ILLUSTRATION HOW THE GLOBAL TIMBER MODEL MISINTERPRETED THE ELASTICITY OF FOREST AREA WITH RESPECT TO NET RETURNS TO FORESTRY FROM PAPERS PUBLISHED BY LUBOWSKI

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In a reply to Sohngen et al. in Nature, we explain that the Global Timber Model misinterprets a critical underlying elasticity expressed in several papers led by Ruben Lubowski (R. Lubowski 2002)(R. N. Lubowski, Plantinga, and Stavins 2006)(Ahmed, Hertel, and Lubowski 2009). Lubowski estimated an elasticity for how U.S. forest area change – conversion of cropland or pasture to forests -- responds to changes in the net returns to forestry, i.e., forest profitability. His analysis estimated changes in five-year periods. However, the parameter the GTM authors used confused the units, leading to a 75x overestimate of this elasticity. Although Lubowski's analysis found that changes in the profitability of forest had only an extremely small effect on forest area, the GTM authors attributed a large effect.

The GTM primarily used an elasticity of 30% (Tian et al. 2018). This means that a 100% increase in the profitability of forestry (the net returns to forest land) would result in roughly a 30% increase in forest area. This number was taken from Table 5.2 (in Lubowski et al. (2006), reproduced as Figure 1 below. The red circles show the 30% elasticities that were both cited and used by the GTM authors. However, the 30% did not estimate a change in total forest area, but instead only a change in a small underlying rate of change. Lubowski had first calculated a small background rate of change from cropland and pasture to forest (just as there is a small background rate of change from forest to cropland and pasture). The 30% parameter only estimated a change in this rate of change. (This is what the legend to the figure explains using technical language.) The elasticity measuring the change in total forest area in response to an increase in net returns to forestry was only 0.004%. It was reported in Lubowski 2002 explicitly, and was also shown in a figure from Ahmed et al. (2009), reproduced below as Figure 2. A red arrow points to this elasticity for forests.

In a subsequent blog post, the GTM authors claimed that this 30% was not a mistake but instead was roughly the Lubowski calculation of a 100-year elasticity. This was not what GTM reporters claimed in their papers. It also could not be correct because in the same Figure 2 below from Ahmed et al. (2009), Lubowski extrapolates the estimated 5-year elasticity to 100 years, and it was only 2.5%. (Lubowski's statistics only show a five-year response, but this 100-year change was a mathematical extrapolation given the functional form of Lubowski's model).

In the same Ahmed paper, Lubowski also translated the elasticity into a different functional form called a CET parameter. This parameter is not technically an elasticity but determines the elasticity in models that use it in conjunction with other parameters. Figure 2 shows the CET parameter for forests, which is barely distinguishable from zero. This reflects the extremely low elasticity for forests, i.e., that even large changes in forestry profitability have almost no effect on forest area. However, the authors also showed the CET parameter for cropland and pasture. Unlike forest, their elasticity was substantial, which means that a 100% increase in profitability of cropland or pasture could cause a large increase in their areas. The figure also shows an average of all land uses. In Favero et al. (2020) the GTM authors mistakenly used this composite CET parameter instead of the forest parameter (Favero, Daigneault, and Sohngen 2020). This was a roughly equivalent error leading to a gross overestimate of how much forest area would increase in response to an increase in forestry's profitability.

Figures

Figure 1: Table in Lubowski (2006) Showing GTM Forestry Area Elasticity Relied on by GTM in Tian et al. (2018)

Source of the 30% elasticity cited in Tian et al. (2018) (appendix B)

Table 2
Own-return land-use choice elasticities[a]

Initial land use	Final land use and time period[b]									
	Crops		Forest		Pasture		Range		Urban	
	1982–97	1992–97	1982–97	1992–97	1982–97	1992–97	1982–97	1992–97	1982–97	1992–97
Crops	0.192**	0.011**	0.332**	0.310**	0.090**	0.183**	0.477**	0.376**	0.156**	0.342**
	(0.005)	(0.001)	(0.024)	(0.043)	(0.017)	(0.031)	(0.036)	(0.048)	(0.005)	(0.016)
Forest	0.178**	0.295**	−0.000	0.001	0.091	−0.000	0.235**	0.232	0.511**	0.792**
	(0.039)	(0.064)	(0.000)	(0.055)	(0.179)	(0.000)	(0.033)	(0.330)	(0.010)	(0.058)
Pasture	0.306**	0.341**	0.023*	0.005	−0.005	−0.012	1.373**	1.042**	0.314**	0.331**
	(0.012)	(0.022)	(0.011)	(0.027)	(0.003)	(0.008)	(0.033)	(0.050)	(0.014)	(0.026)
Range	0.072	0.065	0.064**	0.127	0.159	0.399	−0.002	−0.001	0.385**	0.419**
	(0.069)	(0.229)	(0.023)	(0.906)	(0.700)	(0.417)	(0.001)	(0.971)	(0.036)	(0.031)

[a]Elasticities are evaluated at the means of the data and are the percentage change in the probability of choosing the final land use, conditional on being in the initial use, for a 1% change in the net returns to the final use. Standard errors, in parentheses, are estimated using the Delta Method [11]. * and ** denote significance at the 5% and 1% levels, respectively.

Figure 2: Figure from Ahmed et al. (2009) Showing the Estimated Lubowski Elasticity and the 100-Year Extrapolation

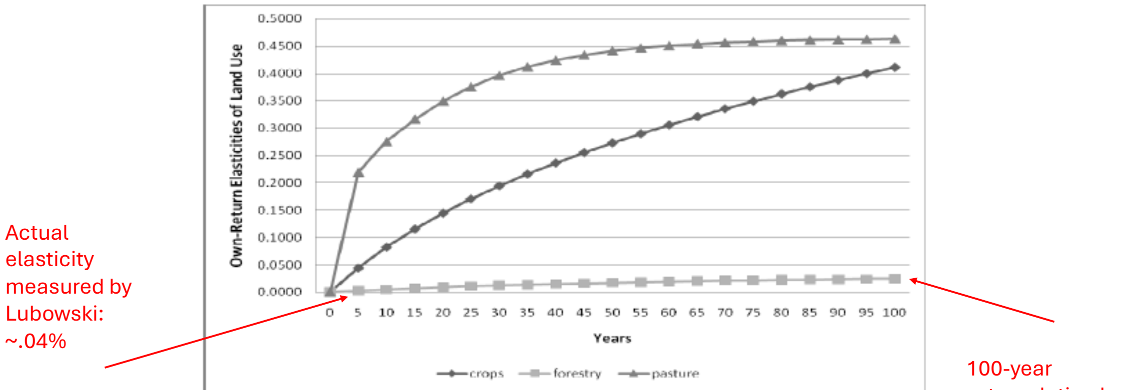

Figure 2: Own-Return Elasticities of Land USe at *t* for Use *i*
Source: Authors' Simulations

Figure 3: Figure from Ahmed et al. (2009) Used by GTM Translating Lubowski elasticity into CET value

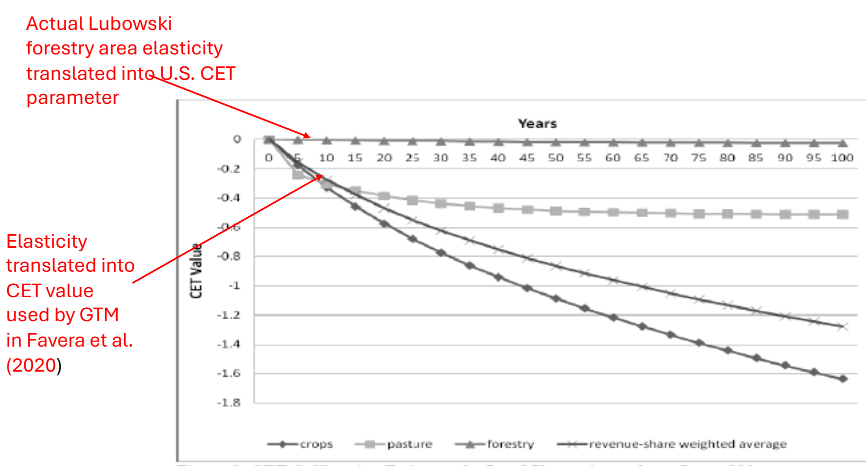

Figure 3: CET Calibration Estimates by Land Use at time *t*, for t=5 to t=100
Source: Authors' Simulations

References

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