Economic Analysis of the Standard Reinsurance Agreement

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Abstract

The paper presents an economic analysis of the Standard Reinsurance Agreement (SRA), the contract that governs the relationship between the Federal Crop Insurance Corporation and the private insurance companies that deliver crop insurance products to farmers. The paper outlines provisions of the SRA and describes the modeling methodology behind the SRA simulator, a computer program developed to assist crop insurers and policymakers in assessing the economic impact of the Agreement. The simulator is then used to analyze how the SRA affects returns from underwriting crop insuranceat various levels of aggregation.

Keywords: crop insurance, Standard Reinsurance Agreement, risk modeling, policy analysis.

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Introduction

Risk sharing between private insurance companies and the government has been an integral part of the federal crop insurance program since 1981. The Federal Crop Insurance Act of 1980 (P.L. 96-365) encouraged the Federal Crop Insurance Corporation (FCIC) to privatize functions of the crop insurance program "to the maximum extent possible". A key component of the 1980 legislation was the enlistment of private insurance companies to not only sell and service crop insurance policies, but for the first time to share the risks on the policies that they write. By 2001, crop insurance companies were writing policies with a total premium of almost $3 billion and retaining risks on almost $2.4 billion through the Standard Reinsurance Agreement (SRA) with the FCIC.

While there has been much research on the federal crop insurance program, most of the focus has been on how insurance affects producer-level risk and the demand for crop insurance. Research on the reinsurance agreement has focused largely on the use of contingency markets such as futures and options as alternatives to traditional reinsurance (Miranda and Glauber; Mason, Hayes and Lence; Turvey, Nayak and Sparling). An exception is a recent paper by Ker and McGowan that considers the ability of crop insurance companies to adversely select against the FCIC. Using a stylized model of the SRA that considered wheat yield distributions in 57 Texas counties, they demonstrated that companies could increase expected underwriting gains by ceding more risk to the FCIC in those year where *ex-ante* projections of wheat yields suggested potential crop insurance losses. Yet, while their paper provides insight into how companies may increase underwriting gains through the SRA, their empirical findings are limited in scope. Crop insurance companies typically write policies in more than one state and several operate nationwide. Expected underwriting gains depend on the underlying crop yield distributions across commodities and regions and the structure of the SRA. Changes in the latter can have significant effects on the distribution of underwriting gains and implications for how companies can best maximize returns.

In this paper, we examine the Standard Reinsurance Agreement between insurance companies participating in delivery of crop insurance products and the FCIC. Using historical data on yields and insurance losses for each crop reporting district, crop, and insurance product, we simulate a distribution of the book of business resulting from underwriting crop insurance. Distributions of returns are then calculated at various levels of aggregation. The effect of SRA on the rates of return are analyzed in aggregate and also at the regional and individual company levels.

Standard Reinsurance Agreement

FCIC provides reinsurance for the participating companies in exchange for a portion of insurance premiums collected by those companies. The reinsurance comes in two forms: proportional and nonproportional. Under the former, the companies cede their liability for ultimate net losses in exchange for an equal percentage of the associated net premiums, i.e. completely transfer a portion of their book of business to the FCIC. The nonproportional reinsurance is then applied to the remaining or *retained* portion of companies' books of business. Nonproportional reinsurance is similar to traditional reinsurance in that the FCIC shares losses with the companies in exchange for a portion of their underwriting gain[1].

Under the proportional reinsurance, each company may allocate its contracts to one of the three reinsurance funds: Assigned Risk Fund, Developmental Fund, and

[1]Underwriting gain is the amount by which premiums collected by a company exceed its losses or the total indemnities it had to pay.

Commercial Fund. The funds differ in the required level of retention and also in the FCIC shares of gains and losses from retained business under the nonproportional insurance.

The Assigned Risk Fund is characterized by the lowest required retention rate (20%) which makes it the primary designation for the high-risk contracts. However, the SRA establishes maximum Assigned Risk Fund cession limits, which vary by state and range between 10% and 75% of the total book of business in the state (USDA/RMA 1997, p.10).

The Developmental and Commercial Funds have higher minimum retention requirements (35% and 50%, respectively). In addition, they are further subdivided into CAT[2] Fund, Revenue Insurance Fund, and "All Other Plans" Fund[3], which differ by the type of products that can be placed in each fund as well as the reinsurance provisions applied to the retained portions of the book of business.

Under the nonproportional reinsurance, the responsibilities of the companies for the retained losses as well as their shares of the underwriting gains depend on state-level *loss ratios* of each company[4]. For the SRA currently in effect[5], the shares of underwriting gains and losses assumed by companies under different realizations of their loss ratios are shown in Table 1. As the loss ratio increases, FCIC assumes a larger fraction of company's losses, up to 100% of the portion of losses in excess of

[2]Catastrophic Risk Protection

[3]The majority of contracts placed in this fund are Actual Production History (APH) products.

[4]A loss ratio is defined as a ratio of the total indemnities paid by the company to the total retained premiums. The loss ratio above 100% means that the company suffered a net underwriting loss, while the loss ratio below 100% indicates that the company earned a net underwriting gain.

[5]The version of the Agreement currently in effect was approved by the RMA and private insurance companies in July 1997 and was subsequently amended by the Agricultural Research, Extension, and Education Reform Act of 1998. The SRA has been renewed annually by RMA through the 2004 reinsurance year. The Agricultural Risk Protection Act of 2000 mandated that the SRA has to be renegotiated by the 2005 reinsurance year, which begins on July 1, 2004. At the time of writing, the negotiations were underway, but no final agreement has been released.

500% of the total retained premiums. At the same time, FCIC claims a larger fraction of companies' underwriting gains as their loss ratios decrease.

Figure 1 illustrates the aggregate effect of SRA on companies' loss ratios for different reinsurance funds. The Assigned Risk Fund provides the highest level of protection against losses but also leaves the reinsureds with the smallest fraction of the gains. The Commercial Fund, on the other hand, gives the reinsureds the highest return in case of the underwriting gain, but also leaves the largest portion of the net losses on their balances.

For modeling purposes, the risk sharing provisions of the SRA can be completely described by the required retention rates for each fund, the *breakpoints* of the loss ratio ranges, and the *shares* of the underwriting losses or gains assumed by the companies within each range.

Modeling Methodology

Overview

The objective of the SRA model is to simulate distributions of rates of return from underwriting crop insurance. The rates are driven by net underwriting gains/losses defined for modeling purposes as the difference between the premiums collected and indemnities paid. Since the latter depends on occurrence or nonoccurrence of random events, rates of return are random variables. Reinsurance provided by FCIC is designed to reduce the downside variability of these random variables and possibly increase their expected values.

Under the SRA, rates of return are determined by particular realizations of companies' loss ratios at the state level and the SRA parameters, i.e. retention rates, breakpoints, and shares. Therefore, in order to analyze the effect of SRA on the rates of return, one needs to model the distribution of loss ratios by state and fund for each company reinsured by the FCIC.

The random variables that drive the loss ratios are farm-level yields and prices, which determine the insurance loss for any given contract and thus ultimately the aggregate losses for any company. However, information on farm-level yields and prices alone is not enough, as it does not reflect the adverse selection present in the crop insurance portfolio and the additional losses companies incur due to moral hazard. Therefore, the farm-level data on yields and prices should be combined with appropriate participation data to fully reflect the distribution of gains and losses in insurance portfolios.

Ideally, one would like to have a long series of historical data on premiums and indemnities and use those to derive distributions of loss ratios at the appropriate level of aggregation. However, practical implementation of this approach would face several obstacles. First, the number of contract types available under the crop insurance program have increased dramatically since 1980, with a large portion of products introduced in or after 1994. Therefore, historical loss data are simply not available for many contracts prior to 1994. Second, program participation has also increased over the last two decades both in terms of the acreage insured and coverage levels selected by the producers. This in turn led to a broader pool of insured risk and decreasing variation in indemnities. Third, composition and geographical distribution of contracts in participating companies' books of business have changed over time. The companies have also changed allocation of their books of business across reinsurance funds. Finally, premium rates[6] have also changed over time, thus affecting historical realizations of companies' gains and losses.

[6] The premium rate of a contract is a ratio of its premium to the associated liability.

In order to circumvent data limitations and derive distributions of loss ratios that reflect the historical changes in the crop insurance programs, the following strategy is implemented. It is assumed that historical *loss costs*, or ratios of indemnities to the total liabilities, accurately reflect the true distribution of underwriting losses. That is, it is assumed that the loss costs by crop reporting district[7], crop, and insurance product observed over the historical period (1981–2001) were generated by stationary data-generating processes that are uniform across companies and reinsurance funds.

Historical loss costs are available for 1981–2001 for selected APH yield contracts but only in aggregate, thus providing no information about the distribution of loss costs for specific APH yield contracts, nor other contracts such as CAT and revenue products. The loss costs for individual products, however, can be simulated by using historical data on yields and prices and then adjusted to match the observed aggregate loss costs.

The derived distribution of loss costs for each district, crop, and product can be combined with the data on liabilities and premium rates for the base year (2001) and aggregated to compute distributions of loss ratios for each company by state and reinsurance fund. The distributions of the loss ratios can then be used along with the SRA parameters to compute expectations and standard deviations of the rates of return by company, state, and/or reinsurance fund.

Implementation

The first step in simulating aggregate loss costs of an insurance company by state and fund is to simulate loss costs for individual insurance contracts (products) included in the company's portfolio. While there are more than 20 types of products

[7]A crop reporting district (CRD) is a statistical unit intermediate between a county and a state. Each state is typically split into nine or ten CRDs and each CRD typically includes eight to twelve counties.

available for more than 100 crops, the lack of adequate data and the limited scope of some programs do not allow to incorporate all of them into a simulation model. For the purposes of analysis, six crops and five major types of insurance products are considered.

The crops incorporated in the model are barley, corn, cotton, soybeans, grain sorghum, and winter wheat (0.8%, 42.7%, 13.2%, 27.3%, 2.2%, and 13.7% of total premiums included in the model, respectively). The insurance products incorporated in the model are (1) Catastrophic Risk Protection (CAT); (2) Actual Production History (APH), Crop Revenue Coverage (CRC), and Income Protection (IP), each at $\{50, 55, \ldots, 85\}\%$ coverage levels; and (3) Revenue Assurance (RA) contracts at $\{65, 70, \ldots, 85\}\%$ coverage. Together, these combinations of crops and products encompass about 65% of the total FCIC liability[8] for the base year (2001). More information about specific contracts can be found in Vedenov (2001).

District level yields for the six crops over the historical period are available from NASS. A simple log-linear time trend

$$\log(y_t^{tr}) = \alpha_0 + \alpha_1(t - 1980), \quad t = 1981 \ldots 2001, \tag{1}$$

is fitted for each crop and district. The district yields detrended to 2001 equivalents are calculated as

$$y_t^{det} = \frac{y_t}{y_t^{tr}} \cdot y_{2001}^{tr}, \qquad t = 1981, \ldots, 2001, \tag{2}$$

where y_t are the observed yields and y_t^{tr} are the corresponding yield trends. The detrended yields then used to construct the empirical probability density function of

[8]While it may seem that the model leaves out a significant portion of the FCIC portfolio, a major part of it consists of specialty crop contracts concentrated mainly in California and Florida. Outside of these two states, the proportion of liability covered by the model is about 75%.

base-year yield distribution by assigning equal weights to each observation. Such an approach allows to capture correlations between yields in different districts and for different crops in a simple and efficient way.

The distribution of yields within the district is modeled using a representative farmer model. For a given realization of a (detrended) district yield y_d, it is assumed that the individual farm's yield y_f is log-normally distributed around the district average so that

$$\log y_f = \log y_d + \log \varepsilon, \quad \varepsilon \sim N(\mu, \sigma), \tag{3}$$

where the parameters μ and σ of normal distribution may depend on the district yield. Under these assumptions, the loss cost for an APH product with the coverage level η can be calculated as $\mathbf{E}_\varepsilon \max\{0, 1 - y_f/(\eta\overline{y})\}$.

The historical loss costs are available in aggregate for selected products (APH 35% and $\{50\%, 55\%, \ldots, 85\%\}$) along with data on liabilities by individual product. Thus the simulated loss costs can be aggregated using the actual liabilities as weights and compared to the historically observed loss costs. The parameters of the normal distribution can be then calibrated so as to minimize the difference between the two.

Formally, for a given district, crop, and year, let $LC_{sim}(i_p|\mu, \sigma)$ be the simulated loss cost for the APH product i_p, given the parametrization (μ, σ) of the yield shock ε, let LC^{agg}_{hist} be the historical aggregate loss cost, let $B \subseteq \{1, \ldots, n_p\}$ be the index subset of APH products included in the aggregate loss cost data, and let $L_{hist}(i_p)$ be the historical liabilities for products in B. The aggregate simulated loss cost for the products in B can then be calculated as

$$LC_{sim}^{agg}(\mu, \sigma) = \frac{\sum\limits_{i_p \in B} L_{hist}(i_p) \times LC_{sim}(i_p|\mu, \sigma)}{\sum\limits_{i_p \in B} L_{hist}(i_p)},$$

and the distribution parameters μ and σ can be found by solving

$$\min_{\mu,\sigma} |LC_{sim}^{agg}(\mu, \sigma) - LC_{hist}^{agg}| . \tag{4}$$

Once the parameters of the random shocks are calibrated, it is assumed that they correctly represent the variability of yields for the specific crop, district, and year and thus can be used to simulate the loss costs for all other products included in the model. In addition to yields, distributions of harvest-time prices are required to calculate loss costs for revenue products. The latter are modeled for each crop as

$$\log p_h = \log p_b + \alpha(\log y_{nat} - \log \overline{y}_{nat}) + z, \tag{5}$$

where p_h is the harvest price, p_b is the base (projected) price, y_{nat} is the detrended national yield, $\overline{y}_{nat}$ is the average detrended national yield, α is the elasticity parameter, and z is a random shock independent of y_{nat} and distributed normally with zero mean and some variance σ^2.

By combining distributions of yields (3) calibrated according to (4) with the price distributions in (5), we can derive the distributions of loss costs for all districts, crops, and products included in the model. Data on base year premium rates and liabilities are then used to aggregate these distributions and arrive at the premium rates and distributions of loss costs by state, company, and reinsurance fund. Specifically, let $L_{base}(i_d, i_c, i_p, i_o, i_f)$ be the base year liability in district i_d, $i_d = 1, \dots, n_d$, for crop i_c, $i_c = 1, \dots, n_c$, and insurance product i_p, $i_p = 1, \dots, n_p$, that the company i_o, $i_o = 1, \dots, n_o$, allocated in the reinsurance fund i_f, $i_f = 1, \dots, n_f$; let $PR_{base}(i_d, i_c, i_p)$ be the base year premium rate for crop i_c and product i_p in district i_d; and let $LC_{sim}(i_d, i_c, i_p, i_y)$ be the simulated equiprobable realizations[9] of the loss costs experienced from underwriting insurance product i_p in district i_d for crop i_c. Then the aggregate liability $L^{agg}(i_s, i_o, i_f)$, the aggregate premium rate $PR^{agg}(i_s, i_o, i_f)$, and the aggregate distribution of loss costs $LC^{agg}(i_s, i_o, i_f, i_y)$ of company i_o in state i_s, $i_s = 1, \dots, n_s$, and reinsurance fund i_f can be calculated as

$$
\begin{aligned}
L^{agg}(i_s, i_o, i_f) &= \sum_{i_d \in i_s} \sum_{i_c=1}^{n_c} \sum_{i_p=1}^{n_p} L_{base}(i_d, i_c, i_p, i_o, i_f), \\
LC^{agg}(i_s, i_o, i_f, i_y) &= \frac{\sum_{i_d \in i_s} \sum_{i_c=1}^{n_c} \sum_{i_p=1}^{n_p} LC_{sim}(i_d, i_c, i_p, i_y) \times L_{base}(i_d, i_c, i_p, i_o, i_f)}{L^{agg}(i_s, i_o, i_f)}, \qquad (6) \\
PR^{agg}(i_s, i_o, i_f) &= \frac{\sum_{i_d \in i_s} \sum_{i_c=1}^{n_c} \sum_{i_p=1}^{n_p} PR_{base}(i_d, i_c, i_p, i_y) \times L_{base}(i_d, i_c, i_p, i_o, i_f)}{L^{agg}(i_s, i_o, i_f)},
\end{aligned}
$$

respectively, where the first summation in all equations is over all districts in the state i_s.

In order to account for the proportional part of the SRA, the base year liabilities need to be adjusted by the appropriate retention rates. If a company i_o retained $\gamma(i_s, i_o, i_f)$ of its book of business in the state i_s and reinsurance fund i_f, then the retained liability is $L_{ret}(i_s, i_o, i_f) = \gamma(i_s, i_o, i_f) \times L^{agg}(i_s, i_o, i_f)$ and retained premium is $P_{ret}(i_s, i_o, i_f) = PR^{agg}(i_s, i_o, i_f) \times L_{ret}(i_s, i_o, i_f)$. The nonproportional part of the SRA then adjusts the distribution of loss ratios $LR^{agg}(i_s, i_o, i_f, i_y) =$

[9] indexed by $i_y = 1, \dots, n_y$

$LC^{agg}(i_s, i_o, i_f, i_y)/PR^{agg}(i_s, i_o, i_f)$ according to the schedules in Table 1.

Finally, if $LR_{adj}(i_s, i_o, i_f, i_y)$ is the distribution of loss ratios by state, company, and reinsurance fund adjusted as per SRA, then the corresponding distribution of net underwriting gains/losses[10] can be computed as

$$NGL(i_s, i_o, i_f, i_y) = (1 - LR_{adj}(i_s, i_o, i_f, i_y)) \times P_{ret}(i_s, i_o, i_f) \quad (7)$$

and, if necessary, can be further aggregated by state, company, and/or reinsurance fund. The subsequent analysis also -uses the rates of return as percent of gross premiums, which can be expressed as $r(i_s, i_o, i_f, i_y) = (1 - LR_{adj}(i_s, i_o, i_f, i_y)) \times \gamma(i_s, i_o, i_f)$. The sample statistics can be then calculated for both distributions in an obvious way, e.g.

$$\begin{aligned} \overline{r}(i_s, i_o, i_f) &= \frac{1}{n_y} \sum_{i_y=1}^{n_y} r(i_s, i_o, i_f, i_y) \\ s_r(i_s, i_o, i_f) &= \sqrt{\frac{1}{n_y} \sum_{i_y=1}^{n_y} (r(i_s, i_o, i_f, i_y) - \overline{r}(i_s, i_o, i_f))^2}. \end{aligned}$$

The model is implemented as a Fortran 95 program that employs historical data and the SRA parameters as input. The program outputs a variety of information including expectations and standard deviations of both rates of return and net underwriting gains/losses at different levels of aggregation.

Simulations Results and Discussion

In order to analyze the effect of the SRA on the variability of the loss ratios and thus the rates of return, the base year (2001) data on companies' books of business,

[10] $NGL > 0$ corresponds to net underwriting gain, while $NGL < 0$ corresponds to net underwriting loss.

allocations, and retention rates have been used to simulate the distributions of the aggregate loss ratios with and without the SRA. A kernel-smoothing procedure with variable bandwidth Epanechnikov kernel (Härdle) has been applied to the empirical distributions computed by the simulator program. Shown in figure 2 are distributions of loss ratios both by individual reinsurance fund (panels (a)–(c)) and in aggregate (panel (d)).

The pre-SRA allocation of business among the reinsurance funds (dotted lines) reflects the difference in the level of protection provided by each of them. The Commercial Fund tends to attract less risky contracts, while Developmental and especially Assigned Risk Funds are used for more risky business. The post-SRA distributions (dashed lines) are visibly more narrow and shifted to the left. The sample statistics also indicate that the reinsurance provided by the SRA lowers both the expected values[11] and variability of the loss ratios (Table 2). As expected, the reinsurance provisions of the Assigned Risk Fund result in the largest decrease in variability of loss ratios (93%) as well as the largest decrease in their expected values (12.3%). The reinsurance provisions of the Developmental and Commercial Funds decrease the variability of loss ratios to a lesser extent, while also resulting in lower decreases in the expected values.

Since most companies underwrite crop insurance in more than one state, it is important to consider how SRA affects returns on the regional basis. Presented in Table 3 are pre- and post-SRA expected underwriting gains for the top 20 states in terms of gross premiums, which together cover 91.5% of the total amount of gross premiums included in the simulation. The states are listed in the ascending order of pre-SRA expected gains.

[11]Recall that loss ratios less than one indicate underwriting gain, and the lower the loss ratio, the higher the gain.

Without reinsurance provided by the FCIC, underwriting of crop insurance would be profitable only in eight mostly Midwestern and Plain states (OH, NC, CO, IN, IL, MN, NE, and IA). The SRA significantly improves the expected gains in all twenty states making all but four of them profitable. Therefore it comes as no surprise that even the states with high expected pre-SRA losses attract more than one insurance company.

The results in Table 2 suggest that the increases in the expected gains due to the SRA could be achieved through either ceding risky contracts completely or placing them in the Assigned Risk Fund. Analysis of premium allocation by state (columns four and six) indicates that this holds true in most cases so that the states with lower pre-SRA expected gains tend to have lower proportion of business retained as well as higher proportion placed in the Assigned Risk Fund. One notable exception is Texas, which has a relatively low pre-SRA expected net underwriting loss yet has 43.3% of business in the Assigned Risk Fund. One possible explanation is that due to the variation of growing conditions within a state, underwriting crop insurance may be quite profitable in some areas or for some crops, while unprofitable for others areas or crops. Aggregated at the state level, the net gains cancel out net losses, but individual companies may have business concentrated mostly in the low-return areas and thus tend to use Assigned Risk Fund to higher extent.

Note also that the net effect of the SRA on expected gains differs significantly by state. The general tendency is the lower the pre-SRA gain, the higher the change in expected gain due to reinsurance, but there are several exceptions to this rule on both sides. On the one hand, Oklahoma, Georgia, and Wisconsin experience rather modest increases in the expected gains compared to their pre-SRA levels. In fact, Oklahoma remains unprofitable even after the SRA. On the other hand, North Dakota, Kansas, and Texas experience relatively high increases in the expected gain even though their pre-SRA gains are of comparable magnitude. Substantial increases in expected gains are also observed in Minnesota and Illinois even though underwriting crop insurance in these two states would be profitable even without the reinsurance.

That the pre-SRA expected gains are positive only in a handful of states suggests that companies have rather limited room for diversification of their portfolios by expanding their business into other states. This argument is further supported by the analysis of regional composition of companies portfolios (Table 4). In 2001, 19 companies participated in underwriting crop insurance. The table presents rates of return and expected gains these companies would experience without the provisions of the SRA. Obviously, a direct comparison of these numbers across companies does not make much sense, since companies underwrite insurance in different states and have different books of business. Therefore the table includes two measures that reflect the regional composition of companies portfolios.

The Herfindahl-Hirschner Index (HHI) is a commonly accepted measure of market concentration (US DOJ) and reflects diversification of companies' portfolios across states[12]. The lower the HHI, the more diversified is the portfolio. Conversely, the closer HHI to the maximum of 10,000, the fewer states are included in the portfolio.

The second measure is the proportions of each company's gross premiums in two regions identified based on the results of Table 3. Region 1 includes the states with negative expected pre-SRA underwriting gains (MS, LA, AR, MT, SD, OK, ND, GA, WI, KS, MO, and TX), while Region 2 includes the states with positive expected pre-SRA underwriting gains (OH, NC, CO, IN, IL, MN, NE, and IA).

The degree of diversification as measured by the HHI does not seem to be directly

[12]The actual numbers of states in which companies underwrite crop insurance are withheld to protect indentity of individual companies.

related to the expected returns from underwriting crop insurance as companies with roughly the same HHI may have dramatically different returns (e.g. Company 2 and Company 12). Variability of returns seems to be slightly more related to the HHI, with lower HHI corresponding to lower standard deviations of pre-SRA returns, although not without exceptions (compare Companies 17 and 19). These results are fairly logical, since the HHI does not take into account returns from individual states nor correlation between crop yields across states but rather reflects overall composition of companies' portfolios.

Allocation of business between the regions, on the other hand, is extremely important in determining the overall rates of return. Indeed, companies with extremely high expected losses have major portions of their business concentrated in Region 1, and *vice versa*. In other words, it is less important in how many states a company underwrites crop insurance than where it does so. Finally, in line with the results in Table 3, the proportion of business placed in Assigned Risk Fund is higher while the proportion of premiums retained is lower for companies who underwrite mostly in Region 1 as opposed to Region 2.

The last set of results illustrate the effect of SRA on returns of individual companies reinsured by FCIC in 2001. Presented in Table 5 are the expected rates of return and their standard deviations calculated with and without the reinsurance. Without the SRA, eight out of 19 companies would experience net underwriting losses and all companies would face extremely high variability of expected returns. The SRA increases the expected returns of all but one company and also significantly decreases the variability. Magnitude of effect varies by individual companies and once again composition of companies' portfolios seems to be the most probable explanation.

While watchdog agencies and industry groups may disagree on whether the SRA generates excessive returns to participating companies, our analysis suggests a picture far more complicated than the one reflected in the bottom line. Net underwriting gains are not distributed equally across states and companies. Rather, they tend to be concentrated in a handful of states where the actuarial performance has been generally good over the time period analyzed. Four states — Illinois, Iowa, Minnesota, and Nebraska, — account for about two-thirds of total net underwriting gains in the model. For this reason, companies' net underwriting gains tend to reflect more where they write business. Companies who concentrate their business in states with high returns tend to have higher rates of return than those who underwrite nationwide. At the same time, the SRA provides a means by which companies can write business in states with poor expected actuarial performance and yet limit their potential exposure by placing business in the assigned risk fund. The results also suggest that any change to the SRA that fails to take into account the regional aspects of the program would potentially have differential, and perhaps destabilizing, impacts on the industry.

Conclusion

This paper presents an economic analysis of the Standard Reinsurance Agreement, the contract that governs the reinsurance relationship between the Federal Crop Insurance Corporation and private insurance companies that deliver crop insurance products to farmers. A simulation model is developed that uses historical data on yields and prices in order to simulate empirical distributions of insurance companies' loss ratios under their recent (2001) distribution of business. The crucial assumption is that the historically observed loss costs, or ratios of indemnities to total liabilities, were generated by stationary data generating processes and thus correctly represent the true distribution of underwriting losses.

The representative farmer model is used to simulate yields for any given district, crop, and year, with parameters of random yield shocks calibrated so that the simulated loss costs match the historically observed ones. The simulated distributions of loss costs are then combined with data on liabilities and retained premiums in order to arrive to distributions of loss ratios aggregated by state, company, and fund for the base year of 2001.

The simulation program is used to analyze the effect of current SRA on the distributions of loss ratios and rates of return at several levels of aggregation. The reinsurance provisions of the SRA result in both higher expected values and lower variability of returns of individual companies thus providing an incentive to participate in underwriting crop insurance. At the regional level, the SRA makes underwriting crop insurance profitable in most of the major crop producing states, although the magnitude of the effect varies significantly by individual states.

Further research may include analysis of companies behavior in allocating their books of business across reinsurance funds so as to maximize their underwriting gains as well as counterfactual simulations of alternative SRA structures and reinsurance provisions.

Table 1. Companies' Shares in Underwriting Gains and Losses under SRA

Insurance Plan / Reinsurance Fund	Gains CAT	Gains Revenue	Gains All Other	Losses CAT	Losses Revenue	Losses All Other
	Loss Ratio between 65% and 100%			*Loss Ratio between 100% and 160%*		
Commercial	75.0%	94.0%	94.0%	50.0%	57.0%	50.0%
Developmental	45.0%	60.0%	60.0%	25.0%	30.0%	25.0%
Assigned Risk	—	—	15.0%	—	—	5.0%
	Loss Ratio between 50% and 65%			*Loss Ratio between 160% and 220%*		
Commercial	50.0%	70.0%	70.0%	40.0%	43.0%	40.0%
Developmental	30.0%	50.0%	50.0%	20.0%	22.5%	20.0%
Assigned Risk	—	—	9.0%	—	—	4.0%
	Loss Ratio less than 50%			*Loss Ratio between 220% and 500%*		
Commercial	8.0%	11.0%	11.0%	17.0%	17.0%	17.0%
Developmental	4.0%	6.0%	6.0%	11.0%	11.0%	11.0%
Assigned Risk	—	—	2.0%	—	—	2.0%

Note: FCIC keeps the portions of underwriting gains or assumes the ultimate net losses in excess of companies' shares as determined in the table. In addition, FCIC assumes 100% of the amount by which companies' retained losses in a given state and fund exceed 500% of the retained net book premium for a given reinsurance year.

Table 2. Pre- and Post-SRA Distributions of Aggregate Loss Ratios, Sample Statistics

	Pre-SRA		Post-SRA		% Change	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
All Commercial	0.957	0.471	0.868	0.205	-9.3%	-56.4%
All Developmental	1.028	0.376	0.928	0.100	-9.7%	-73.5%
All Assigned	1.129	0.305	0.989	0.020	-12.4%	-93.6%
All Funds	0.977	0.440	0.883	0.177	-9.6%	-59.7%

Table 3. Pre- and Post-SRA Returns for Selected States

State[1]	Number of Companies	Gross Premiums[2][3]	% Premiums in ARF[4]	Retained Premiums[2][3]	% Retained	Expected Gain[3] Pre-SRA	Expected Gain[3] Post-SRA	Change[3]
MS	8	70.20	55.6%	33.70	48.0%	-28.99	-3.84	25.15
LA	7	31.82	40.3%	20.20	63.5%	-28.16	-4.99	23.17
AR	11	44.69	36.3%	29.90	66.9%	-20.78	-3.65	17.13
MT	13	43.04	36.4%	29.30	68.1%	-15.75	0.03	15.78
SD	12	131.83	15.5%	111.90	84.9%	-8.70	7.16	15.86
OK	12	48.66	36.1%	32.60	67.0%	-6.67	-0.16	6.50
ND	13	134.06	36.9%	92.10	68.7%	-5.36	6.82	12.18
GA	10	60.53	35.8%	38.60	63.8%	-4.78	1.62	6.40
WI	9	36.99	7.6%	34.60	93.5%	-3.40	3.32	6.72
KS	14	164.43	13.5%	141.90	86.3%	-1.97	9.79	11.76
MO	14	76.32	9.1%	68.20	89.4%	-1.83	6.34	8.17
TX	10	297.55	43.3%	185.90	62.5%	-1.19	13.76	14.95
OH	12	47.24	9.9%	42.80	90.6%	0.19	4.24	4.05
NC	9	39.12	15.0%	32.30	82.6%	2.93	3.39	0.46
CO	13	40.81	10.5%	37.10	90.9%	2.98	3.86	0.88
IN	13	80.64	11.3%	73.00	90.5%	3.79	9.13	5.33
IL	13	162.27	6.3%	152.80	94.2%	15.90	29.49	13.59
MN	14	179.34	8.9%	164.40	91.7%	25.29	39.46	14.17
NE	13	175.98	10.2%	160.80	91.4%	36.08	31.20	-4.88
IA	13	223.80	5.1%	213.90	95.6%	49.01	51.55	2.54
US Total	19	2,284.08	20.6%	1,853.40	81.1%	-11.42	214.99	226.41

Notes: (1) States are sorted by the expected gains without reinsurance (column 7). Only the top 20 states in terms of gross premiums are included in the table. (2) All premiums are calculated as a part of the simulation and are not actual premiums collected and/or retained by participating companies. (3) Expressed in millions of dollars. (4) ARF is Assigned Risk Fund.

Table 4. Regional Composition of Insurance Portfolios and Pre-SRA Returns by Company

Company[1]	HHI[2]	% Premiums in Region 1[3]	% Premiums in Region 2[3]	% Premiums in ARF[4]	% Retained	Exp. Rate of Return[5]	Std. Dev.[5]
1	2,259	81.5%	11.1%	35.3%	60.4%	-12.7%	37.9%
2	857	68.2%	23.4%	34.3%	72.0%	-10.0%	36.4%
3	716	54.5%	36.7%	19.5%	76.3%	-9.0%	41.4%
4	4,711	88.8%	8.9%	30.8%	74.8%	-2.8%	35.1%
5	583	47.0%	39.1%	13.2%	89.4%	-1.9%	37.2%
6	2,362	97.8%	1.4%	24.5%	80.3%	-1.8%	29.6%
7	3,019	73.6%	19.1%	14.9%	84.9%	-1.6%	38.1%
8	683	48.6%	38.9%	16.9%	86.5%	-0.9%	38.0%
9	2,268	48.6%	47.0%	14.7%	88.3%	1.2%	62.7%
10	1,134	63.7%	34.3%	25.1%	66.5%	1.3%	33.8%
11	9,897	100.0%	0.0%	22.2%	81.3%	2.0%	49.1%
12	795	43.6%	48.9%	29.6%	73.5%	2.8%	38.1%
13	940	44.4%	49.0%	18.3%	85.3%	3.1%	51.6%
14	1,407	34.8%	61.2%	13.7%	87.7%	8.9%	56.9%
15	1,346	25.3%	69.4%	17.7%	77.5%	10.3%	55.9%
16	9,823	0.0%	99.1%	0.3%	99.7%	11.7%	98.8%
17	3,342	3.6%	96.4%	12.5%	89.8%	14.4%	77.2%
18	7,461	3.0%	97.0%	6.8%	94.5%	15.1%	93.3%
19	10,000	0.0%	100.0%	2.8%	97.1%	20.8%	37.1%
All	629	49.2%	41.9%	20.6%	81.1%	-0.5%	39.5%

Notes: (1) The dollar amounts of premiums are withheld and companies' names are replaced by scrambled identifiers due to the proprietary nature of data used. (2) HHI is the Herfindahl-Hirschman Index. (3) Region 1 includes MS, LA, AR, MT, SD, OK, ND, GA, WI, KS, MO, and TX. Region 2 includes OH, NC, CO, IN, IL, MN, NE, and IA (see Table 3). (4) ARF is Assigned Risk Fund. (5) Expected rates of return and their standard deviations are expressed as percents of gross premiums.

Table 5. Pre- and Post-SRA Rates of Return by Company

	Pre-SRA		Post-SRA		Change	
Company(1)	Exp. Rate of Return(2)	Std. Dev.(2)	Exp. Rate of Return(2)	Std. Dev.(2)	in Exp. Rate of Return(2)	in Std. Dev.(2)
1	-12.7%	37.9%	3.1%	8.9%	15.8%	-29.0%
2	-10.0%	36.4%	6.5%	10.7%	16.5%	-25.7%
3	-9.0%	41.4%	5.9%	13.1%	14.9%	-28.3%
4	-2.8%	35.1%	5.3%	10.3%	8.1%	-24.8%
5	-1.9%	37.2%	9.0%	15.8%	10.9%	-21.4%
6	-1.8%	29.6%	6.3%	10.8%	8.1%	-18.8%
7	-1.6%	38.1%	6.8%	14.9%	8.4%	-23.2%
8	-0.9%	38.0%	9.3%	14.3%	10.2%	-23.7%
9	1.2%	62.7%	10.9%	18.3%	9.7%	-44.4%
10	1.3%	33.8%	7.4%	10.6%	6.1%	-23.2%
11	2.0%	49.1%	8.6%	24.2%	6.6%	-24.9%
12	2.8%	38.1%	10.0%	13.8%	7.2%	-24.3%
13	3.1%	51.6%	11.2%	17.4%	8.1%	-34.2%
14	8.9%	56.9%	14.8%	19.9%	5.9%	-37.0%
15	10.3%	55.9%	14.3%	17.5%	4.0%	-38.4%
16	11.7%	98.8%	19.7%	35.5%	8.0%	-63.3%
17	14.4%	77.2%	18.7%	27.7%	4.3%	-49.5%
18	15.1%	93.3%	20.2%	32.9%	5.1%	-60.4%
19	20.8%	37.1%	19.2%	25.2%	-1.6%	-11.9%
All	-0.5%	39.5%	9.4%	14.0%	9.9%	-25.5%

Notes: (1) The dollar amounts of premiums are withheld and companies' names are replaced by scrambled identifiers due to the proprietary nature of data used. (2) Expressed as percents of gross premiums.

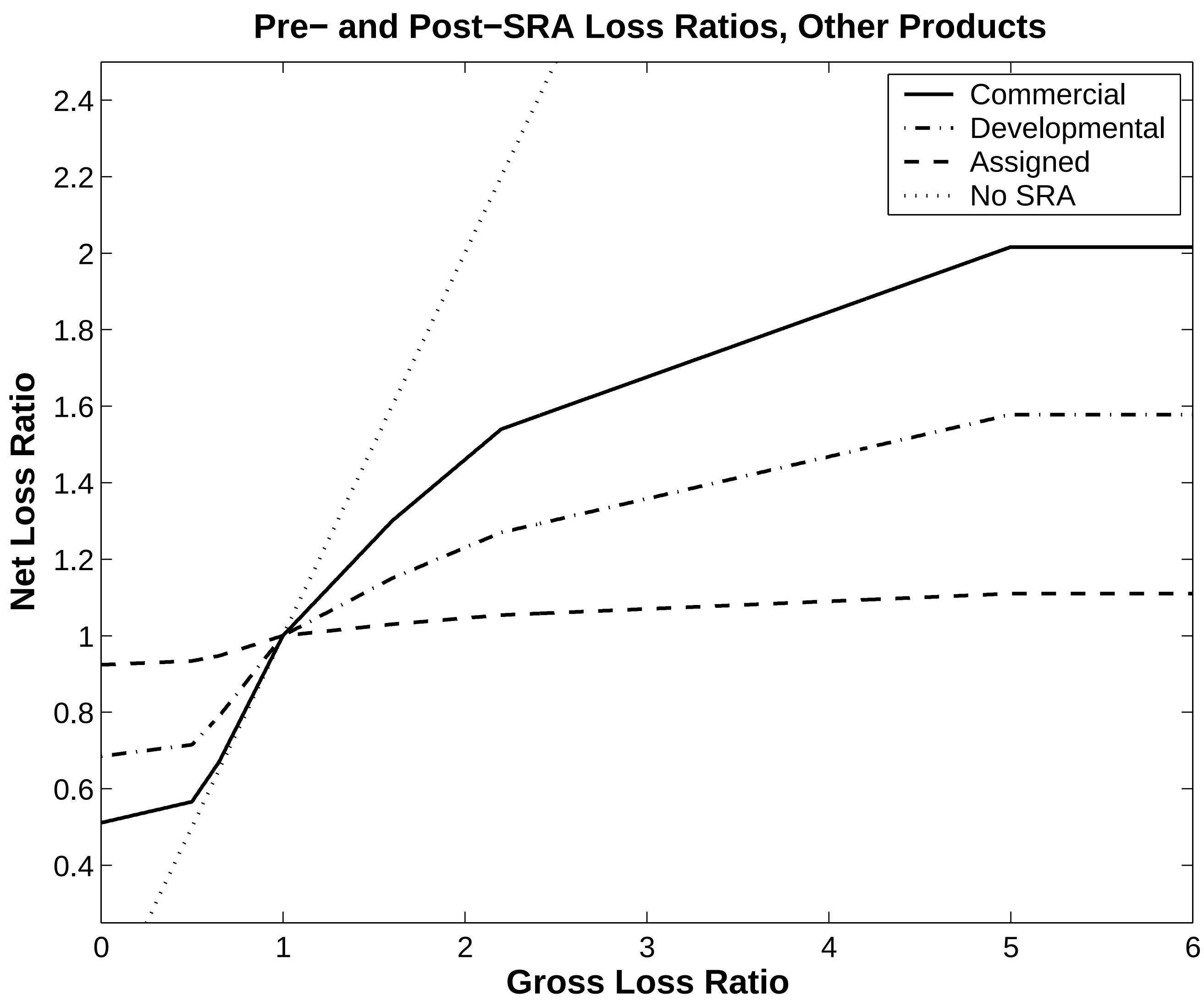

Figure 1. Post-SRA loss ratios by reinsurance fund. Commercial and developmental funds are shown for “all other plans”.

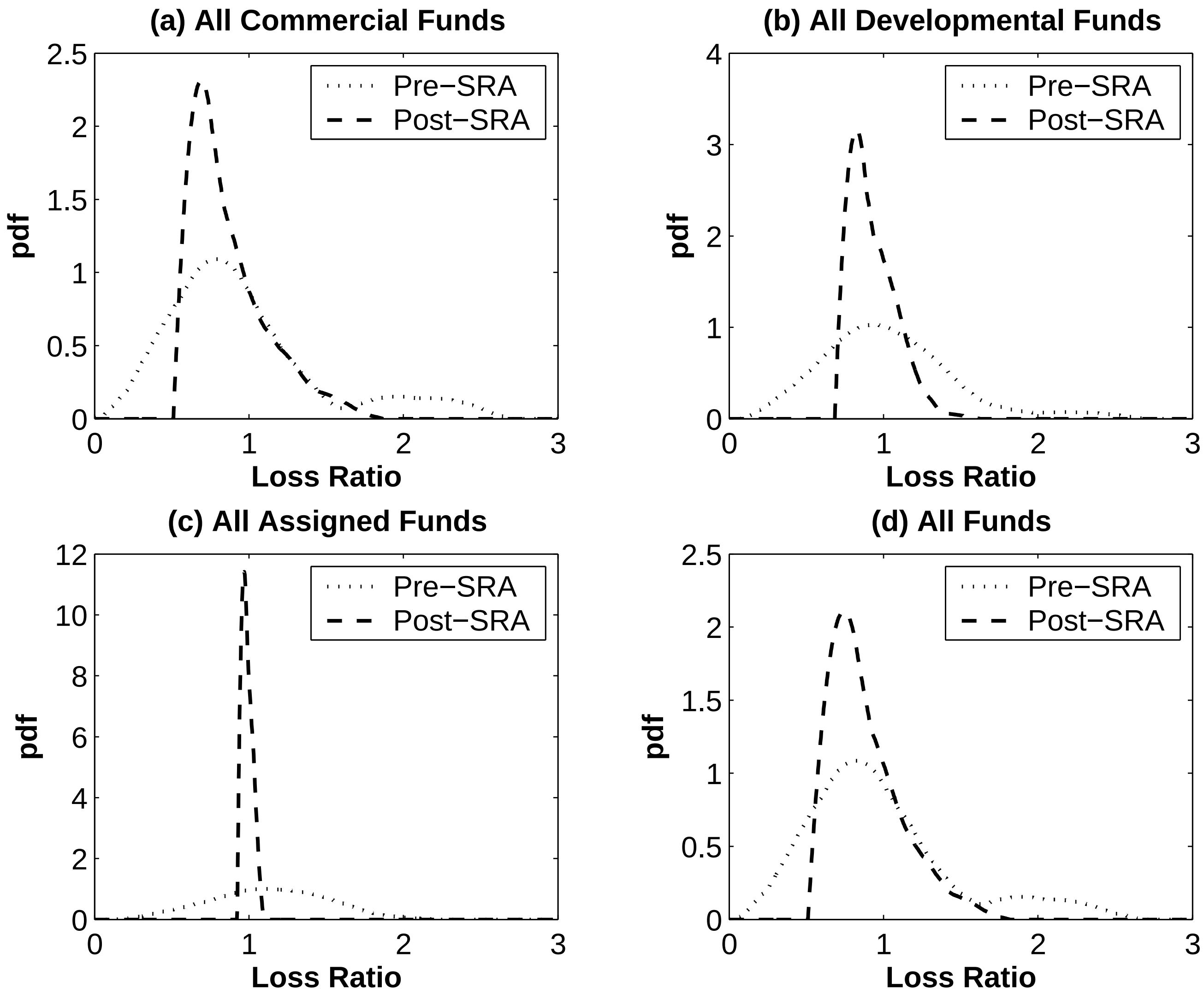

Figure 2. Effect of SRA on distribution of loss ratios for the aggregated book of business: *(a)* all commercial funds, *(b)* all developmental funds, *(c)* assigned risk fund, *(d)* all funds.

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