Appendix B:
Modeling Participation Effects From Changing EBI Weights

The simulations used in this study are designed to capture the impacts of changes in the EBI weights. A simple approach would assume that the same set of offers is made regardless of changes in the weights. Different outcomes would still be possible because a change in weights could change the total EBI score for each offer. As some scores increase and others decrease, the set of offers accepted into the program will change, leading to a new mixture of environmental benefits and costs.

However, it is not realistic to assume a constant set of offers. Instead, "incentive effects" are likely to be important. Two issues are of particular concern:

- If the EBI weight vector changes, it is possible that different sets of acres (out of the roughly 300 million currently eligible acres) would be offered to the CRP. Some current participants would no longer find the program attractive, while some current nonparticipants would become interested in the program.

- Lands currently available for enrollment may be systematically different from the full set of lands that are eligible. In particular, land currently enrolled in the CRP cannot be "re-offered," and this land may be different than land not currently enrolled.

This appendix outlines how the models used in scenarios 1 to 4 (chapter 3) address these concerns. Additional details are available from the authors. Major elements used in these models include the following:

- Each simulated enrollment is based on a "weighting" of the observations in the CRP offer file. That is, instead of assuming that each acre offered to the CRP represents 1 acre, each offer is assigned an *expansion factor*. The expansion factor measures how many eligible, but not offered, acres are identical to the acres covered by this offer.

- We simulated both a 2-million-acre enrollment in a single signup and a 33-million-acre program constructed from a multiyear series of signups.

The essential notion is that each observation in the CRP offer file is representative of a larger set of acreage that could be offered into the CRP. This implies that for a given offered acre, there are other observationally equivalent acres. Some of these observationally equivalent acres are already enrolled in the CRP, while others belong to landowners who have decided not to offer them to the CRP during this signup.

The expansion factor is estimated by first computing *predicted offer rates*. We assume that a landowner's decision to offer an acre to the CRP is influenced by an acre's EBI score, along with profitability and other concerns. By modeling the probability of making an offer, as a function of the EBI

score (hence as functions of EBI weights), we can estimate a new probability (of making an offer) when the EBI weights change.

This model involves two data sources:

- For each Major Land Resource Area (MLRA), the Farm Service Agency's likelihood-to-bid (LTB) model is used to simulate the acres eligible for the CRP. In addition to simulating total acreage, the LTB model also simulates the distribution of EBI scores across eligible acres in an MLRA.
- The complete set of offers made to the CRP's 26th signup includes data on the location (the MLRA) of all offers and each offer's EBI scores.

For each of these datasets, we define "cohorts" of similar points. Each cohort is defined by geography (its MLRA) and attributes (the EBI factor scores). For each cohort, an *offer rate (OR)* is computed:

OR = (acres offered in this cohort) / (eligible acres in this cohort)

where eligible acres does not include land currently enrolled in the CRP.

We regress the relationship between the *offer rate* and several explanatory variables.

(A) $\mathrm{OR} = f(X,\beta)$,

where X is a vector of independent variables including EBI scores, measures of land productivity, and average landowner characteristics (such as county-wide median age), and $\beta)$ is a vector of coefficients to be estimated.

For a variety of reasons, we estimate the parameters of $f(\cdot)$ with a "bootstrapping" methodology that employs individual observation data rather than aggregated data:

(B) $OR_i = f(X_i, \beta)$,

where OR_i is an offer rate imputed to each observation i in the offer file. This estimator uses simulation techniques (repeated regressions on randomly drawn observations) to control for errors in variables, problems that may arise from aggregating offers into cohorts.

The results of this regression are then used to generate the *expansion factor* for all offers in a simulation. These expansion factors are used as follows:

- Each simulation is characterized by a unique EBI weight vector.
- For each observation (i) in the offer file, we predict

$$\overline{OR}_{i0} = f(X_{i0},\beta) \text{ and } \overline{OR}_{i1} = f(X_{i1},\beta),$$

where $\overline{OR}_{i0}$ and $\overline{OR}_{i1}$ are the "old" and "new" predicted offer rates, respectively. These predictions use each offer's attributes and the estimated values

of β from equation B. In particular, X_{i0} contains the actually observed EBI factor scores, and X_{i1} contains the EBI factors scores that this point would have under this simulation's "unique" EBI weight vector.

For each offer, an expansion factor is computed:

$$XP_i = \overline{OR}_{i1} / \overline{OR}_{i0}$$

Thus, if the old offer rate ($\overline{OR}_{i0}$) is 25 percent and the new offer rate ($\overline{OR}_{i1}$) is 50 percent, the *XP* will be 2.0.

- For each observation, the effective acres (EA) are computed as:

  $$Ea_i = actual\_acres_i * XP_i.$$

  Where *actual acres* is the actual acreage included in offer *i*.

- All the offers are sorted by EBI scores.

  As with the base case, a simulated CRP is generated by "signing up" the best 2 million acres. Note that each offer's effective acres, rather than actual acres, are used when adding lands to the simulated CRP.

The above "single signup model" simulates the kinds of lands enrolled in a single signup (of a few million acres). We also consider how the entire CRP would change under different EBI weights. To address this question, we scale up the results of a single signup to approximate a 33-million-acre program.

To do this, it is useful to recall that the CRP was created from multiple signups. That is, landowners are given multiple opportunities to enroll their land into the CRP. We simulate this by iterating the single signup model with an expansion factor based on predicted offer rates until a specified enrollment limit has been reached. In each iteration, all acres with an EBI score that exceeds a cutoff are accepted. These acres are also removed from the set of eligible acres that may be accepted by future signups. Achieving the specified enrollment limit sometimes required adjusting the value of the EBI cutoffs used in the simulations; these adjusted cutoff values were close to but not always the same as the EBI cutoff actually used by FSA.

This process requires establishing "representative acreage" for each observation in the offer file. This representative acreage represents the total number of eligible acres (including land currently enrolled in the CRP) represented by the offer. The representative acres value, for each offer, is estimated using cohort level data from the LTB dataset and the offers dataset.

The actual acres that an observation *i* offer would contribute (to a simulated CRP), in round *r*, is:

$$\text{(C) Offered\_}acres_{ir} = (Prob\_offer_i * XP_i) * (representative\_acres_i - contracted\_acres_{ir})$$

where:

$Prob\_offer_i$	The base probability of an acre, represented by this offer, is offered to the CRP. This is simply the observed offer rate for the cohort to which the offer belongs.
XP_i	The predicted expansion factor for this offer, given a proposed EBI weight vector.
$Representative\_acres_i$	The number of acres this offer represents.
$Contracted\_acres_{ir}$	Total acres that are represented by this offer, accepted in prior rounds. $= \sum_{t=1}^{r-1} contracted\_acres_t$ Note that in round s, $contracted\_acres_s$ is a subset of $offered\_acres_s$. In particular, $contracted\_acres_s$ are the $offered\_acres_s$ that have EBI scores exceeding the cutoff used in round s.