APPENDIX G. GATEs

GATEs for treatment T_1

Table G1 highlights that much of the TE heterogeneity across farm subgroups can be associated essentially to three features: farm specialization in perennial crops, geographical location and, to a lesser extent, livestock intensity. On the one hand, these results seem to indicate that dropping CC and GP requirements produces a more severe reduction in the FADN-AFI when farms specialize in permanent crops. On the other hand, our findings clearly emphasize that the sharp divide between the North and the South (Coderoni and Esposti, 2018) is clearly associated to TE heterogeneity.

Table G1. *TE CrI (Treatment T_1) by farm subgroups identified by fitting a shallow regression tree to $\tau(\boldsymbol{x}_i)$ (Figure 2b [1] of the main text)*

Subgroup	Description	95% CrI	
		Lower	Upper
g8	Farms specialized in perennial crops located in Italy's southmost regions	-2.03	-0.50
g9	Farms specialized in perennial crops located in southern-central Italy	-1.25	-0.47
g10	Farms specialized in perennial crops located in Italy's mountain regions	-1.57	-0.45
g11	Farms specialized in perennial crops located in northern Italy	-0.71	0.02
g12	Farms in southern-central Italy with low livestock intensity	-0.91	-0.03
g13	Farms in southern-central Italy with moderate to high livestock intensity	-0.62	0.33
g14	Farms in the Po valley's flatlands that do not specialize in perennial crops	-1.00	0.40
g15	Farms in the Po valley that do not specialize in perennial crops	-0.44	0.66

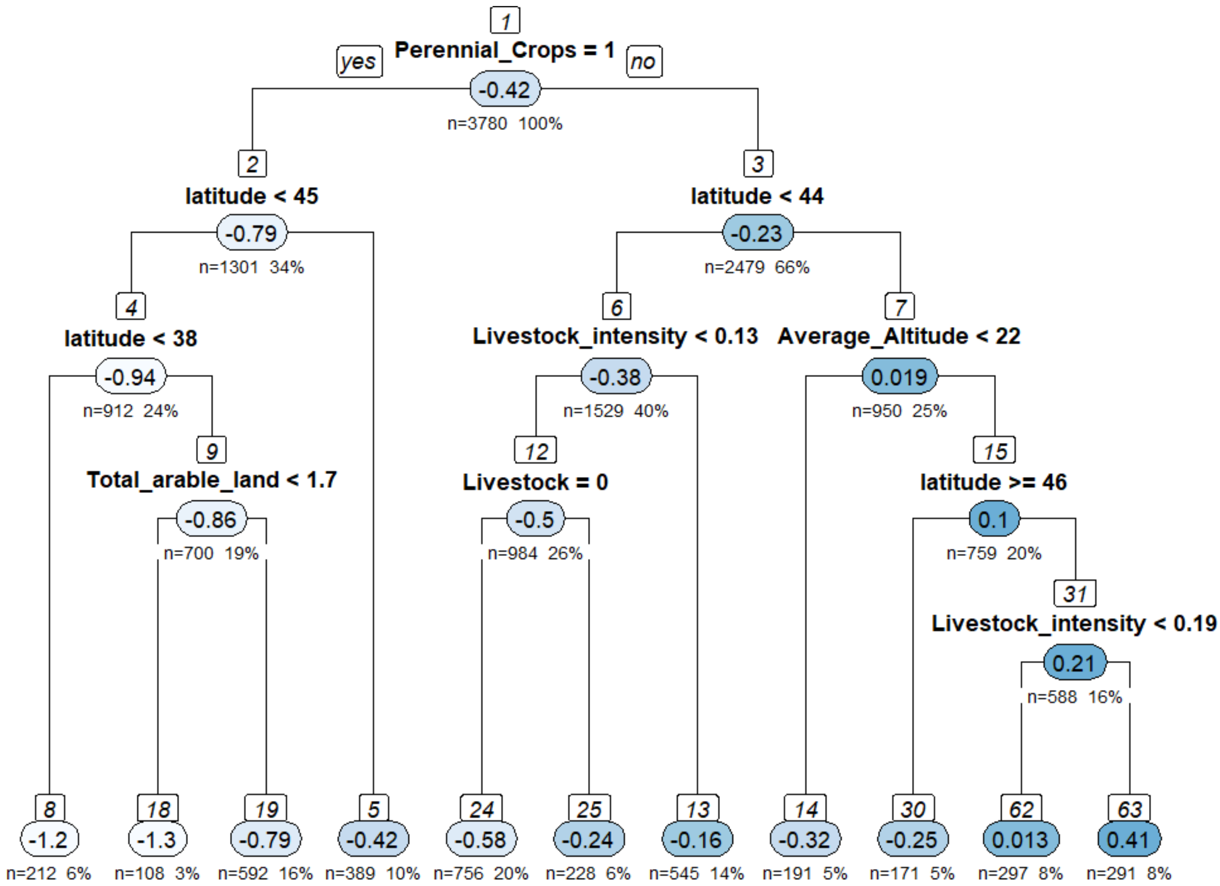
However, since the TE estimates for groups 13 to 15 are rather noisy, we further investigate this geographical and agronomic heterogeneity by performing subgroup comparisons, as discussed in Sections 5 and 6. Table G2 displays the results of this exercise. Our comparisons suggest that the clearest subgroup differences emerge when comparing the clusters in the leftmost branches of the trees (i.e., farms cultivating perennial crops) both among themselves and with farms in the rightmost terminal nodes (i.e., farms not cultivating perennial crops). Conversely, the differences among the subgroups located to the right of the first tree split are more ambiguous, with most 95% CrI centred around or including zero. In other words, there seem to be marked TE discrepancies both between differently specialized farms and farms diversely located across Italy. However, the latter are less clear when focussing on farms that do not specialize in perennial crops.

Finally, we grow the tree in Figure 2b (1) without artificially limiting its depth. Instead, we prune the finest leaves using the standard complexity-based regularizing mechanism built in the R package rpart. The resulting tree is shown in Figure G1. The new branches identify another set of potentially relevant sources of TE heterogeneity: farm size (expressed as total arable land) and farm specialization in livestock breeding. Despite the interesting identification of very specific farm clusters, however, growing deeper trees adds several layers of complexity when it comes to interpreting the results. Not only do the number of potential comparisons grow, but also the interpretability of the subgroups becomes challenging. For this reason, we limit our discussion to the tree and the clusters shown in Figure 2b (1) and leave the results in Figure G1 available upon request.

Table G2. *Differences between the TE (Treatment T_1) of subgroups defined in table G1.*

Group difference	Average	95% CrI		0 ∉ CrI
		Lower	Upper	
g8 - g9	-0.332	-0.981	0.142	
g8 - g10	-0.204	-1.128	0.623	
g8 - g11	-0.863	-1.675	-0.115	X
g8 - g12	-0.713	-1.474	-0.025	X
g8 - g13	-1.026	-1.847	-0.394	X
g8 - g14	-0.867	-1.870	0.045	
g8 - g15	-1.314	-2.238	-0.411	X
g9 - g10	0.151	-0.553	0.808	
g9 - g11	-0.520	-0.998	-0.066	X
g9 - g12	-0.361	-0.821	0.089	
g9 - g13	-0.700	-1.208	-0.194	X
g9 - g14	-0.559	-1.351	0.243	
g9 - g15	-0.973	-1.634	-0.310	X
g10 - g11	-0.654	-1.138	-0.222	X
g10 - g12	-0.500	-1.243	0.235	
g10 - g13	-0.841	-1.585	-0.105	X
g10 - g14	-0.683	-1.650	0.203	
g10 - g15	-1.109	-1.854	-0.390	X
g11 - g12	0.177	-0.415	0.764	
g11 - g13	-0.173	-0.794	0.409	
g11 - g14	-0.009	-0.660	0.661	
g11 - g15	-0.437	-0.973	0.058	
g12 - g13	-0.332	-0.755	0.068	
g12 - g14	-0.184	-0.812	0.458	
g12 - g15	-0.603	-1.147	-0.070	X
g13 - g14	0.175	-0.631	0.933	
g13 - g15	-0.259	-0.828	0.283	
g14 - g15	-0.414	-0.979	0.064	

Figure G1. *Deeper regression tree fitted to the MAP IATEs for treatment T_1.*



GATEs for treatment T_2

As discussed in Section 6, the farm clusters identified by the tree in Figure 3a (1) (treatment T_2) do not seem to exhibit significant heterogeneous TE. We verify this by calculating subgroup differences as in the previous section. Table G3 confirms that: (i) such comparisons are on average small and (ii) with few exceptions, the corresponding 95% CrI do not trace out systematic differences.

Table G3. *Differences between the TE (Treatment T_2) identified by fitting a shallow regression tree to $\tau(\boldsymbol{x}_i)$ (Figure 2a [1] of the main text).*

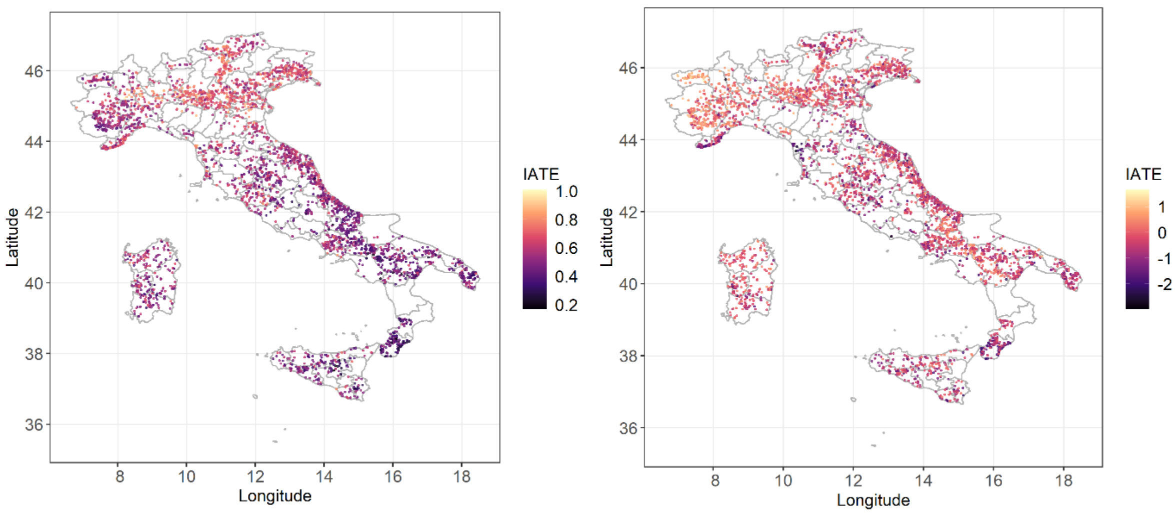
Group difference	Average	95% CrI		0 ∉ CrI
		Lower	Upper	
g8 - g9	-0.046	-0.226	0.077	
g8 - g10	-0.120	-0.417	0.148	
g8 - g11	-0.196	-0.471	0.022	
g8 - g12	-0.129	-0.385	0.062	
g8 - g13	-0.209	-0.498	0.005	
g8 - g14	-0.178	-0.577	0.165	
g8 - g15	-0.296	-0.661	-0.019	X
g9 - g10	-0.067	-0.386	0.230	
g9 - g11	-0.138	-0.413	0.055	
g9 - g12	-0.076	-0.285	0.081	
g9 - g13	-0.156	-0.388	0.001	
g9 - g14	-0.122	-0.524	0.228	
g9 - g15	-0.243	-0.578	0.035	
g10 - g11	-0.079	-0.286	0.134	
g10 - g12	-0.012	-0.336	0.312	
g10 - g13	-0.097	-0.485	0.298	
g10 - g14	-0.056	-0.419	0.303	
g10 - g15	-0.184	-0.587	0.220	
g11 - g12	0.063	-0.197	0.344	
g11 - g13	-0.024	-0.298	0.283	
g11 - g14	0.018	-0.410	0.441	
g11 - g15	-0.102	-0.492	0.284	
g12 - g13	-0.081	-0.252	0.059	
g12 - g14	-0.045	-0.351	0.230	
g12 - g15	-0.163	-0.425	0.046	
g13 - g14	0.039	-0.359	0.393	
g13 - g15	-0.081	-0.350	0.169	
g14 - g15	-0.116	-0.459	0.216	

Better policy targeting: geographical distribution of the IATEs

Section 6 of the main text concludes that one of the primary factors contributing to TE heterogeneity is geographical location. Therefore, it appears feasible to enhance policy targeting in this direction. Notably, certain aspects related to geographical distinctions have already been addressed by the policy such as, for instance, the distinction between plain and mountain agriculture (e.g., compensatory payments for mountain areas under Pillar 2 payments) or the Italian North/South divide (e.g., measures aiming at setting up young farmers activated only in the South; see Coderoni et al., 2023). With the introduction of the new CAP and the implementation of the novel Pillar 1 measure known as Eco-Schemes, we anticipate an even more precise targeting of geographical features through this new instrument.

To better illustrate how the present results can be informative to improve the geographical targeting of AEPs, we provide an illustration of the geographical distribution of IATE estimates in Figure G2. These maps show that, on the one hand, the compliance with the CC and GP requirements plus the adoption of AEMs (treatment T_2) sorts a stronger positive effect in farms located in the Po valley (Figure G2, left panel). On the other hand, when farms neither comply with the CC and GP requirements nor adopt AEM (treatment T_1), the detrimental effect on the FADN-AFI is stronger in central and southern Italy, as well as along the Tuscany and Liguria coastlines.

Figure G2. *Left panel: geographical distribution of the MAP IATEs for treatment* T_2*. Right panel geographical distribution of the MAP IATE for treatment* T_1*.*



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