(Towards) A prototype stochastic general equilibrium model of the global food system

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Outline

- Initial comments on uncertainty and risk

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- Conclusions thereof

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- They face risks of ill-being (bankruptcy / food shortage) because of this — presumably growing larger with climatic change
- We analysts are uncertain with respect to how much the risks grow
- Unless our uncertainties are modeled and quantified in appropriate ways joint with those of producers and consumers, we will *almost certainly* give wrong advice

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- Basically, the assumption on insurance is false. Making insurance markets work is costly. An infinite number of such markets are required
- An alternative (Radner 1972) is to specify a few insurance markets: general equilibrium with incomplete asset markets (GEI)

A case

- A tribe farms by making efforts, x, on their land and reaping their crops, y, according to what nature, w, allows. The crop model, $y = F(x, w)$, is known and invariant, but the outcome of nature is known only by its invariant probability distribution, $\pi(w)$.

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- A utility function, $U(x, y)$, measures the well-being of the tribe in a single year
- The chief decides a strategy with respect to effort, x^*, depending on the model he leans on, static GE or stochastic dynamic GEI

Making the case more realistic

- The tribe may find ways to store crops from one year to the next: Barns and/or livestock
- The tribe may trade with other tribes forming markets at certain points in time
- Tribes may specialize in wage labor or production management according to endowments and resources
- Markets for insurance contracts can be formed to spread risk
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- Groups of tribes form nations and a modern world is created
- *but none of these modifications change the fundamental contrasts between GE and GEI*

The case with static GE model

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- The marginal effect of nature on well-being is given by derivative of the value function (envelope theorem):

$$\partial_w U^*(w) = \partial_y U(x^*, F(x^*, w))\partial_w F(x^*, w)$$

The dependence of x^* on w plays no role for the marginal effect

The case with stochastic dynamic GEI model

- The value function is now an expected present well-being taking all possible states in all future into account

$$U^*(y,\pi) = \max_x \{U(x,y) + \beta \mathrm{E}_{\pi(w)}\ U^*(F(x,w),\pi)\}$$

where the expectation is taken over nature next year

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- The marginal effect of *a change in the probability distribution of nature* on well-being can be calculated

$$\partial_\pi U^*(y,\pi) = \beta \partial_\pi \mathrm{E}_{\pi(w)}\ U^*(F(x,w),\pi)$$

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- Ensemble prediction of nature, ensemble crop model and ensemble utility function play no role alone

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  - what research on food security needs, and what modern macro and resource economics is about
  - more difficult than GE models. Differential equations need be solved — approximately
  - the big picture can presumably be painted with relatively low resolutions over within-year time, between-year time, space, commodities and states of nature






Thanks for your attention

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