the labor market ? "New-Keynesian" approach versus (Post-)Keynesian approach. Thomas (1995) Mortensen & Pissarides (1992).

ション ふゆ ア キョン キョン ヨー もくの

Gaël Giraud

). Background on neo-classical nodels

I. The Demand side

II. The supply side

III. Matching demand and supply

• Prey-predatory-like ODE with debts :

$$\begin{aligned} \frac{\omega_t}{\omega_t} &:= e^{A+B\lambda_t} + C - \alpha \\ \dot{D}_t &= rD_t + I_t(\mu_t(D_t), r) - \mathbf{s}\pi_t \\ \frac{\dot{\lambda}_t}{\lambda_t} &= \frac{e^{D+E\mu_t(D_t) - Fr} + G}{\sigma} - (\delta + \alpha + \eta). \end{aligned}$$

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Gaël Giraud

). Background on neo-classical models

I. The Demand side

II. The supply side

III. Matching demand and supply



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Some Criteria for Economic Models







I. The Demand

II. The supply side



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Some Criteria for Economic Models

Gaël Giraud

). Background on neo-classical nodels

I. The Demand

II. The supply side

III. Matching demand and supply

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Gaël Giraud

0. Background on neo-classical models

. The Demand ide

I. The supply side

III. Matching demand and supply

• Choose your normative social welfare function:

- Utilitarian ? $U(x_1, ..., x_N) := \frac{1}{N} \sum_{i=1}^{N} u_i(x_i)$ People are perfectly substitutable but have the same weight (Stern vs Nordhaus).

ション ふゆ ア キョン キョン ヨー もくの

Gaël Giraud

). Background on neo-classical nodels

. The Demand ide

I. The supply side

III. Matching demand and supply

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• - Rawlsian ?
$$U(x_1, ..., x_N) := Min_i u_i(x_i)$$

Maximin criterion.
People are complementary.

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0. Background on neo-classical models

. The Demand ide

I. The supply side

III. Matching demand and supply

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 Rawlsian ? U(x₁,...,x_N) := Min_iu_i(x_i) Maximin criterion.
People are complementary.

• Hybrid ?
$$U(x_1, ..., x_N) := \left[\prod_{i=1}^N u_i(x_i)\right]^{\frac{1}{N}}$$

Gaël Giraud

0. Background on neo-classical models

. The Demand ide

I. The supply side

III. Matching demand and supply

• Choose your normative social welfare function:

- Utilitarian ? $U(x_1, ..., x_N) := \frac{1}{N} \sum_{i=1}^{N} u_i(x_i)$ People are perfectly substitutable but have the same weight (Stern vs Nordhaus).

• - Rawlsian ?
$$U(x_1, ..., x_N) := Min_iu_i(x_i)$$

Maximin criterion.
People are complementary.

• Hybrid ?
$$U(x_1,...,x_N) := \left[\prod_{i=1}^N u_i(x_i)\right]^{\frac{1}{N}}$$

 Your normative criterion should be ordinal, not cardinal. Mertens & Dhillon (1999), Fleurbaey & Maniquet (2006). Fairness and distributional issues.

くしゃ 本面 そうせん ほう うめんろ

• If you are Utilitarian, the normative social discount rate should be

r = g

ション ふゆ ア キョン キョン ヨー もくの

with g = real GDP growth. (Mertens & Rubichink (2010)).

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

. The Demand

I. The supply side

 If you are Utilitarian, the normative social discount rate should be

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with g = real GDP growth. (Mertens & Rubichink (2010)).If you are "Rawlsian", should'nt it be ?

r < 0.

ション ふゆ ア キョン キョン ヨー もくの

Some Criteria for Economic Models

Gaël Giraud

0. Background on neo-classical models

I. The Demand

I. The supply side

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r < 0.

• Command versus control ?

Hayek's argument: command is impossible because of the cost of extracting information. Public policy deals with second-best.

Incomplete markets are not even second-best optimal...

Elinor Ostrom : cooperative information sharing among people ?

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0. Background on neo-classical models

. The Demand

I. The supply side

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0. Background on neo-classical models

. The Demand

I. The supply side

Gaël Giraud

0. Background on neo-classical models

I. The Demand side

I. The supply side

III. Matching demand and supply

Natural resources should be modeled as finite stocks. (Meadows (1972))

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0. Background on neo-classical models

I. The Demand side

I. The supply side

III. Matching demand and supply

- Natural resources should be modeled as finite stocks. (Meadows (1972))
- We should carefully distinguish between:
 - physical constraints (2d law...)
 - behavioral assumptions (consumption, mobility,...)
 - institutional environments (legal framework, banking sector...)

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