Predicting the Spatial Patterns of Land Conversion

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Main points

- Empirical basis of current economic models of global land markets is thin.
- Spatially explicit data can help to fill current gaps…
- … and improve existing work by incorporating increased spatial heterogeneity in land use analyses.
- Today we develop an example that shows:
  - The potential of spatial data for improving economic modeling.
  - And the limitations we still face.

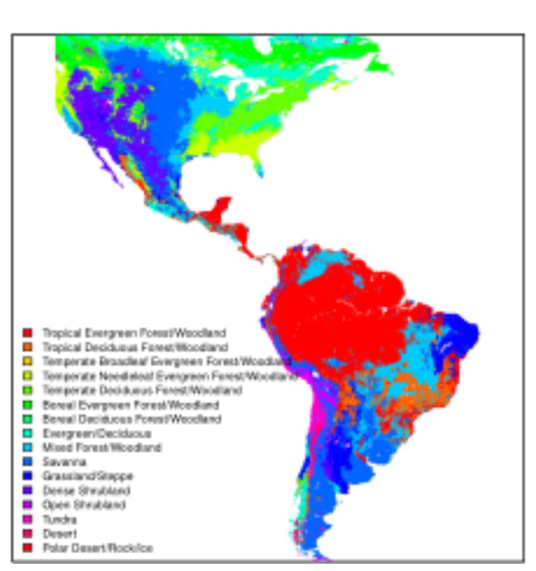
A key unknown--land supply elasticities

Land Supply Elasticity Defined:

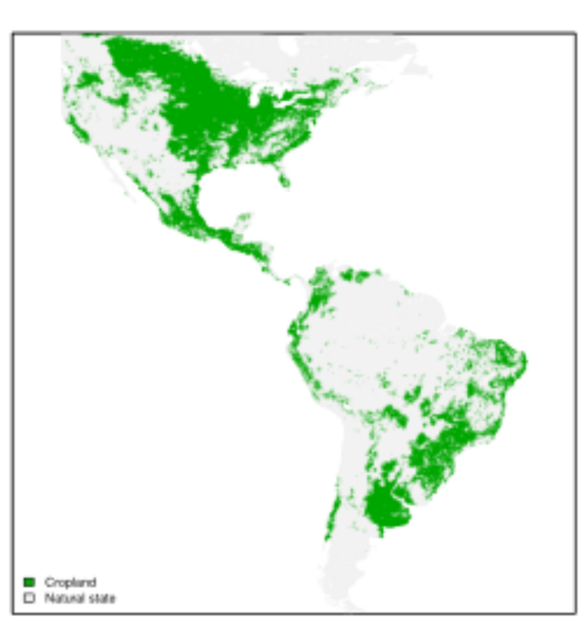
% change in land supplied from a commercial or natural state to agriculture (or vice versa) given a 1% change in relative returns.

Modeling the transition from natural vegetation to cropland (work in progress)

Maps of potential vegetation provide natural cover before land was converted to agriculture (Ramankutty and Foley, 1999):



Discrete choice: land is in agriculture, Z=1, Z=0 otherwise (Monfreda et al., 2008):



Regressors

Land supply elasticities

- Require price, but we do not have gridded/subnational data on land returns or prices!
- Instead, we have measures of access to markets
- Model land returns as functions of market access (Von Thunen's model):

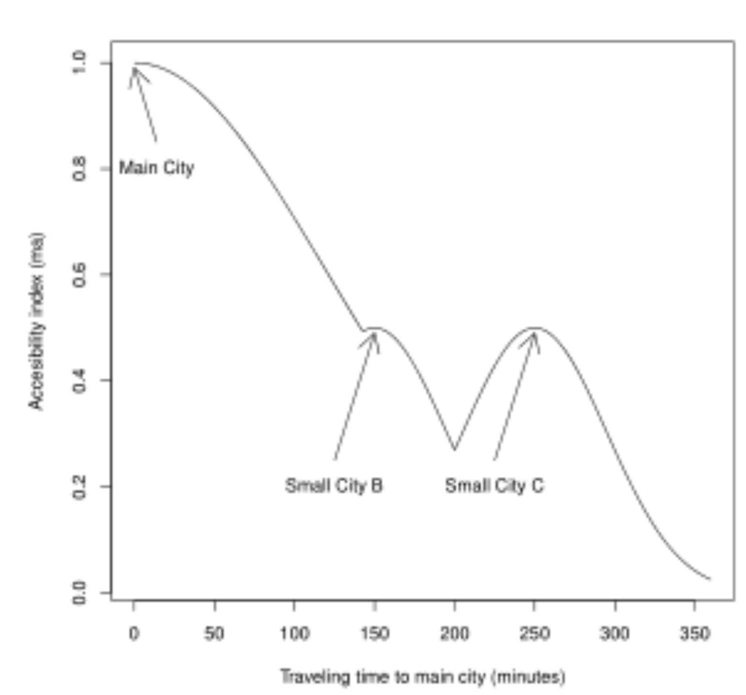
$$Returns_i = Access_i^{\gamma_1}$$

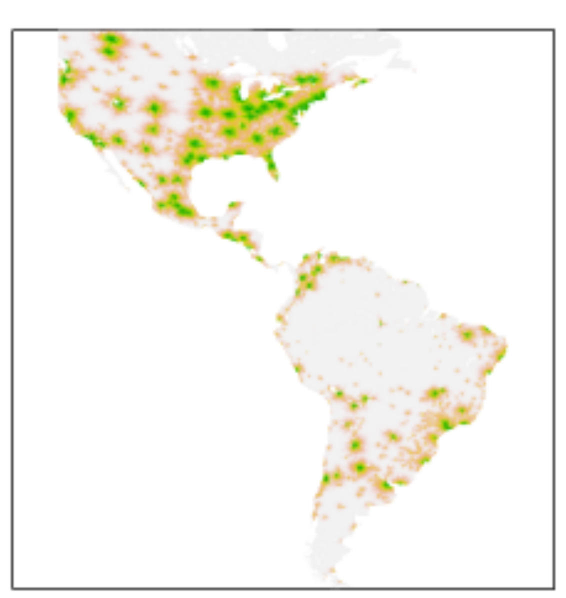
Model land use decision (Z) as a logit function of land use drivers to infer transition probabilities from natural cover to cropland

$$P(Z_i = 1|S_i) = \Lambda(\alpha_0 + \alpha_1 S_i + ... + \alpha_n S_n + \varepsilon_i).$$

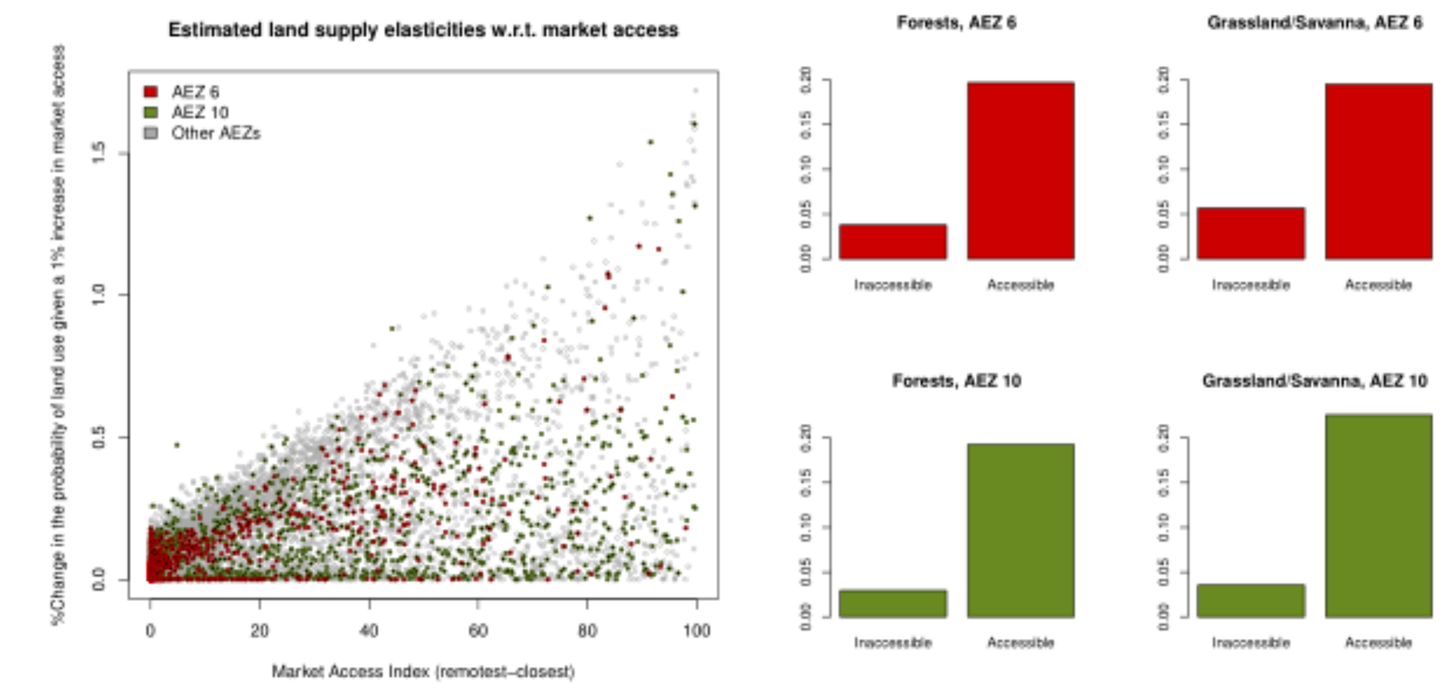
VARIABLES		UNITS	SOURCE
Biophysical	Potential Vegetation*	1-14	Ramankutty & Foley
	Soil Fertility Constraints	1-7	IIASA Global AEZ
	Average annual precipitation	mm	IIASA Global AEZ
	Elevation	meters	NOAA SAGE's Atlas
	Soil pH	0-14	SAGE
	Soil Carbon		SAGE
	Monthly temp (ave. 1961-1990)**	Degree Celsius	CRU
Socio-economic	Market Access	index	Verburg et al
	Area equipped for irrigation	% of gridcell	Siebert et al
	Built-up land	% of gridcell	Miteva, B.
	Protected Areas	0-2	GEONETWORK
Descriptive	GTAP 18 and 108 AEZs	AEZs	Uris Baldos

Market access index decreases with travel time from the location of a large market (Verburg, 2011)





Land supply elasticities and land accessibility



Accessible lands are those with market access greater than 13 (percentile 75). Inaccessible are below the 75% percentile. The elasticities on the right plot are weighted averages using predicted probabilities of land use as weights.

In summary

- Using global grids of agricultural production and its determinants produce land supply elasticities that:
  - Are in line with previous literature using actual price changes.
  - Reject the hypothesis of homogeneous elasticities across countries/ AEZs.

Advantages and disadvantages of spatial data for econometric modeling of global land use

Advantages:

- Are global.
- Are gridded.
- Are comprehensive.

Disadvantages:

- Are dated.
- Assumptions underlying the final product are often opaque.
- Emphasis on biophysical attributes (as opposite to socio-economic variables.)

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