The Market Structure for Crop Insurance and the Effects on Insurance Contracts

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Abstract: In this paper, we examine how the market structure for crop insurance agent services impacts their pursuit of rents in the federal crop insurance program. Agents may attempt to influence producers’ insurance choices to maximize total compensation. The ability of agents to exercise this influence likely depends on the level of competition among selling agents. We develop a signaling game model of producer-agent interaction from which we generate testable hypotheses for how risk, agent compensation mechanisms, and agent market power affect the amount of coverage selected by producers. Using a detailed, producer level dataset from five states, we find evidence that agent market power matters in the insurance coverage decisions of producers. These effects vary by region and compensation structure. In Iowa, we find that a 10-percentage point increase in an agent’s market share increases the premiums of policies they sell by an average of $0.36 per acre while in Washington, the same increase in market share is associated with a decrease of $0.11 per acre. In some cases, agent market power may help alleviate adverse selection problems in federal crop insurance by limiting the behavior of opportunistic producers.

Keywords: Federal crop insurance, market structure, crop insurance agents

JEL Codes: Q18, Q13, Q12
Introduction

Federal crop insurance has become the primary source of risk management for American farmers, covering over 80 percent of all U.S. cropland. To achieve this level of participation, the government subsidizes premiums such that producers pay only a portion of the total cost of insurance. Due to subsidization, crop insurance is now the most expensive farm support program in the U.S. (Babcock, 2012). Total program costs average six billion dollars per year but have been as high as 13.4 billion in a single year (USDA RMA, 2017). The Congressional Budget Office estimates $90 billion in total taxpayer costs between 2012 and 2022 (Babcock, 2012).

The USDA Risk Management Agency (RMA) partners with private insurance companies to deliver the federal crop insurance program. The government subsidizes the private companies offering and the agents selling contracts. Subsidization may encourage rent-seeking behavior on the part of the crop insurance industry (Smith et al., 2016; Glauber, 2012; Babcock, 2012; Lusk, 2016). Between 2000 and 2009, crop insurance companies, agents, and reinsurance companies garnered 60 percent of total program subsidies, amounting to $2.7 billion in annual revenue (Smith et al., 2016). Babcock (2012) estimates that for every dollar paid to indemnify farmers, a dollar goes directly to the insurance industry.

Recent work considers the rent-seeking behavior of insurance companies (Smith et al., 2016; Pearcy and Smith, 2015) but little consideration has been given to the potential rent-seeking of insurance agents. Individual insurance agents act as middlemen between farmers and insurance companies by procuring policies from producers and selling their portfolio of contracts, referred to as the book of business, to authorized insurance companies. Crop insurance agent compensation rates depend on the total premiums they transfer to insurance companies, and may be influenced by the expected losses associated with their book of business. Agents may pursue rents by writing
contracts for insurance products and coverage levels that maximize the agent’s total compensation, which may not maximize producer outcomes. Agents’ ability to influence producers’ insurance decisions depends on their market power, farmers’ production knowledge and relative risk level.

We explore how insurance agents use market power to influence the crop insurance decisions of two types of producers, opportunistic and passive. Passive producers do not observe their individual production risk level when selecting insurance while opportunistic producers possess more information relative to the agent and act accordingly. We model the interaction between producers of each type and a representative crop insurance agent in the context of a signaling game. We hypothesize that the effect of an increase in the agent’s market power on passive producers depends on the agent’s beliefs about the producer’s risk level as well as the agent compensation mechanisms. We predict that as an agent gains market power, they will attempt to reduce the coverage selected by opportunistic producers to increase the quality of the book of business.

We test our hypotheses empirically using contract level data from five states, Iowa, Nebraska, Oklahoma, Montana, and Washington. We estimate the relationship between measures of market power and the insurance coverage choices of producers. We find both positive and negative market power effects on the coverage of passive producers and generally negative effects on opportunistic producers. The negative coverage effect on opportunistic producers suggests that market concentration may help offset some adverse selection in federal crop insurance.

The Standard Reinsurance Agreement (SRA) stipulates the rules governing the relationship between the government and private insurance companies. Authorized providers sell and service insurance products and share underwriting gains and losses with USDA. The government returns a portion of total premiums received to offset administrative and operating costs. Agent
compensation is based on the total amount of insurance transferred to insurance companies (total premiums) and the performance of their portfolio of business (underwriting gains or losses) (Walters et al., 2010). The agents’ incentives include maximizing the premiums collected by farmers and the actuarial performance of the policies they sell to insurance companies. We refer to these motivations as the volume incentive and quality incentive respectively.

The SRA restricts agent behavior in two important ways. First, premiums cannot be influenced by agents or insurance companies. Agents found manipulating premiums can be banned from the industry (Pearcy and Smith, 2015). Second, agents must sell any approved policy to a farmer that demands it, provided the farmer resides in the agent’s state. Agents cannot compete on the basis of price or refuse the business of high risk farmers (Glauber, 2004). In this context, we can define agent rent-seeking as any excess profit derived by selling coverage above or below that which is optimal for the farmer.

Agents may leverage their knowledge of insurance products to influence the types of insurance purchased by farmers. More comprehensive insurance policies (e.g. revenue and high coverage “buy-up” plans) carry higher premiums which increase agent compensation. Alternatively, if an agent expects a prospective customer to suffer major losses, the quality incentive would direct the agent to minimize their exposure. The extent to which an agent can exert either type of influence will depend on the agent’s individual market share, the regional concentration of agents, i.e. how much competition exists among sellers, and the producer’s perceived risk level.

Just, Calvin, and Quiggin (1999) show that three incentives motivate a farmer to participate in federal crop insurance or not: risk aversion, premium subsidies, and asymmetric information. When purchasing crop insurance, the farmer chooses a percentage of their historical average yield
to insure, known as the coverage level. If actual yield falls below the yield guaranteed by the policy (coverage level times historical yield) the policy generates an indemnity equal to the difference, paid at a pre-determined price.\(^1\) The further the producer’s actual yield falls below this guaranteed level, the larger the insurance payout.

Traditional economic models of insurance show that risk averse producers should elect the maximum coverage level possible as subsidies make crop insurance actuarially advantageous. Much of the literature, however, does not support this theory. Producers generally do not choose coverage per the standard expected utility maximization framework. Babcock (2015) states that producers treat federal crop insurance as an investment instrument and less of a risk management tool. Producers choose coverage that maximizes the difference between expected indemnities (payments for losses) and out-of-pocket premiums (total premium less government subsidies) without regard for risk aversion.

When choosing a crop insurance product, farmers must select from a menu of options including the coverage level, policy type, individual vs. area protection, and price election. Product characteristic combinations can easily number in the hundreds, making many producers highly reliant on agent expertise (Schnitkey and Sherrick, 2017). Agents with market power may take advantage of these and other information asymmetries to maximize compensation.

High market concentration leads to higher prices than would be realized in a competitive market (Cotterill, 1986; Calem and Carlino, 1991; Davis, 2005). Several studies focus exclusively on health insurance where premiums are found to increase with the market power of insurance companies (Wholey et al., 1995; Bates et al., 2012; Dafny et al., 2012). In contrast, Shim (2015)

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\(^1\) Crop insurance contracts use commodity futures prices to determine the guarantee. Relevant harvest time futures prices (e.g. December corn, November soybeans, and September wheat) traded during spring months are used to set contracts.
finds that high market concentration is associated with greater firm fragility in the case of property-liability insurance. We extend this body of work to the market for crop insurance.

A growing body of research considers the supply side of the crop insurance industry. Pearcy and Smith (2015) model the interaction between farmers, insurance agents, and insurance companies in a theoretical setting and draw conclusions about how government policy influences the behavior of each market participant. They consider the possibility of insurance companies colluding to exert market power but assume individual agents cannot do the same. Smith et al. (2016) extend that work by empirically estimating the effect of insurance company market power on the commission rates paid to agents. They find that monopsony power by insurance companies significantly depresses agent compensation.

Walters et al. (2010) attempt to identify the influence of insurance agents on the amount of crop insurance premiums paid by farmers as well as the amount of indemnities incurred. They find some evidence of agents inflating premiums and selecting low risk farmers. These results may be driven, at least partially, by the extent of competition among agents or individual agent market power. We contribute to the growing literature on the supply-side of crop insurance by analyzing the role of competition in the first tier of the market.

In the following sections, we model the producer’s crop insurance decision problem, the agent’s insurance selling problem, and the interaction between the two parties. We then describe the data and empirical model used in estimation, present results, and summarize our conclusions.

**Producer-Agent Interaction Game**

We model the interaction between a crop insurance selling agent and a representative producer. For simplicity, we assume producers choose only the coverage level, represented by the variable
that determines the percentage of historical yield guaranteed. Producers treat crop insurance as a standalone investment tool and choose $\mu_i$ to maximize the difference between expected indemnity payments received less out-of-pocket premiums paid. As $\mu_i$ increases, both potential indemnities and out-of-pocket costs to the producer rise. See Appendix A for a complete detailing of the producer’s insurance maximization problem. We assume that producers cannot perfectly observe their optimal choice of insurance coverage, denoted $\mu_i^*$. Instead we assume that producers vary in knowledge of their subjective risk profiles. Due to imperfect knowledge, all producers rely on agent expertise to some degree when making crop insurance decisions.

A representative producer $i$ has an individual yield distribution $f(y_i)$. We assume producers vary in their knowledge of this distribution. For simplicity, we assume producers have either imperfect knowledge of $f(y_i)$ or no knowledge. Producers with imperfect knowledge of $f(y_i)$ can estimate their expected production levels for the upcoming crop year and approximate their risk of loss. While these types of producers cannot perfectly anticipate losses, or calculate their optimal coverage level exactly, they may still exploit information asymmetries when purchasing crop insurance. We refer to these as “opportunistic” producers. Conversely “passive” producers do not observe $f(y_i)$ and can only approximate their production levels based on broad population production averages.

In addition to being opportunistic or passive, we model producers as having either high or low production risk. High-risk producers are more likely to suffer a production loss and receive an indemnity payment for any given coverage level. The proportion of high risk producers in the overall population is represented by $p$. High risk and low risk types have cumulative yield

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5 Other insurance choices include the policy type (e.g. yield vs. revenue coverage), unit structure, and price election amount. We ignore these choices in the interest of simplicity.
distributions $F(y|H)$ and $F(y|L)$ respectively where $F(y|L)$ first order stochastically dominates $F(y|H)$, i.e.

$$F(y|L) \leq F(y|H) \quad \forall \ y$$

The producer’s expected utility for a given insurance coverage level and risk level is:

$$\mathbb{E}[U_i(\mu_i)|Risk \ Level]$$

We express the producer’s utility as an expectation because the

Opportunistic producers are privately informed about their risk level while passive producers are not. Prior to any interaction with the insurance agent, producers of either type form an approximation of their optimal coverage level $\mu_i^*$. Opportunistic producers use their private risk information to approximate $\mu_i^*$ while passive producers cannot. For simplicity, we delineate approximations as either above or below the average coverage level in an area $\bar{\mu}$. An above average approximation is denoted $\mu_i^+$ while a below average approximation is denoted $\mu_i^-$. 

$$\mathbb{E}_i(\mu_i^*|Risk \ Level) = \mu_i \in \{\mu_i^+, \mu_i^-\}$$

Producer $i$ communicates their approximated optimal coverage level $\mu_i$, either $\mu_i^+ > \bar{\mu}$ or $\mu_i^- < \bar{\mu}$, to a representative crop insurance agent $j$ who then recommends a coverage level $\mu_j$ where:

$$\mu_j(\mu_i, \alpha_j) = \mu_i \pm \alpha_j$$

The term $\alpha_j$ captures the agent’s influence over the producer’s coverage choice. The agent chooses a positive $\alpha_j$ to up the producer’s coverage and a negative $\alpha_j$ to reduce coverage. The choice of a positive or negative recommendation depends on the agent’s beliefs about the risk level of the producer and how agents are

Crop insurance agents sell policies to maximize their total commission received from the insurance company who acquires the policy. This commission, equal to some commission rate
times total premiums transferred to the insurance company, can increase in two ways. First, the commission rate (percentage of total premium transferred) can rise. Insurance companies may pay a higher commission rate for a high-quality policy that generate underwriting gains (premiums exceeding indemnities). The incentive to maximize the commission rate, what we refer to as the “quality incentive,” may lead the agent to recommend a negative $\alpha_j$ to a risky producer, thereby minimizing losses. Second, the agent can sell a policy with high total premiums (producer paid plus government subsidies) by convincing the producer to purchase a high coverage policy. The agent will recommend a positive $\alpha_j$ in response to this “volume incentive.” See Appendix B for a full explanation of the agent’s profit maximization problem.

The producer, however, may find the recommendation deviates too far from their original approximation and opt to work with a different agent altogether. Competition among agents has the effect of attenuating any one agent’s ability to influence producers. A competing agent $k$ may undercut agent $j$ by offering a recommendation closer to the producer’s approximated optimal coverage level. The producer will choose to purchase a policy from agent $k$ carrying coverage level $\mu_k = \mu_l + \alpha_k$ if:

$$|\mu_l + \alpha_k| < |\mu_l + \alpha_j| \Rightarrow |\alpha_k| < |\alpha_j|.$$ 

We denote the probability of this occurring as $V(\alpha_j)$. The probability of being undercut by a competitor is increasing in $\alpha_j$ if $\alpha_j$ is positive and decreasing in $\alpha_j$ if $\alpha_j$ is negative.

$$V'(\alpha_j) \begin{cases} < 0 & \text{if } \alpha_j > 0 \\ > 0 & \text{if } \alpha_j < 0 \end{cases}$$

The prospect of losing the producer to a competing agent forms a natural constraint on the agent’s influence.
We model the interaction process as a signaling game, examining the behavior of each producer type separately. We first consider an opportunistic producer who interacts with a profit maximizing agent over the following four stages. Figure 1 illustrates the extensive form signaling game.

**Opportunistic Producer-Agent Interaction**

1. Nature determines the producer to be a high or low-risk type. For simplicity, we exclude the possibility of moral hazard whereby a producer’s risk level can be influenced by their choice of insurance coverage.

2. An opportunistic producer $i$ observes their type privately and forms an approximation of their optimal coverage level $\mu_i$. The producer communicates this approximation as being either higher or lower than the average coverage level across all producers. The producer’s strategy set given their risk level is then:

   $$ S_i(Risk\ Level) = \{\mu_i^+, \mu_i^-\} \text{ where } \mu_i^+ > \bar{\mu} \text{ and } \mu_i^- < \bar{\mu}. $$

3. Agent $j$ observes the producer as having a high approximation ($\mu_i^+$) or low approximation ($\mu_i^-$) which they use to form a belief about the producer’s risk level. Given the agent observes $\mu_i^+$, the probability that the producer a high-risk type is given by $\gamma$ and the probability of being a low-risk type is $1 - \gamma$. If the agent observes $\mu_i^-$, the agent believes the producer to be high and low risk with probability $\lambda$ and $1 - \lambda$ respectively.

   $$ \text{Prob}(High\ Risk|\mu_i^+) = \gamma, \text{ Prob}(Low\ Risk|\mu_i^+) = 1 - \gamma $$

   $$ \text{Prob}(High\ Risk|\mu_i^-) = \lambda, \text{ Prob}(Low\ Risk|\mu_i^-) = 1 - \lambda $$

Based on this information, agent $j$ recommends the producer either increase their coverage (suggest a positive $\alpha_j$) or decrease their coverage (suggest a negative $\alpha_j$). The producer
accepts this offer with probability $V(\alpha_j)$ and chooses to accept the offer of a competing agent with probability $1 - V(\alpha_j)$. The agent’s strategy set is:

$$S_j(\mu_i) = \{\alpha_j, -\alpha_j\} \text{ where } \alpha_j > 0 \text{ and } -\alpha_j < 0.$$ 

4. Payoffs are observed in expectation since actual payoffs are not realized until harvest time. Given the producer’s signal $\mu_i$, the agent’s payoffs are ordered as follows:  

$$\mathbb{E}[\Pi_j(\mu_i + \alpha_j)|H] < \mathbb{E}[\Pi_j(\mu_i - \alpha_j)|H],$$

$$\mathbb{E}[\Pi_j(\mu_i + \alpha_j)|L] > \mathbb{E}[\Pi_j(\mu_i - \alpha_j)|L]$$

The above states that when selling to a high-risk producer, the agent will prefer to sell a low coverage policy to reduce their exposure to losses and increase their expected commission rate. If the producer’s risk of loss is low, the agent prefers to increase the coverage level and maximize the policy’s premium. In other words, the agent’s quality incentive dominates when selling to high-risk producers while the volume incentive dominates for low-risk producers. The opportunistic producer’s payoffs are ordered thusly:

$$\mathbb{E}[U_i(\mu_i + \alpha_j)|H] > \mathbb{E}[U_i(\mu_i - \alpha_j)|H],$$

$$\mathbb{E}[U_i(\mu_i + \alpha_j)|L] < \mathbb{E}[U_i(\mu_i - \alpha_j)|L]$$

Producers are also motivated by actuarial performance and volume but value them differently. High-risk producers want to maximize expected indemnities, so they prefer a

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6 The full comparison of payoffs between $\alpha_j > 0$ and $\alpha_j < 0$ is $V(\alpha_j) \cdot \mathbb{E}[\Pi_j(\mu_i + \alpha_j)|i] \geq V(-\alpha_j) \mathbb{E}[\Pi_j(\mu_i - \alpha_j)|i]$. The probability of the agent losing the sale to a competing agent drops out of the inequality because we assume the distribution of competing recommendations to be symmetric and thus $V(\alpha_j) = V(-\alpha_j)$.

7 Similarly, the full comparison of producer payoffs is $V(\alpha_j) \cdot \mathbb{E}[U_i(\mu_i + \alpha_j)|i] + (1 - V(\alpha_j)) \cdot \mathbb{E}[U_i(\mu_i + \alpha_k)|i] \geq \mathbb{E}[U_i(\mu_i - \alpha_j)|H] + (1 - V(-\alpha_j)) \cdot \mathbb{E}[U_i(\mu_i + \alpha_k)|i]$ which simplifies to $\mathbb{E}[U_i(\mu_i + \alpha_j)|i] \geq \mathbb{E}[U_i(\mu_i - \alpha_j)|H]$. 


higher coverage level. Low-risk types are more concerned about their out-of-pocket premium costs, so they prefer lower coverage policies.

There are four possible Perfect Bayesian Equilibria (PBE) for the opportunistic producer. Only a separating PBE where opportunists truthfully reveal their type can be supported under certain conditions, which we present here. See Appendix C for a description of the three unsupportable equilibria.

**Separating PBE:** High-risk producers signal a high coverage approximation and low-risk producers signal a low coverage approximation.

\[ \gamma = 1, \lambda = 0 \]

\[ S_i(H) = \mu_i^+, S_i(L) = \mu_i^- \]

\[ S_j(\mu_i^+) = \alpha_j < 0, S_j(\mu_i^-) = \alpha_j > 0 \]

Given that agent \( j \) observes a signal of \( \mu_i^+ \) from an opportunistic producer, he/she believes the producer to be a high-risk type with certainty (\( \gamma = 1 \)). The agent recommends the producer reduce their coverage by choosing \( \alpha_j < 0 \) because \( \mathbb{E}[\Pi_j(\mu_i - \alpha_j)|H] > \mathbb{E}[\Pi_j(\mu_i + \alpha_j)|H] \). If the producer signals \( \mu_i^- \), the agent correctly identifies them as a low-risk type (\( 1 - \lambda = 1 \)) and chooses \( \alpha_j > 0 \) as \( \mathbb{E}[\Pi_j(\mu_i + \alpha_j)|L] > \mathbb{E}[\Pi_j(\mu_i - \alpha_j)|L] \).

Anticipating the agent’s responses, a high-risk producer will not deviate from his/her equilibrium path, provided the following conditions hold:

\[ \mathbb{E}[U_i(\mu_i^+ - \alpha_j)|H] > \mathbb{E}[U_i(\mu_i^- + \alpha_j)|H] \text{ and } \mathbb{E}[U_i(\mu_i^- + \alpha_j)|L] > \mathbb{E}[U_i(\mu_i^+ - \alpha_j)|L] \]

\[ \Rightarrow \mu_i^+ - \alpha_j > \mu_i^- + \alpha_j \]

\[ \Rightarrow |\alpha_j| < \frac{\mu_i^+ - \mu_i^-}{2} \]
The above condition states that the amount by which the agent can influence the producer’s approximated coverage level cannot exceed, in absolute value, half the difference between $\mu_i^+$ and $\mu_i^-$. This places a natural constraint on the agent’s ability to affect an opportunistic producer’s insurance choice and incentivizes opportunistic producers to reveal their true type.

**Passive Producer-Agent Interaction**

We now examine the interaction between a passive producer and a crop insurance agent. Passive producers differ from opportunistic producers in that they cannot observe their individual risk type. Instead, passive producers may only approximate their risk level based on the proportion of high risk producers in the area. In this way, passive producers possess no more information than the agent selling the policy and cannot exploit information asymmetries.

Because passive producers are uninformed about their risk level, they must commit to a single action, meaning we only need to consider pooling equilibria without the possibility of deviating. The interaction between passive producers and agents unfolds over the following three stages. Figure 2 modifies the game tree in Figure 1 to reflect the passive producer’s lack of private information.

1. Without knowing whether they are a high-risk or low-risk type, the passive producer approximates his/her optimal coverage level and sends a signal to the agent. The passive producer’s strategy set is not conditional on their risk profile.

   $$S_i = \{\mu_i^+, \mu_i^-\} \text{ where } \mu_i^+ > \bar{\mu} \text{ and } \mu_i^- < \bar{\mu}.$$

2. The agent’s response to the producer’s signal depends on the overall probability of dealing with a high-risk producer $p$. 


\[ S_j(\mu^+_i) = \alpha_j > 0 \text{ if } \]
\[ p \leq \frac{1}{1 - \left( \frac{\mathbb{E}[\Pi_j(\mu^+_i + \alpha_j)|H] - \mathbb{E}[\Pi_j(\mu^+_i - \alpha_j)|H]}{\mathbb{E}[\Pi_j(\mu^+_i - \alpha_j)|L] - \mathbb{E}[\Pi_j(\mu^+_i + \alpha_j)|L]} \right)} \equiv \Psi_1 \]
\[ S_j(\mu^-_i) = \alpha_j < 0 \text{ if } p > \Psi_1 \]
\[ S_j(\mu^-_i) = \alpha_j > 0 \text{ if } \]
\[ p \leq \frac{1}{1 - \left( \frac{\mathbb{E}[\Pi_j(\mu^-_i + \alpha_j)|H] - \mathbb{E}[\Pi_j(\mu^-_i - \alpha_j)|H]}{\mathbb{E}[\Pi_j(\mu^-_i - \alpha_j)|L] - \mathbb{E}[\Pi_j(\mu^-_i + \alpha_j)|L]} \right)} \equiv \Psi_2 \]
\[ S_j(\mu^-_i) = \alpha_j < 0 \text{ if } p > \Psi_2 \]

The agent’s decision depends not on the individual characteristics of the producer but on the overall probability that a producer is high-risk. If high-risk producers are rare, i.e. \( p \) falls below the thresholds defined above, the agent will attempt to expand the producer’s coverage. If the population contains many high-risk individuals, \( p \) will exceed the thresholds and agents will reduce coverage levels to improve the quality of their books of business.

3. The producer accepts the agent’s recommendation with probability \( V(\alpha_j) \). The offer is rejected if a competing agent \( k \) offers a recommendation closer to the producer’s approximation, which occurs with probability \( 1 - V(\alpha_j) \).

Passive producers and agents alike choose their strategies based on the probability of the producer being a high-risk type. This means that both parties are reacting to overall averages in the producer population as opposed to individual characteristics, as in the case of opportunistic producers.
Market Power and Agent Influence

We summarize the equilibrium strategies taken by opportunistic and passive producers and examine how market power affects the agent’s behavior. For opportunists, we find that the only sustainable equilibrium is a separating PBE where producers truthfully reveal their risk level. The agent responds by bidding down high-risk opportunists and bidding up low-risk opportunists choice of coverage. When dealing with passive producers, agents cannot infer any additional information about the producer’s risk level. Instead, they influence the producer to either increase or decrease coverage based on the prevalence of risky producers in the overall population.

The agent tailors his/her insurance recommendation to each producer type and belief about their risk level. The agent’s action set is summarized below.

$$\alpha_j \mid \text{opportunistic producer} \begin{cases} < 0 & \text{if producer is believed to be high risk} \\ > 0 & \text{if producer is believed to be low risk} \end{cases}$$

$$\alpha_j \mid \text{passive producer} \begin{cases} < 0 & \text{if population is high risk} \\ > 0 & \text{if population is low risk} \end{cases}$$

Recall, however, that opportunistic producers suffer most from adverse selection which means low-risk opportunists are unlikely to enter the insurance pool in the first place. Therefore, cases where agents attempt to increase opportunistic producers’ coverage levels will be rare or non-existent. The most common interaction between opportunistic producers and agents will involve agents decreasing producers’ coverage levels.

Agent market power has the effect of increasing the producer’s probability of accepting a recommendation from the agent for all values of $\alpha_j$, i.e. $V(\alpha_j)$ increases for all $\alpha_j$. This may be the result of fewer competing agents in the insurance market, i.e. higher concentration, or an
increase in the agent’s individual market share. In either case, the result is a decreased likelihood of losing the sale to a competing agent.

To see how an increase in market power impacts the agent’s influence, we examine the agent’s response function in general form. We begin with opportunistic producers. The agent’s expected profit given the producer’s approximated coverage level $\mu_i$ is as follows:

$$\max_{\alpha_j} \mathbb{E}[\Pi_j(\alpha_j|\mu_i)] = V(\alpha_j) \cdot \mathbb{E}[\Pi_j(\mu_i + \alpha_j)|H] + (1 - P(H|\mu_i)) \cdot \mathbb{E}[\Pi_j(\mu_i + \alpha_j)|L]$$

Again, the agent chooses an influence factor $\alpha_j$ which we now allow to be any positive or negative number. The term $P(H|\mu_i)$ is the conditional probability that a producer is high-risk given their coverage approximation $\mu_i$ and $V(\alpha_j)$ is the probability of successfully closing the sale as a function of $\alpha_j$.\(^8\) Taking the first order condition and applying the Implicit Function Theorem, the following comparative static describing the effect of market power on agent influence results:

$$\frac{\partial \alpha_j}{\partial V(\cdot)} |\text{opportunistic producer} = \begin{cases} 
> 0 & \text{if } P(H|\mu_i) < \frac{1}{1 - \mathbb{E}\left[\frac{\Pi_j(\cdot)|H}{\Pi_j(\cdot)|L}\right]} \\
< 0 & \text{if } P(H|\mu_i) > \frac{1}{1 - \mathbb{E}\left[\frac{\Pi_j(\cdot)|H}{\Pi_j(\cdot)|L}\right]} 
\end{cases} \equiv \Omega(\Lambda)$$

where $\Lambda \equiv \mathbb{E}\left[\frac{\Pi_j(\cdot)|H}{\Pi_j(\cdot)|L}\right] < 1$

The above conditions state that the agent’s response to greater market power (or less competition) depends on two factors: the conditional probability that the producer is high-risk opportunist $P(H|\mu_i)$ and the threshold $\Omega(\Lambda)$ which is a function of how insurance companies compensate agents. If, given the producer’s approximated coverage level $\mu_i$, the probability that

\(^8\) In the interaction game, we represented the conditional probability of the producer being high-risk as $\gamma$ and $\lambda$ for the specific coverage approximations $\mu_i^+$ and $\mu_i^-$. Here we consider the conditional probability generally for any value of $\mu_i$. 

the producer is high-risk exceeds $\Omega(\Lambda)$, the agent will use their market power to lower the coverage level of an opportunistic producer. Conversely, if $P(H|\mu_i)$ falls below the threshold defined $\Omega(\Lambda)$, the agent will leverage market power to increase the producer’s coverage.

The general form expected profit function for an agent selling to a passive producer can be expressed as:

$$\max_{\alpha_j} \mathbb{E}[\Pi_j(\alpha_j|\mu_i)] = V(\alpha_j) \cdot \left[ p \cdot \mathbb{E}[\Pi_j(\mu_i + \alpha_j)|H] + (1 - p) \cdot \mathbb{E}[\Pi_j(\mu_i + \alpha_j)|L] \right]$$

Recall that passive producers cannot observe their own risk types. Passive producers can only play a pooling strategy where they approximate an optimal coverage level without knowing if they are high or low-risk and communicate this approximation to the agent. The agent, who cannot update his/her beliefs about the passive producer’s true riskiness, chooses an $\alpha_j$ to adjust the producer’s approximated coverage level. The probability that the passive producer is high-risk is the unconditional probability of dealing with a high-risk producer $p$.

To see how variations in market power impacts the agent’s recommendation to a passive producer, we again take the first order condition of the above objective function and apply the Implicit Function Theorem.

$$\frac{\partial \alpha_j}{\partial V(\cdot)} \bigg|_{\text{passive producer}} = \begin{cases} 0 & \text{if } p < \frac{1}{1 - \mathbb{E}\left[\frac{\Pi_j(\cdot)|H}{\Pi_j(\cdot)|L}\right]} \equiv \Omega(\Lambda) \\ < 0 & \text{if } p > \frac{1}{1 - \mathbb{E}\left[\frac{\Pi_j(\cdot)|H}{\Pi_j(\cdot)|L}\right]} \equiv \Omega(\Lambda) \end{cases}$$

where $\Lambda \equiv \mathbb{E}\left[\frac{\Pi_j(\cdot)|H}{\Pi_j(\cdot)|L}\right] < 1$

The above condition is like that of opportunistic producers but the conditional probability $P(H|\mu_i)$ is replaced with the unconditional probability $p$. Again, the effect of agent market power
depends on both the probability that the producer is high-risk, and the threshold defined by $\Omega(\Lambda)$. If the overall proportion of high-risk producers in the population falls below $\Omega(\Lambda)$, the volume incentive dominates, and market power increases the agent’s influence in a positive direction. If the proportion of risky producers exceeds the threshold, the quality incentive dominates, and powerful agents will act to reduce the producer’s coverage level.

Note that the threshold $\Omega(\Lambda)$ captures the way insurance companies compensate agents based on the expected performance of the policy being acquired by the company. The term $\Lambda \equiv \mathbb{E}\left[\frac{\Pi_j(\cdot)|H}{\Pi_j(\cdot)|L}\right]$ is the change in expected profit from increasing a high-risk producer’s coverage level divided by the change in expected profit from increasing a low-risk producer’s coverage level. It represents how important the quality incentive is in the agent’s compensation. The ratio cannot exceed one as we assume the denominator will always be at least as large as the numerator. High coverage policies sold to low-risk producers are at least as attractive to insurance companies as high coverage policies sold to high-risk producers. The ratio $\Lambda$ can however, be negative. This is true if increasing the coverage of a high-risk producer hurts expected agent profit, i.e. a meaningful quality incentive exists for the agent.

As $\Lambda$ rises towards one, i.e. the change in profit from increasing a high-risk producer’s coverage level approaches the change for a low-risk type, $\Omega(\Lambda)$ increases. Another way of stating this is that as the quality component of an agent’s compensation becomes less important and the volume incentive is emphasized, the threshold $\Omega(\Lambda)$ rises. A higher $\Omega(\Lambda)$ means the likelihood that the producer is risky can be high and market powerful agents will still try to increase their coverage. In fact, as long as $\mathbb{E}[\Pi_j(\cdot)|H]$ and $\mathbb{E}[\Pi_j(\cdot)|L]$ are non-negative, $\Omega(\Lambda)$ will be greater than or equal to one and an increase in the agent’s market power will necessarily cause them to increase the coverage of both opportunistic and passive producers. A positive $\mathbb{E}[\Pi_j(\cdot)|H]$ means
the agent’s quality incentive is totally overshadowed by his/her volume incentive, even for high-risk types.

In the separating PBE, we show that opportunistic producers will approximate a high \( \mu_i \) if they are high-risk and a low \( \mu_i \) if they are low-risk. We also know that high-risk producers make up most of the opportunistic population due to their asymmetric information and adverse selection. Therefore, most opportunist will signal a high \( \mu_i \) with a conditional probability \( P(H|\mu_i) \) equal to one and the agent responds by attempting to lower the coverage level. No other strategy can be supported in equilibrium (see Appendix C). The agent’s ability to reduce an opportunistic producer’s coverage increases with their market power.

As long as a quality incentive exists for the agent, i.e. \( \Lambda \equiv \mathbb{E}\left[ \frac{\Pi_j'\left(\cdot\right)H}{\Pi_j'\left(\cdot\right)L} \right] < 0 \), the agent acts to reduce the coverage of opportunistic producers. This is because opportunistic producers are more likely to experience a loss and receive an indemnity payment which increase relative to premiums as the policy’s coverage level increases. Large losses hurt the agent’s commission by lowering the quality of their book of business, making it less attractive to insurance companies. If the opportunistic producer is low-risk, which should be rare due to adverse selection, the quality incentive will be dominated by the volume incentive and agents with market power will increase the producer’s coverage level to maximize the premium side of their compensation.

The threshold \( \Omega(\Lambda) \) implies that regional differences may emerge in how market power affects agents’ influence on passive producers. Imagine two states with the same proportion of high-risk producers (\( p_A = p_B = p \)) but differ in the way agents are compensated. In state A, insurance companies generously reward agents for books of business that perform well, i.e. a strong quality incentive exists. In state B, insurance companies emphasize total premiums so the volume incentive drives agent behavior in that state. In this example, \( \Lambda_A < \Lambda_B \) meaning \( \Omega(\Lambda_A) < \)
\[ \Omega(\Lambda_B) \]. If \( \Omega(\Lambda_A) < p < \Omega(\Lambda_B) \) then an increase in agent market power will have different effects in each state despite having the same overall levels of risk among their producer populations.

Using data from five states, we test the predicted effects of market power on agent influence empirically for both opportunistic and passive producers. We provide an overview of the data used in our analysis and discuss the empirical model in the following sections.

**Data**

Data for this study were obtained from the USDA Risk Management Agency at the individual crop insurance unit level. Units are individual parcels of land within a producer’s land holdings that the farmer insures under its own contract. Each insured unit maintains its own production history against which actual yields are compared to determine if an indemnity payment is triggered. A single producer may receive an indemnity on one unit but not on a neighboring unit.

For each insured unit, the farmer chooses what policy type to purchase and the amount of coverage (as a percentage of historical yield or revenue) which together with how many acres are being insured, determine the premium cost and liability guaranteed by the policy. More comprehensive policies come with higher premiums, lower subsidies, and larger liabilities.

For each producer-unit level contract, we observe the crop insured, crop year, county location, total premiums paid (producer out-of-pocket expense and government subsidies), total dollar amount of liability insured, coverage level, number of acres insured, farm practice used on the unit (e.g. irrigated vs. non-irrigated), whether transitional yields are used in calculating

\[ \text{9 There are four types of crop insurance units: basic, optional, enterprise, and whole farm. Whole farm and enterprise are the largest and most aggregated unit types while basic and optional units allow for smaller pieces of land to be insured individually.}

\[ \text{10 Coverage levels range from 50 percent to 85 percent in five percent increments. Over time, high coverage “buy-up” policies have become more popular as subsidies for them have risen.} \]
historical yields, the insured’s share in any crop sharing agreement, and indemnities paid for losses. We also observe the agent who sold the policy and approved insurance company (AIP) that ultimately acquires the contract.\textsuperscript{11}

The scope of the data spans selected counties in five states (Iowa, Nebraska, Oklahoma, Montana, and Washington) from 1995 to 2009.\textsuperscript{12} Iowa, Oklahoma, and Washington datasets contain counties from across the growing regions in their respective states while Nebraska and Montana are regionally focused.\textsuperscript{13} While the Nebraska counties we observe are in the western part of the state, they are similar to Iowa in terms of land heterogeneity and crop mix. Oklahoma, Montana, and Washington exhibit greater within-county variation in growing conditions (Walters et al., 2014).\textsuperscript{14} We limit the crops analyzed to the most acres planted in each state. For Iowa, this includes corn and soybean contracts. Wheat, corn, and soybean policies are covered in the Nebraska dataset while Oklahoma contains these three plus sorghum and cotton. Both Montana and Washington focus on wheat and barley crop insurance policies as these make up greater than 90 percent of contracts observed in each state.

From the raw data, we construct two measures of agent market power. First, we determine each agent’s yearly market share by dividing the number of producers who purchase at least one contract from the agent by the total number of producers who purchased at least one contract within the county that year. Each agent’s market share is then:

\[
MS_{jnt} = \frac{\sum_{i=1}^{I} A_{ijnt}}{\sum_{j=1}^{J} \sum_{i=1}^{I} A_{ijnt}}
\]

\textsuperscript{11} Some policies denote multiple selling agents. We drop these as we are unable to award the sale to a unique agent.
\textsuperscript{12} The dataset is highly confidential due to the individual farm level detail. As such, sharing of the dataset has been strictly limited.
\textsuperscript{13} Nebraska coverage is limited to five counties in the west while Montana is limited to four counties in the north-central part of the state.
\textsuperscript{14} Walters et al. (2014) also used this dataset. See their work for more details.
where $A_{int}$ equals one if producer $i$ operating in county $n$ purchases at least one contract from agent $j$ during year $t$. We treat all policies sold to a single producer by a single agent as one sale. This strategy deals with any potential endogeneity between producers with large operations and coverage choice.\(^\text{15}\)

We square and sum the individual market shares across all agents in the same county to create a Herfindahl index of agent market concentration.

$$HI_{nt} = \sum_{j=1}^{J} (MS_{jnt})^2 \in (0,1)$$

The Herfindahl index is normalized to between zero, denoting perfect competition among agents, and one, representing monopoly by a single seller.

Many of the observed contracts after 2000 do not identify the agent who sold the policy.\(^\text{16}\) This raises two important issues. One, contracts that do not report an agent may differ systematically from those that do. Using only contracts with listed agents could introduce selection bias into estimation results. The second challenge is the construction of individual market shares and Herfindahl indices for agents when not all market information is available. To make use of these missing agent contracts, we would have to assume that agents are randomly left off contracts and each agent stands the same chance of being unobserved for market shares and Herfindahl indices to be accurate and unbiased. This is a strong assumption that is unlikely to hold.

\(^{15}\) This strategy is also the most consistent with our theoretical framework where market power is modeled as the probability that a single producer receives recommendations from multiple agents. In this way, an agent’s market share can be thought of as the percentage of crop insurance customers an agent sells to out of all crop insurance consumers in the market.

\(^{16}\) Missing agents are concentrated to the Nebraska, Oklahoma, Montana, and Washington datasets for which 35\%, 41\%, 26\%, and 39\% respectively of all contracts do not report an agent. Only 6\% of Iowa contracts are missing this information making it the most reliable dataset for agent information.
Between the two issues raised by missing observations, we believe the later to be the most serious. To deal with this, we limit our data to only counties with over 90 percent of the contracts reporting a selling agent. This ensures that any effects of non-random missing agents are minimized while maintaining large sample sizes.\textsuperscript{17}

Our theoretical model proposes that opportunistic producers exist and exercise opportunism in contract selection by observing, albeit imperfectly, their individual risk level and choosing a level of insurance coverage that maximizes their expected returns to insurance. Opportunistic producers should generate superior returns to insurance relative to other producers in the same region over time. They should also, due to the adverse selection problem, incur losses more frequently than their passive counterparts. For each producer, we calculate their returns to insurance as the difference between total indemnities per acre received and total out-of-pocket premiums per acre paid over all years we observe the producer. We then define opportunistic producers as those in the 75\textsuperscript{th} percentile for the county in which they operate. We also stipulate that opportunists must be observed for at least five years to prevent a single isolated loss year placing them in the opportunistic group.\textsuperscript{18}

Another important aspect of a crop insurance policy is the insured’s share in the crop. In crop sharing agreements, both the landlord and the tenant may insure their share of the crop separately. Whether the insured is a producer-operator or a landlord with respect to a given unit may influence their choice of crop insurance. We designate contracts where the insured has a

\textsuperscript{17}We change the threshold for missing agent contracts and find our results to be robust (see Robustness Checks). We still use contracts that do not report the agent for specifications involving Herfindahl indices, subject to the 90\% reporting threshold, but models using individual agent market shares drop these observations.

\textsuperscript{18}We also adjust the thresholds for defining opportunistic producers and discuss how our results change in the Robustness Checks section.
greater than 50 percent stake in the crop as being producer/operators as these are likely active farmers working the land vs. those with less than a 50 percent share who we deem to be landlords.\textsuperscript{19}

After dropping county-years that did not meet the minimum requirement for reporting agents, we are left with a total of 423,388 observations. Iowa contributes close to half of the total observations across all five states. This is due to both the reliability of the data (only six percent of all observations do not report the selling agent) and the high concentration of row crop production in the state (Iowa ranks first in the nation for corn and soybean production).

Table 1 shows summary statistics by state. Regional differences in insurance choices are clear from the table. Total premiums per acre (producer paid plus subsidies) range from an average of two dollars per acre in Washington to almost nine dollars per acre in Iowa. Insured liability, the amount a policy would pay out in the event of a total loss, is equally variable across states. Iowa stands out as having the highest premiums and insured liability per acre. This reflects high crop values, higher coverage levels, and higher APH yields (the historical average yield used to set policy guarantees) in that state. Liabilities capture other forms of coverage choices such as policy type and unit structure which we do not report in Table 1 but likely vary from state to state. At 157 dollars of liability insured per acre, Iowa producers appear to prefer more comprehensive coverage.

Transitional, or T-yields, are used when fewer than the required 10 years of production history are available to compute a unit’s APH. Special T-yields are also available for new producers or a crop that is new to the producer.\textsuperscript{20} Iowa producers are far less likely to use transitional yields in computing APH, indicating there is relatively little attrition in Iowa farming.

\textsuperscript{19} A small number of contracts have insured shares of exactly 50%. It is not obvious in these cases whether the insured is a producer-operator or a landlord. To deal with this, we take the average of insured acres for contracts with 50/50 insured shares and classify contracts with above average acreage as producer-operators.

\textsuperscript{20} T-yields are based on a historical county average. A unit must have the most recent four years of yield history to be insured. If records are not available for any of the previous four years, a T-yield is used in its place.
Only nine percent of contracts in Iowa use some form of transitional yield vs. 72 percent of policies observed in Washington. Producers in Montana and Washington insure more acreage per unit than other states. This may be due to larger farm sizes or to fewer units insured per farm.

Most contracts across the five states involve producer-operators with the exception of Washington where just over half of the policies are for landlords. Iowa contains the largest contingent of active producers at 71 percent of observed contracts. Land heterogeneity contributes to the observed differences is loss risk between states (Walters et al., 2014). Contracts in Iowa, Nebraska, and Washington display the least amount of risk with four, seven, and four percent of units respectively recording an indemnity during the 1995 to 2009 period. Oklahoma demonstrates the highest risk with half the observed policies reporting an indemnified loss and average indemnities of close to 30 dollars per acre. Montana is the second most risky state behind Oklahoma at 20 percent of policies experiencing a loss and indemnities of $5.68 per acre.\(^{21}\)

Walters et al. (2014) confirm the observed differences in risk. They show yield performances in each state during the 1995 to 2009 time period relative to a historical average, concluding that the high losses experienced in Oklahoma and Montana can be partially explained by a period of relatively poor yields during this period. Walters et al. (2014) also point out that land heterogeneity in Oklahoma and Montana relative to homogeneous Iowa, Nebraska, and to a lesser extent Washington, create greater variability in production.

Variations in risk help explain differences in the representation of opportunistic producers in each state. By our definition, over a third of the observed contracts in Oklahoma and 13 percent of Montana contracts are insured by opportunistic producers. This comports with the high loss

\(^{21}\) Note that summary statistics are presented for the period 1995 to 2009, subject to the requirement that over 90% of the policies in
percentage and large indemnities paid to producers in those states.\textsuperscript{22} Opportunism in crop insurance may increase with risk as producers learn from loss experiences and adjust their coverage choices. Low loss percentage states Iowa, Nebraska, and Washington report the fewest opportunists, possibly due to the limited opportunities to learn from experience.

Agent competition varies moderately from state to state. Iowa has the greatest number of agents operating per county at over 96 and the lowest average agent market share at six percent of the market per agent. The market concentration Herfindahl index is also the lowest of the five states at 0.05. This could be driven in part by the high average premiums paid by Iowa producers.\textsuperscript{23} Oklahoma appears to be the least competitive with an average market share and Herfindahl index of 13 percent and 0.12 respectively. While total premiums paid in Oklahoma are moderate, persistent underwriting losses could explain the relatively low agent competition. Despite this, all five states are considered unconcentrated by the United States Federal Trade Commission.

We also observe an identifier for the approved insurance provider (AIP) that ultimately acquires each insurance contract from the agent. From this, we calculate an insurance company Herfindahl index as we did for agents with one difference: instead of defining the market as a county, we consider the market for insurance companies to be the entire state. This is due to the large reach of AIPs and the fact that an agent can easily sell a policy to any company operating in the same state.\textsuperscript{24} Insurance company competition appears more variable than agent competition. Iowa is still considered unconcentrated, but Oklahoma, Montana, and Washington are considered

\textsuperscript{22}The percentage of policies insured by opportunists in Oklahoma exceeds 25\%, the percentile threshold used to define opportunistic producers. This is because we define opportunists as the producer level based on all policies insured over the observation period while summary statistics in Table 1 are reported at the unit-contract level. Opportunists in Oklahoma insure more policies per producer than opportunists in other states which explains the overrepresentation.

\textsuperscript{23}We address this possible source of endogeneity between premiums and agent market competition in the empirical section.

\textsuperscript{24}As of the writing of this paper, there are 16 AIPs operating through the Standard Reinsurance Agreement with USDA Risk Management Agency (RMA).
moderately concentrated and Nebraska crosses the threshold to be considered highly concentrated.\textsuperscript{25}

The five states we observe differ significantly across several dimensions, most notably in terms of land heterogeneity, risk, and the potential for underwriting gains. We describe our empirical framework for estimating the effects of agent market competition on producer choices in the following section.

**Empirical Model of the Effects of Agent Market Power on Insurance Coverage**

We estimate the influence of agent market power on producers’ insurance choices using the following two specifications:

1. $Y_{ijnt} = \alpha_i + \tau_t + \eta_{1n} + \lambda_{1nt} + X_{ijt}\beta_1 + \omega LOST_{1t-1} + \delta_1 (LOST_{1t-1} * OPR_{t}) + \gamma_1 MS_{jt} + \psi_1 (MS_{jt} * OPR_{t}) + e_{ijnt}$

2. $Y_{ijnt} = \alpha_i^2 + \tau_t^2 + \eta_{2n} + \lambda_{2nt} + X_{ijt}\beta^2 + \omega^2 LOST_{2t-1} + \delta^2 (LOST_{2t-1} * OPR_{t}) + \gamma^2 HI_{nt} + \psi^2 (HI_{nt} * OPR_{t}) + v_{ijnt}$

For each specification, the unit of observation is a single insurance contract purchased by producer $i$ from a crop insurance agent $j$. The policy is sold in county $n$ and covers the insured for crop year $t$. A producer may purchase multiple contracts in the same year by dividing their farm into separately insurable units. We design specification (1) to estimate the effects of an individual agent’s market power and specification (2) to capture effects of overall market competition for agent services.

\textsuperscript{25} Smith et al. (2016) calculate insurance company Herfindahl indices based on statewide gross premiums collected for crop year 2008. We find some differences between their measures of market concentration and ours, though both estimates show Iowa to be highly competitive relative to other states.
The term $Y_{ijnt}$ represents two dependent variables that measure the producer’s insurance choice: total premiums per acre and the total liability per acre. Premiums include both that which producers pay out-of-pocket and subsidies paid by the government. Both premiums and liability rise as producers elect more comprehensive insurance plans. Agents are compensated proportionally to total premiums, so the agents’ influence should be most apparent for this variable. Insured liability, though highly correlated with premiums, may capture other channels of agents’ influence not reflected in premiums. Liabilities also proxy for the agents’ risk exposure which can impact their commissions.

Despite modeling insurance decisions with respect to coverage level, we do not use coverage level as an explicit dependent variable. This is because a producer makes several decisions for each insurance unit that together, determine premiums and guaranteed liabilities. Two difference policy types with the same coverage level may differ in premium by tens of dollars per acre. Using coverage level as a single choice variable is the most tractable for modeling purposes but incomplete for empirically estimating the agent’s influence.

Insurance preferences may vary across producers which could be correlated with agent characteristics.\textsuperscript{26} Assuming these preferences vary by individual but not over time, we can correct for preference heterogeneity with producer fixed effects, represented by $\alpha_i$. We include $\tau_t$ and $\eta_n$ as fixed effects to control for unobservable geographic and temporal heterogeneity in insurance choices. We also include county-by-year interactions, denoted $\lambda_{nt}$, to capture local factors that vary with time such as weather and price shocks.\textsuperscript{27} Note that the variable $HI_{nt}$ is constant for all observations in the same county and year. To allow for variation in this variable, we substitute

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\textsuperscript{26} As an example, a producer who prefers high premium, high liability insurance may seek out an agent with large market share that is well established within the county.

\textsuperscript{27} County-by-year fixed effects are especially important in specifications where the dependent variable is premiums as USDA Risk Management Agency (RMA) sets premiums by county and year to reflect local risk conditions.
crop reporting district by year fixed for $\lambda_{nt}$ in specification (2). Producer fixed effects were found to be preferable to random effects per a Hausman test.

We control for observable factors specific to the producer, unit, and crop year that affect premiums and liabilities with the row vector $X_{ijt}$. These include the type of crop grown on the unit, the practice used (e.g. irrigated vs. non-irrigated), actual production history of yield (APH), and dummy variables denoted whether transitional yields are used in calculating the unit’s APH. In addition to observable characteristics, we attempt to capture how different types of producers choose insurance plans. We include in $X_{ijt}$ a dummy variable equal to one if the insured is deemed a producer-operators as opposed to a landlord in crop sharing arrangements.

The dummy variable $LOSS_{it-1}$ equals one if the producer received an indemnity on at least one contract during the previous year. Conditional on APH, this variable approximates the producer’s subjective risk of suffering a loss during the year insured. We choose lagged losses over temporal losses to proxy for risk because as the policy’s premiums and liabilities increase, the probability that the policy pays out an indemnity increases. Using current losses would invite endogeneity between our risk measure and dependent variables. We show in our model of producer behavior that farmers will increase coverage as their risk of loss increases. To test our assumption that opportunistic producers are better informed about their individual risk level which informs their crop insurance choices, we interact $LOSS_{it-1}$ with the opportunist dummy variable $OPRT_i$. Note that because we consider opportunism a producer characteristic that does not change with time and we control for all time-invariant producer traits, the variable $OPRT_i$ does not enter the

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28 Crop reporting districts group together several counties within the same state according to shared crop production attributes. USDA uses these districts for reporting purposes.
model by itself. We expect that opportunists are more sensitive to risk, meaning the coefficient $\delta$ should be positive and significant.

The variables of interest in specification (1) are $MS_{jt}$, the market share of the agent selling the policy in year $t$, and $MS_{jt} \times OPRT_i$, the interaction between market share and the opportunistic producer dummy. The variable $\gamma^1$ is the effect of the selling agent’s market share on passive, or non-opportunistic producers. The effect of market share on opportunistic producers is the sum of $\gamma^1$ and $\psi^1$ where $\psi^1$ is the differential effect. The important variables in specification (2) are $HI_{nt}$, the Herfindahl index measuring overall agent competition in market $n$ during crop year $t$, and $HI_{nt} \times OPRT_i$, the interaction between the Herfindahl index and the opportunistic indicator for producer $i$. The coefficients $\gamma^2$ and $\psi^2$ represent the effect of agent market concentration on passive and opportunistic producer insurance choice respectively.

Per our theoretical model, the effect of agent market power on passive producers is ambiguous depending on the overall risk level in the area and agent incentive structures within the state. If insurance companies care about policy risk and risk levels are such that increasing coverage negatively impacts the agent’s commission, then $\gamma^1$ and $\gamma^2$ should be negative. If production risk is low and companies are less sensitive to actuarial performance, the volume incentive will overpower the quality incentive and $\gamma^1$ and $\gamma^2$ will be positive. The adverse selection problem is most pronounced in opportunistic producers. Assuming agents can observe opportunistic traits in producers such as education, years in farming, and crop insurance sophistication, they will attempt to reduce their premiums and liabilities. We predict negative market power effects on opportunists so estimates of $\psi^1$ and $\psi^2$ should both be negative.
Results

Tables 2 and 3 display our main regression results.\textsuperscript{29} The dependent variable in Table 2 is total premiums paid per acre insured and the dependent variable in Table 3 is the total dollar amount of liability insured per acre. We estimate the effects of agent market share and agent market concentration separately for each state and report the estimates side-by-side. Coefficients on the agent market share variable are interpreted as the effect of going from no market power (a market share of zero) to selling all the policies in the county. For the market concentration variable, coefficients represent the effect of going from perfect competition (Herfindahl index equal to zero) to monopoly (Herfindahl index of one).\textsuperscript{30} The coefficients on the interactions between market share and market concentration show how market power affects opportunists differently than passive producers. Our data contains several observations with much larger premiums and liabilities than expected. Results were shown to be slightly sensitive to the inclusion of these observations. As such, we drop outliers from our estimations.\textsuperscript{31}

Table 2 shows that agent market share has a positive and statistically significant impact on passive producers in Iowa. There, the estimated coefficient of 3.6 means that a 10-percentage point increase in an agent’s market share (e.g. going from 10 percent of the market to 20 percent) will increase the premiums they collect by an average of $0.36 per acre. The effect of the same increase in market share on opportunists nets out to a decrease of $0.31 per acre. Translated to elasticities, these estimates indicate that a one percent increase in agent market share increases the total

\textsuperscript{29} We use district-by-year fixed effects for all Oklahoma specifications, including those with agent market share as the variable of interest due to a large number of counties observed in that state’s dataset.

\textsuperscript{30} It should be noted that it is not possible to observe a value of zero for either agent market share or agent market concentration. Instead, a zero value serves as a theoretical indication of perfect competition where competition is increasing as both measures approach zero.

\textsuperscript{31} We define outliers using the interquartile range rule. Premiums and liabilities per acre below $p(25)-1.5*IQR$ or above $p(75)+1.5*IQR$ are excluded where $p(25)$ and $p(75)$ are the 25\textsuperscript{th} and 75\textsuperscript{th} percentiles respectively.
premiums of passive producers by 0.03 percent and decreases premiums of opportunistic producers by 0.02 percent.

Though small, these effects may be more meaningful in the context of the total premium paid to insure a farm. Calculated at the mean, a typical farm operation in Iowa insures a total of 403 acres. Our estimated effects suggest that going from a market share of zero to dominating the market would raise the total premium an agent collects from an Iowa farm by $1,451, a 45 percent increase. The same change in market share would cause the agent to reduce an opportunistic producers total farm premium by $1,261, or 55 percent.\(^{32}\)

Estimates from Washington indicate that an agent’s market share reduces premiums for both passive and opportunistic producers. An increase of one percent in the selling agent’s market share cuts premiums per acre by 0.06 percent for passive producers and by 0.08 percent for opportunists. Though point estimates from Washington appear smaller in magnitude, they are actually larger than those found in Iowa in terms of elasticities.

We find that market share in Oklahoma is positively associated with the premiums of opportunistic producers, contradicting our model prediction that agents with market power seek to reduce the coverage taken on by opportunists. Though statistically insignificant, agent market share effects on passive and opportunistic producers are positive and negative respectively in both Nebraska and Montana.

Competition among agents also impacts the premium choices of producers. Again, Iowa displays the clearest relationship between agent market power and producer choices. Estimates suggest that one percent increase in the concentration of agents raises premiums by 0.06 percent

\(^{32}\) The average acres insured per farm of 402.92 acres is the product of the average number of units insured by a producer per year (4.77) and the average size of each unit (84.47 acres). The percent changes in total premiums are calculated by dividing the change in farm premiums by average farm premiums for each producer type.
for passive producers and reduces premiums by 0.06 percent for opportunists. We find evidence that Montana agents reduce the premiums of opportunistic producers when competition is low. We see that competition for agent services in Washington negatively impacts premiums for all producers with the effect on opportunists being larger in magnitude. The difference in premiums per acre between perfect competition and monopoly is estimated at -$2.08 per acre and -$8.75 per acre for non-opportunists and opportunists respectively.

We estimate the relationship between agent market power and producer liability insured in Table 3. As in the case of premiums per acre, agent effects on liabilities are most pronounced in Iowa. Our estimates indicate that on average, a monopolistic agent sells policies carrying $34.25 more in guaranteed liability per acre than an agent with no market share. This effect nets out to -$10.38 for opportunistic producers. Coefficients from the agent market concentration model confirm these estimates. A one percent increase in the agent Herfindahl index raises liability insured by 0.03 percent for passive types and reduces liabilities by 0.01 percent for opportunistic types.

Nebraska estimates indicate a negative effect of agent market share on insured liability for opportunistic farmers while overall market concentration appears to have a large and significant effect for all producers. Our model suggests a market concentration elasticity of 0.1 percent – the largest found of the five states. Nebraska opportunists do not differ statistically in their response to agent competition. For a typical Nebraska farming operation, the effect of moving from perfect competition to monopoly in agent services more than doubles the insured liability of the operation.

We again find a positive effect of agent market share on opportunistic producers in Oklahoma, though the magnitude of the effect is small. Conversely, agent market concentration appears to depress insured liabilities in Oklahoma. The negative effect is larger for opportunists
than for passive producers, but effect sizes are small in both cases. A one percent increase in the concentration of insurance agents in Montana leads to a 0.03 percent decline in liability insured by opportunistic farmers. While meaningful, the coefficient is only significant at the 10 percent level. Liabilities insured in Washington are negatively impacted by agent market share.

Overall, the results presented in Tables 2 and 3 demonstrate that agents play a role in the insurance decisions of producers, though effects tend to be small in magnitude and vary across states. Our theoretical model predicts that, due to adverse selection, agent market power should have the effect of reducing coverage elected by opportunistic producers. Estimated effects of market power on opportunistic producers tend to confirm this hypothesis. Of the 20 market power effects on opportunists estimated in Tables 2 and 3, 17 are negative and 10 are negative and statistically significant. The differential effects on opportunists are especially clear in Iowa. The theory that agents make different recommendations to different producer types rests on the assumption that agents can identify which type a producer is upon meeting. It may be the case that in Iowa, opportunists are more easily identifiable or exhibit traits that agents perceive as opportunistic while passive and opportunistic producers are less distinguishable in other states.

Opportunistic producers generate excessive returns from insurance over time. These gains have spillover effects on taxpayers because of the way insurance companies use the reinsurance markets. Babcock and Hart (2006) show that in good years, companies retain a large portion of underwriting gains but transfer the majority of underwriting losses to the government in bad years. Agent market power appears to have the positive side-effect of limiting opportunistic behavior by reducing the risk exposure these producers pose to taxpayers. In this way, monopoly power among agents may help alleviate some of the problems associated with adverse selection in federal crop insurance. To the extent that market power raises the coverage of low-risk producers, the adverse
selection problem is made worse by increasing premium costs for those least likely to enter the insurance pool, further discouraging them from entering.

For passive producers, the predicted effect is ambiguous depending on two factors: the overall risk level in the area and how actuarial performance affects agent compensation. If insurance companies reward agents based on expected underwriting gains, the risk-level in the county must be sufficiently low to entice agents into selling high coverage policies. Conversely, if companies only care about maximizing premiums, agents will sell high coverage policies without regard for loss risk.

Estimates for Iowa lend support to the former. Iowa agents with market power increase both the policy premium and liability sold to non-opportunistic producers. We find the opposite to be true in Washington where agent market power appears to lower policy premiums. Results from Nebraska, Oklahoma, and Montana are mixed or inconclusive. Examining the actuarial performances of crop insurance policies in each state may help explain the observed differences.

In Table 1, we see that Iowa and Washington have the lowest loss risk and indemnities per acre of the five states. Additionally, variability in losses and indemnities are low relative to other states. Results for Iowa conform to our hypothesis that in a low risk environment, agents with market power recommend high coverage policies if the producer is not an opportunistic type. In Washington, we find the opposite. Both agent market share and market concentration are correlated with lower total premiums per acre for passive producers. Washington appears much less risky than Nebraska, Oklahoma, and Montana and yet, agent effects are not clearly negative in those states. Nebraska reports the largest positive response in insured liabilities to agent competition. If risk plays a key role in agent commission rates, we should see negative effects emerge in the Plains states that are at least as negative as those found in Washington.
The lack of significant negative results in these states may be attributable to differences in compensation structures between insurance companies operating in those states. Approved insurance providers (AIPs) doing business in Washington may be more sensitive to potential underwriting losses and pay commissions that reflect this. If the rewards for policies that produce underwriting gains are sufficiently large, agents will exercise market power by selling safe, low coverage policies even if the actual risk of loss is low. Because we do not observe commission rates in our data, we cannot know how the relationships between commission rates and actuarial risk compare across states.

We can however, proxy for exogenous variations in commission rates. Smith et al. (2016) examine the factors that influence agent compensation. They show that greater concentration of AIPs leads to lower commission rates paid to agents in a way consistent with classical monopsony power theory. They also find that the commission rates a company pays are improved when the company expects to achieve underwriting gains. Expected underwriting gains (EUG) are defined as the expected difference between total premiums collected and indemnities paid for losses, expressed as a percentage of total premiums. The finding that EUG improve commissions supports the theory that companies reward agents for low-risk policies.\(^{33}\)

We calculate the state-wide insurance company Herfindahl index and expected underwriting gains (EUG) for each insurance company in our dataset as proxies for commission rates. As described in the data section, we compute the company Herfindahl index as the sum of squared market shares of each authorized insurance provider (AIP) observed.\(^{34}\) We calculate EUG

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\(^{33}\) Prior to changes to the Standard Reinsurance Agreement (SRA) in 2010, insurance companies offered bonuses to agents if their policies contributed to underwriting gains (Smith et al., 2016).

\(^{34}\) Company market share is the sum of all policies the company acquires in the state during a year divided by the total number of policies sold in the state the same year where a policy is defined as all individual unit contracts purchased by a producer in a single year.
as total premiums collected by the insurance company during the previous year less all indemnities paid out the same year, divided by lagged total premiums. We follow Smith et al. (2016) in lagging underwriting gains to reflect the company’s most recent information and to eliminate endogeneity with individual contract premiums. We compute EUG at the state level as company underwriting gains, and thus agent commissions, are determined at that level of aggregation.

The insurance company Herfindahl index and EUG variables proxy for exogeneous shifts in agent commission rates, holding the quality of the policy constant. In other words, these variables increase the agent’s expected profit for all levels of risk, which should intensify the volume incentive for agents. Only agents with market power however, may on this incentive. An increase in commission rates overall will cause high market power agents to sell higher premium policies because loss risk will have a smaller impact on their compensation. To test how commission rate variation changes the behavior of agents, we interact our agent market share variable with both the insurance company Herfindahl index and expected underwriting gains (EUG).

Table 4 reports the effect of agent commission proxy variables on total premiums per acre. We limit the estimation to agent market share and premiums as these most directly measure an individual agent’s profit incentive. Insurance company Herfindahl index is dropped from the regression due to perfect collinearity with year fixed effects. What is important is the interactions between insurance company market concentration, company EUG, and agent market share. The estimated coefficients tell us how agents with high market share respond to exogenous increases in commission rates.

Smith et al. (2016) use a historical average of underwriting gains over multiple years to calculate each company’s expectation of future underwriting gains. As we do not have access to company historical data, we are left to use the previous year’s performance.
Again, Iowa and Washington produce the clearest results of the five states. By evaluating the market share effect at the minimum and maximum values of our proxy variables, we can compare the effect of agent market power in low and high commission environments. A one percent increase in agent market share reduces premiums by 0.05 percent at the minimum estimated commission rate and increases premiums by 0.01 percent at the maximum estimated commission rate. For Washington, a percent increase in agent market share in a low commission environment reduces premiums by 0.31 percent and increases premiums by 0.03 percent in a high commission environment.

As insurance companies gain market power over agents, they can be more selective in the books of business they accept from agents. High market concentration of insurance companies emphasizes the quality incentive. If an insurance company expects to earn underwriting gains in the upcoming crop year, agents working with that company and that have high market share will endeavor to sell high premium policies. The extent to which an agent can take advantage of high commissions is limited by his/her market power. In other words, how agent market share affects premiums depends on prevailing commission rates in the state. High commissions strengthen the volume incentive, causing agents to exercise market power by increasing premiums while low commissions environments favor the quality incentive where agent market power leads to lower premiums.

Consistent with our main results, commission effects are not detectible in Nebraska or Oklahoma. Montana shows a negative impact of the interaction of company EUG and agent market share on premiums, suggesting that in Montana, an increase in commission rates may cause powerful agents to sell lower coverage plans. Stated differently, as commission rates fall, agents
with high market share attempt to sell higher premium plans to maintain total compensation.\textsuperscript{36} Our proxy variables for agent commissions are imperfect, however. Better instruments for commission rates would allow us to accurately estimate the effects of commission rate variation on agent selling behavior.

**Robustness Checks**

A possible source of endogeneity in our main results relates to changes in producer preferences over time. Producer fixed effects control for time invariant insurance preferences but as producers gain experience in the crop insurance program, their preferences for different policy types and coverage levels may change. Our estimated effects will be biased if these producer specific trends coincide with characteristics of selling agents. As a producer increases their crop insurance expertise, they may be drawn to more sophisticated crop insurance products that carry higher premiums and liabilities. Expert producers may seek out well established insurance agents with large market shares. In this example, the estimated effect of the agent’s market share on premiums and liabilities chosen by the producer will be the result of reverse causality.

Note that this potential source of bias affects the agent market share variable but not the overall concentration of agents in a market, i.e. the agent Herfindahl index. This is because market concentration characterizes an entire county during a year and not a specific agent that a producer can seek out. We consider the agent Herfindahl index to be exogenous to producer preferences.

To address the potential endogeneity of agent market share, we identify when a producer purchases a policy from an agent for the first time and when they are a return customer. We create a dummy variable equal to one if the producer has purchased a policy from the agent before and

\textsuperscript{36} Recall that an agent’s revenue from selling an insurance policy is the product of the commission rate per dollar of premium and the total premium collected on the policy.
introduce this as an explanatory variable. We also interact the return customer dummy with agent market share variable to test if the agent market share effect remains after the first meeting between producer and agent. If the effects we observe in Tables 2 and 3 are driven by producers with high coverage preferences seeking out high market share agents, the effect of agent market share after the first encounter should net out to zero. Anecdotally, we know that producers often establish a relationship with their agent and work with them over multiple years. Once a relationship is established and the producer is no longer seeking out agents that match their changing insurance preferences, any variation in that agent’s market share will be exogenous to the producer’s preferences.

For the correlation between an agent’s market share and insurance choices to be considered causal, the coefficient on the interaction of agent market share and the return customer dummy will be insignificantly different from the un-interacted market share coefficient. We report the estimated effect of agent market share on premiums and liabilities for first time purchases and renewals in Table 5. We ignore differential effects for opportunistic producers and only consider general effects on all producer types for simplicity.

We can confirm in three out of five states (Iowa, Nebraska, and Washington) that the effect of the selling agent’s market share on policy coverage is not exclusive to the first encounter between producers and agents. Not only does the market share effect persist in Iowa after the first purchase, it strengthens in magnitude for both total premiums and liabilities. In fact, the effect is only significant in Nebraska when producers work with the same agent more than once. In Washington, effect sizes are attenuated when the producer renews with an agent but the net effect is still statistically different from zero. The model picks up a small agent effect in Montana at $0.62 per acre for the first encounter and there is no statistical difference in agent effects thereafter.
As far as the first encounter represents a biased estimate of the market share effect and repeat encounters represent the true causal effect, then our results for Washington in Tables 2 and 3 may be biased downward by around 40 percent while estimates for Iowa and Nebraska could be underreported. We can also conclude that agents exercise their market share more after establishing a relationship with a producer in Iowa and Nebraska. The coefficient on the un-interacted repeat customer dummy is negative in all 10 specifications and statistically significant in six. This suggests that when a producer renews with an agent whose market share is near zero and vulnerable to competition from other agents, the producer purchases less coverage. Our model sheds some light on this result. In first encounter scenarios, the agent has little information about the producer. We know anecdotally that when a new client comes to an agent, they can observe their historical APH but little more. The agent can’t know how often they receive an indemnity, what types of policies they prefer, or how much they insure on average. These information asymmetries break down as the agent works with a producer over time which may lead the agent to use their market power to influence the producer’s insurance decisions.

We define several thresholds for defining variables and our results may be sensitive to changes in those thresholds. The first is the cutoff for the percentage of policies in a county reporting the selling agent. We establish a threshold where 90 percent of contracts in the county must list an agent to be included in regressions. This requirement excluded a large number of observations. To test the sensitivity of our results to this threshold, we lower this cutoff to 70 and 80 percent and re-estimate the models in Tables 2 and 3. We observe some variation in point estimates across the three thresholds, but results are generally robust. Estimates for Iowa and Washington strengthen slightly as the threshold becomes more stringent, suggesting that estimates are improved as data become more reliable.
We also test the sensitivity of our results to changes in the definition of opportunistic producers. Originally, we classify opportunists as those with returns to insurance (indemnities received less premiums paid out-of-pocket per acre) over all years observed in the 75th percentile for their county. We re-run our regressions defining opportunists as those in the 70th, 80th, and 90th percentile for their counties. Our results are robust to changes in the opportunist threshold. In most cases where significant differential effects are found between passive and opportunistic producers, those effects become larger in magnitude as the threshold for defining opportunists increases, suggesting that as opportunism rises, so too do agents attempt to influence them.

Lastly, we change the definition of an insurance market from a county to a crop reporting district (groups of neighboring counties that share similar agricultural traits) and the state as a whole. We calculate agent market shares and agent Herfindahl indices accordingly and re-estimate our main regressions. Generally, results are similar across the three market aggregation techniques though effect sizes appear smaller for models defining the entire state as an insurance agent market.

**Conclusions**

Federal crop insurance is delivered through a partnership between the federal government and private crop insurance companies. This relationship is governed by the Standard Reinsurance Agreement entered into by each party which stipulates the “rules of the game.” Crop insurance agents sell policies directly to producers, then transfer the policies onto the books of insurance companies. Companies pay the agent a percentage of the total premium transferred but also reward agents for policies with low risk of loss the help the company achieve actuarial gains (difference between premiums taken in and losses paid out). Crop insurance agents balance two incentives:
maximizing total premiums (volume incentive) and contributing to actuarial gains for the company (quality incentive). We explore how agents use market power to pursue these incentives.

Much of the crop insurance literature addresses issues related to producer choice without considering the role played by the selling agent. Studies generally find evidence for adverse selection and moral hazard in crop insurance, but little is known about the influence of agents on the insurance choices of producers. Recent works focus on the supply side of the crop insurance program and the effects of market power possessed by insurance companies but do not examine market power on the part of selling agents. We address this gap by estimating the relationship between producer coverage choice and crop insurance agent market power. Agents may attempt to influence the types and coverage levels chosen by farmers to maximize their own compensation. The extent to which they can exercise this influence may depend on the market competition for agent services.

We model the interaction between a representative crop insurance agent and producers of different types in a game theoretic framework. Using a comprehensive, producer level dataset covering over 400,000 individual insurance contracts in five states, we test the impact of agent market power on passive and opportunistic producers. Passive producers are less informed about their individual risk of loss. Opportunists possess some private information which informs their insurance choices, and pose a much greater adverse selection problem than passive producers. We find evidence that agent market power may increase or decrease the premiums and liabilities of passive producers depending on location and agent compensation regime.

We find evidence of rent seeking-seeking by crop insurance agents with market power. Results indicate that a one percent increase in agent market concentration, as measured by a Herfindahl index, in Iowa leads to a 0.06 percent increase in premiums paid by passive producers.
and 0.06 percent decrease in the premiums paid by opportunistic producers. In Washington, a one percent increase in the concentration of agent services reduces premiums for passive and opportunistic producers by 0.1 percent and 0.2 percent respectively. Estimates for the effect of individual agent market shares are similar. While these two states are similar in actuarial risk, they may differ in how risk affects the commission rates paid by insurance companies.

Agent market power reduces the coverage taken on by opportunistic producers, in most cases. If agents can detect opportunistic traits in producers, e.g. superior crop insurance knowledge, growing practices, education level, etc., they use market power to push these producers toward lower coverage policies. Lower coverage reduces the risk exposure to the insurance company which the company may reward with higher commission rates. As opportunists achieve excessive returns from insurance, our results imply that high market concentration of insurance agents can help alleviate the problems associated with adverse selection in federal crop insurance.

Our results indicate that crop insurance agent market power can, under certain conditions, improve the performance of the federal crop insurance program. The required conditions involve crop insurance companies rewarding agents for policies that generate underwriting gains with high commission rates (the percent of premium paid to the selling agent). The 2010 Standard Reinsurance Agreement (SRA) capped commission rates at 100 percent of a company’s Administrative and Operating (A&O) subsidy if the company achieves underwriting gains for the crop year. Companies that suffer underwriting losses can pay up to 80 percent of A&O subsidies to agents. These caps were in response to excessive agent commission payments that are partially subsidized by the government.

To the extent that agent market power coincides with commissions that reflect actuarial performance, high market concentration of agents may be good for the taxpayers who subsidize
the program. Where agent commissions do not reflect actuarial performance, or when what we call the “quality incentive” for agents is absent, market power could hurt taxpayers by raising premiums. For example, while agent commission rates grew only slightly throughout the 2000s, total commissions payments per policy more than tripled from 2001 to 2008 due to higher premiums collected (Babcock, 2009). Policymakers could modify the SRA to tie commission rates directly to policy loss ratios (claims paid relative to premiums collected). Total commissions could also be capped on a dollar per acre insured basis to prevent agents from over-insuring producers.
References


Figure 1. Opportunistic Producer-Agent Signaling Game

Figure 2. Passive Producer-Agent Game

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Table 2. The Influence of Selling Agent Market Power on Crop Insurance Premiums.

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<td>-0.49</td>
<td>0.07</td>
<td>-11.40***</td>
<td>-6.67**</td>
</tr>
<tr>
<td></td>
<td>(3.29)</td>
<td>(3.43)</td>
<td>(1.84)</td>
<td>(3.00)</td>
<td>(2.72)</td>
</tr>
</tbody>
</table>

Policy characteristics                   | Yes        | Yes        | Yes       | Yes       | Yes        |
Producer Fixed Effects                   | Yes        | Yes        | Yes       | Yes       | Yes        |
County Fixed Effects                     | Yes        | Yes        | Yes       | Yes       | Yes        |
Year Fixed Effects                       | Yes        | Yes        | Yes       | Yes       | Yes        |
County by year Fixed Effects             | Yes        | Yes        | Yes       | Yes       | Yes        |

Observations                             | 185,871    | 190,430    | 33,530    | 34,956    | 60,778     |
Producers                                | 23,939     | 24,157     | 3,146     | 3,282     | 13,895     |
Within panel R-squared                   | 0.44       | 0.43       | 0.34      | 0.33      | 0.33       |

Notes: *** p<0.01, ** p<0.05, * p<0.1. Errors corrected for clustering at the producer level in parentheses. a Due to a large number of counties observed in Oklahoma, county by year fixed effects were replaced with crop reporting district by year fixed effects for that state. The agent market concentration variable is the same for all observations within the same county-year so district by year fixed effects are used instead in regressions (2), (4), (6), (8), and (10).
Table 3. The Influence of Selling Agent Market Power on Crop Insurance Liabilities.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Iowa (1)</th>
<th>Nebraska (2)</th>
<th>Oklahoma (3)</th>
<th>Montana (4)</th>
<th>Washington (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss lag</td>
<td>-1.25*</td>
<td>-1.44**</td>
<td>-0.33</td>
<td>-0.63</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.68)</td>
<td>(0.68)</td>
<td>(0.56)</td>
<td>(0.65)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>Loss lag * Opportunist</td>
<td>0.77</td>
<td>0.09</td>
<td>1.30</td>
<td>-2.36</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(1.39)</td>
<td>(1.29)</td>
<td>(2.29)</td>
<td>(1.49)</td>
<td>(1.43)</td>
</tr>
<tr>
<td>Agent market share</td>
<td>34.25***</td>
<td>3.56</td>
<td>-2.09</td>
<td>3.63*</td>
<td>11.21***</td>
</tr>
<tr>
<td></td>
<td>(7.44)</td>
<td>(4.44)</td>
<td>(1.74)</td>
<td>(2.12)</td>
<td>(2.90)</td>
</tr>
<tr>
<td>Agent market share * Opportunist</td>
<td>-44.63***</td>
<td>11.57*</td>
<td>9.14**</td>
<td>-5.67</td>
<td>-8.62</td>
</tr>
<tr>
<td></td>
<td>(16.69)</td>
<td>(4.44)</td>
<td>(2.12)</td>
<td>(2.90)</td>
<td>(2.90)</td>
</tr>
<tr>
<td>Agent Herfindahl</td>
<td>86.72***</td>
<td>201.33***</td>
<td>-6.88*</td>
<td>1.21</td>
<td>-3.97</td>
</tr>
<tr>
<td></td>
<td>(21.73)</td>
<td>(42.30)</td>
<td>(3.91)</td>
<td>(15.55)</td>
<td>(11.74)</td>
</tr>
<tr>
<td>Agent Herfindahl * Opportunist</td>
<td>-113.92***</td>
<td>-5.11</td>
<td>16.79*</td>
<td>24.88*</td>
<td>-64.38</td>
</tr>
<tr>
<td></td>
<td>(41.37)</td>
<td>(20.26)</td>
<td>(10.05)</td>
<td>(13.63)</td>
<td>(39.52)</td>
</tr>
<tr>
<td>Policy characteristics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Producer Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County by year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>185,871</td>
<td>190,430</td>
<td>33,530</td>
<td>60,778</td>
<td>40,576</td>
</tr>
<tr>
<td>Producers</td>
<td>23,939</td>
<td>24,157</td>
<td>3,146</td>
<td>13,895</td>
<td>3,916</td>
</tr>
<tr>
<td>Within panel R-squared</td>
<td>0.42</td>
<td>0.41</td>
<td>0.61</td>
<td>0.41</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Notes: *** p<0.01, ** p<0.05, * p<0.1. Errors corrected for clustering at the producer level in parentheses. a Due to a large number of counties observed in Oklahoma, county by year fixed effects were replaced with crop reporting district by year fixed effects for that state. The agent market concentration variable is the same for all observations within the same county-year so district by year fixed effects are used in regressions (2), (4), (6), (8), and (10).
### Table 4. The Effect of Changes in Agent Compensation on Insurance Policy Premiums.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Iowa (1)</th>
<th>Nebraska (2)</th>
<th>Oklahoma (3)</th>
<th>Montana (4)</th>
<th>Washington (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent market share</td>
<td>1.98</td>
<td>2.83</td>
<td>-17.48</td>
<td>-2.95</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>(1.31)</td>
<td>(5.50)</td>
<td>(11.43)</td>
<td>(3.83)</td>
<td>(0.82)</td>
</tr>
<tr>
<td>Agent market share * Company Herfindahl</td>
<td>-28.54**</td>
<td>-7.97</td>
<td>81.53</td>
<td>22.02</td>
<td>-11.53***</td>
</tr>
<tr>
<td></td>
<td>(12.65)</td>
<td>(20.12)</td>
<td>(52.73)</td>
<td>(21.89)</td>
<td>(3.53)</td>
</tr>
<tr>
<td>Company EUG</td>
<td>-0.05</td>
<td>0.01</td>
<td>0.08</td>
<td>0.03</td>
<td>-0.13</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.14)</td>
<td>(0.17)</td>
<td>(0.06)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Agent market share * Company EUG</td>
<td>4.16***</td>
<td>-0.24</td>
<td>0.00</td>
<td>-1.52***</td>
<td>1.74***</td>
</tr>
<tr>
<td></td>
<td>(1.00)</td>
<td>(1.36)</td>
<td>(0.42)</td>
<td>(0.28)</td>
<td>(0.44)</td>
</tr>
<tr>
<td>Insurance policy controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Producer Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County by year Fixed Effectsa</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>182,615</td>
<td>33,378</td>
<td>59,205</td>
<td>40,379</td>
<td>58,102</td>
</tr>
<tr>
<td>Producers</td>
<td>23,747</td>
<td>3,145</td>
<td>13,578</td>
<td>3,901</td>
<td>7,307</td>
</tr>
<tr>
<td>Within panel R-squared</td>
<td>0.44</td>
<td>0.34</td>
<td>0.33</td>
<td>0.20</td>
<td>0.17</td>
</tr>
</tbody>
</table>

**Notes:** ***p<0.01, **p<0.05, * p<0.1. Errors corrected for clustering at the producer level in parentheses. a Due to a large number of counties observed in Oklahoma, county by year fixed effects were replaced with crop reporting district by year fixed effects for that state. The number of observations is lower than regressions in Tables 2 and 3 due to missing values for EUG.
Table 5. The Influence of Selling Agent Market Power on Crop Insurance Liabilities.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Iowa</th>
<th>Nebraska</th>
<th>Oklahoma</th>
<th>Montana</th>
<th>Washington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium</td>
<td>2.07***</td>
<td>-0.75</td>
<td>0.41</td>
<td>0.62*</td>
<td>-1.65***</td>
</tr>
<tr>
<td>Liability</td>
<td>20.06***</td>
<td>-8.15</td>
<td>0.93</td>
<td>3.21</td>
<td>-15.21***</td>
</tr>
<tr>
<td>Agent market share</td>
<td>(0.63)</td>
<td>(0.74)</td>
<td>(0.37)</td>
<td>(0.34)</td>
<td>(0.25)</td>
</tr>
<tr>
<td>Premium</td>
<td></td>
<td>(7.43)</td>
<td>(1.65)</td>
<td>(2.09)</td>
<td>(3.24)</td>
</tr>
<tr>
<td>Liability</td>
<td></td>
<td>(5.54)</td>
<td>(0.74)</td>
<td>(0.37)</td>
<td></td>
</tr>
<tr>
<td>Repeat customer</td>
<td>-0.25***</td>
<td>-0.28***</td>
<td>-0.12</td>
<td>-0.06</td>
<td>-0.07**</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.08)</td>
<td>(0.10)</td>
<td>(0.05)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Agent market share * Repeat</td>
<td>1.31***</td>
<td>2.12***</td>
<td>0.02</td>
<td>-0.47</td>
<td>0.72***</td>
</tr>
<tr>
<td></td>
<td>(0.37)</td>
<td>(0.78)</td>
<td>(0.33)</td>
<td>(0.45)</td>
<td>(0.22)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.17)</td>
<td>(1.55)</td>
<td>(1.98)</td>
<td>(2.92)</td>
</tr>
<tr>
<td>Policy characteristics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Producer Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County by year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>185,871</td>
<td>33,530</td>
<td>60,778</td>
<td>40,576</td>
<td>61,919</td>
</tr>
<tr>
<td>Producers</td>
<td>23,939</td>
<td>3,146</td>
<td>13,895</td>
<td>3,916</td>
<td>7,355</td>
</tr>
<tr>
<td>Within panel R-squared</td>
<td>0.44</td>
<td>0.34</td>
<td>0.33</td>
<td>0.19</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>0.42</td>
<td>0.61</td>
<td>0.41</td>
<td>0.59</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Notes: *** p<0.01, ** p<0.05, * p<0.1. Errors corrected for clustering at the producer level in parentheses. a Repeat customer is a dummy variable equal to one if the producer has purchased at least one policy from the agent in the past. b Due to a large number of counties observed in Oklahoma, county by year fixed effects were replaced with crop reporting district by year fixed effects for that state.
Appendix A. Producer Insurance Decision Problem

A risk neutral representative producer decides whether and how much insurance to buy per acre according to the following optimization problem:

$$\max_{\mu} \mathbb{E}[U_i(\mu)] = \mathbb{E}[I(\mu_i, \theta, \bar{y}_i, y_i; F(y)) - (1 - s(\mu_i))\rho(\mu_i, \theta, \bar{y}; G(y))]$$

The variable $I(\cdot)$ represents indemnities paid out by the insurance policy in the event of a loss which depends on the amount of coverage $\mu_i$, the guaranteed price $\theta$, historical average yield $\bar{y}$, and realized yield $y_i$. The producer pays a per acre premium $\rho$ net of government subsidies $s$. Both premiums and subsidy rates depend on the choice of coverage with high coverage policies carrying higher premiums and lower subsidy rates, i.e. $\rho_{\mu_i} > 0$ and $s'(\mu_i) < 0$.

Assuming total premiums $\rho$ are set equal to expected indemnities within a region and formally expressing the expected indemnity function, the above equation can be written as:

$$\max_{\mu} \int_{\mu\bar{y}_i}^{\mu_i\bar{y}_i} \theta(\mu_i\bar{y}_i - y_i)dF(y) - (1 - s(\mu_i))\int_{0}^{\mu_i\bar{y}_i} \theta(\mu_i\bar{y}_i - y_i)dG(y)$$

Indemnities are triggered when yields fall below the guaranteed threshold $\mu_i\bar{y}_i$ and increase as yields fall further below the guarantee. The producer’s expectation of indemnities is based on his/her individual distribution of crop yields $F(y)$ while premiums are set using the distribution of yields across all producers in an area $G(y)$.

Differentiating with respect to $\mu_i$ and applying Leibniz Rule generates the first order condition:\[37\]

\[37\] Note that the derivates of $F(\mu\bar{y})$ and $G(\mu\bar{y})$ with respect to $\mu$ drop out of the first order condition. This is because yield per acre $y$ is a continuous variable and the probability of realizing any one specific value is zero. Therefore, $f(\mu\bar{y}) = g(\mu\bar{y}) = 0$. 

55
Solving the above equation for $\mu_i$ generates the following expression for the producer’s optimal choice of coverage level.

$$\mu^*_i = \Gamma(\bar{y}_i, s(\mu_i); F(y), G(y)) = \left(1 - s(\mu^*_i)\right) - \frac{F(\mu^*_i \bar{y}_i)}{F'(\mu^*_i)G(\mu^*_i \bar{y}_i)} + \frac{\int_0^{\mu^*_i g} y_i dG(y)}{\bar{y}_i G(\mu^*_i \bar{y}_i)}$$

We see that the producer’s optimal choice of coverage is a function of their historical yield, their distribution of yields relative to the distribution of yields in the overall region, and the subsidy rate schedule. To ensure a non-negative optimal coverage level, $\mu^*_i$, the following condition must hold:

$$F(\mu^*_i \bar{y}_i) \geq \left(1 - s(\mu^*_i)\right)G(\mu^*_i \bar{y}_i) + \frac{s'(\mu^*_i) \int_0^{\mu^*_i g} y_i dG(y)}{\bar{y}_i}$$

The above states that the farmer’s subjective probability of suffering a loss large enough to trigger an indemnity payment must exceed a certain threshold. This can be thought of as a participation constraint where producers only enter the insurance pool if the expected returns outweigh the actuarial cost.

From the first order condition, we generate comparative statics showing how the producer’s optimal insurance coverage changes with various parameters. We use the implicit function theorem to produce the following relationships:

i. Increasing government subsidy rates unambiguously increases the producer’s optimal choice of coverage.

$$\frac{\partial \Gamma(\cdot)}{\partial s(\mu^*_i)} = -\frac{1}{2s'(\mu^*_i)} > 0$$

ii. An increase in the producer’s subjective risk of loss increases their optimal choice of coverage level, holding the risk of loss across all producers in the area constant.
\[
\frac{\partial \Gamma(\cdot)}{\partial F(\mu_i^* \bar{y}_i)} = \frac{-1}{2s'(\mu_i^*)G(\mu_i^* \bar{y}_i)} > 0
\]

iii. If the risk level across all producers in the area rises relative to that of the individual producer, his/her optimal coverage level falls.

\[
\frac{\partial \Gamma(\cdot)}{\partial G(\mu_i^* \bar{y}_i)} = \frac{(1 - s(\mu_i^*)) - \mu_i^* s'(\mu_i^*)}{2s'(\mu_i^*)G(\mu_i^* \bar{y}_i)} < 0
\]

Taken together, the above conditions constitute the definition of adverse selection. Producers whose risk levels exceed that of the rate setting area are more likely to enter the insurance pool and take on greater coverage while low risk producers insure less or choose not to enter the pool at all.

Each producer \( i \) within a given rate-setting area (typically a county) will have his/her own optimal insurance coverage level \( \mu_i^* \) based on their individual risk of loss relative to the county. Producers however, may not know this value. The above coverage decision and the comparative statics that follow from it assume a fully informed producer who knows their exact distribution of yields \( F(y) \) and how it compares to the distribution of yields across all producers in the area \( G(y) \). This may be too strong an assumption. Instead we consider the possibility that producers vary in knowledge of their subjective risk level.

We explore this further in later sections but first, we model the agents selling problem.
Appendix B. Insurance Agent Selling Problem

Insurance agents generate profit by selling policies to producers then re-selling those policies to insurance companies. Companies pay agents a commission equal to the commission rate, a percentage of the total premium, times the total premium transferred. Currently, the commission rate cannot exceed a cap set out by the Standard Reinsurance Agreement (SRA). Different policy types carry different commission caps. For instance, commissions for revenue policies, which insure against both price and production risk, are capped at 18.5 percent of premium vs. 21.9 percent for traditional yield-only polices. Commission limits also vary geographically. Agents in Corn Belt states enjoy lower maximum compensation rates that do agents in other regions. Prior to 2011 however, commissions were not capped, and agents could negotiate any commission rate with insurance companies.

After changes to the SRA in 2011, whether an agent receives the maximum available commission depends on whether underwriting gains or losses are sustained by the purchasing insurance company for the crop year.\footnote{An underwriting gain is achieved when total premiums collected by the insurance company in a state exceed all indemnities paid out in the same state.} Positive underwriting gains on the agent’s book of business (the portfolio of insurance policies they transfer to an insurance company) may increase the maximum allowable compensation rate if those gains contribute to the company’s overall actuarial performance. Underwriting losses on the agent’s book of business may reduce the cap and the agent’s commission will suffer. We define underwriting gains associated with a given policy as the difference between premium per acre collected, \(\rho\), and indemnities paid per acre, \(I\). A difference greater than (less than) zero indicates positive (negative) underwriting gains to the insurance company purchasing the policy from the agent.
An important detail of the crop insurance market is that agents are forbidden from turning down a sale by law. Agents may attempt to influence producers by encouraging them to take on more coverage or less coverage than is optimal. In doing so, agents may increase their total compensation, extracting rents from the crop insurance program. Note that rent-seeking is only possible if producers cannot perfectly calculate their true optimal coverage level $\mu_i^*$ as detailed in the previous section. Producers who can make this calculation can at any time demand a policy carrying this exact optimal coverage level, regardless of the agent’s efforts to influence their selection. We now consider the objective function of selling agents.

A representative agent $j$ chooses a coverage level to sell to the producer $\mu_j$ to maximize expected profit.

$$\max_{\alpha_j} \mathbb{E}[\Pi_j(\mu_j)] = \left[ \mathbb{E} \left[ c \left( \phi(\mu_j) \right) \right] - z \right] \cdot \rho(\mu_j)$$

where $\phi(\mu_j) \equiv \rho(\mu_j) - I(\mu_j)$

and $c(\cdot) \in (0, c^{\text{max}}]$

The agent receives commission rate $c(\cdot)$ per dollar of premium collected $\rho(\mu_j)$. Commissions are bounded by $c^{\text{max}}$, the maximum possible commission for the policy type and coverage level. The agent’s commission rate depends on the actuarial performance of the policy, measured by expected underwriting gains $\phi(\mu_j)$. As actuarial performance improves, the commission rate approaches $c^{\text{max}}$, i.e. $c'(\cdot) > 0$. The agent also incurs a constant cost $z$ per dollar of premium sold which we assume to be less than the compensation rate for all values of $\mu_j$.

Because the agent does not know with certainty if the policy will incur a loss, the agent maximizes profits based on expectations of the farmer’s actuarial risk. The above objective

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39 This is true for farmers operating in the same state as the insurance company. Agents and insurance companies are not obligated to sell policies to producers outside their state.
function shows that agents must balance the desire to maximize the premium collected from producers, what we will call the “volume incentive,” with the potential effect this has on underwriting gains, or the “quality incentive.” Increasing the level of coverage may increase expected losses on the policy which could outweigh the increase in premiums collected.

Differentiating the agent’s objective function generates the following first order condition:

\[ \mathbb{E} \left[ c' \left( \phi(\mu_j) \right) \phi' \left( \mu_j \right) \right] \cdot \rho(\mu_j) + \left[ \mathbb{E} \left[ c \left( \phi(\mu_j) \right) \right] - z \right] \cdot \rho'(\mu_j) = 0 \]

This condition shows that the agent raises the coverage level of the policy until the marginal profit due to volume (increasing premium) just offsets the negative marginal profit from underwriting gains. Because the marginal premium profit must be positive by definition, the first order condition suggests that at the optimal coverage level, the change in underwriting gains due to an increase in coverage must be negative, i.e. \( \phi'(\mu_j) = \rho'(\mu_j) - I'(\mu_j) < 0 \).

The coverage level that satisfies the above condition depends on the guaranteed price, the producer’s historical yield, and agent operating costs, conditional on the yield distributions of the farmer and the county.

\[ \mu_j^* = \Psi(\theta, \bar{y}, z; F(y), G(y)) \]

For an agent to sell the profit maximizing level of coverage shown above, he/she must possess all information concerning the producer’s risk level and be able to fully influence the producer’s crop insurance decision. We now relax the constraint that producers and agents are fully informed and examine how the two interact in an environment of asymmetrical information and agent competition.
Appendix C. Opportunistic Producer – Agent Interaction Game Unsupported Equilibria

1. **Separating PBE (2):** High-risk producers signal a low coverage approximation and low-risk producers signal a high coverage approximation.

   \[ \gamma = 0, \lambda = 1 \]
   \[ S_i(H) = \mu_i^-, S_i(L) = \mu_i^+ \]
   \[ S_j(\mu_i^+) = \alpha_j < 0, S_j(\mu_i^-) = \alpha_j > 0 \]

   This equilibrium cannot be supported as opportunistic producers will have an incentive to deviate. High-risk producers can increase their payoff by signaling \( \mu_i^+ \) while low-risk producers can do so by signaling \( \mu_i^- \).

2. **Pooling PBE (1):** Both high-risk and low-risk producers alike signal a high coverage approximation.

   \[ \gamma = p \]
   \[ S_i(H) = S_i(L) = \mu_i^+ \]
   \[ S_j(\mu_i^+) = S_j(p) \]

   Here the agent’s response function depends on the proportion of high-risk producers in the population, \( p \). This equilibrium cannot be sustained because low-risk opportunistic producers will have an incentive to deviate and send a low coverage signal.

3. **Pooling PBE (2):** Both high-risk and low-risk producers alike signal a low coverage approximation.

   \[ \lambda = p \]
   \[ S_i(H) = S_i(L) = \mu_i^- \]
   \[ S_j(\mu_i^-) = S_j(p) \]
Again, the agent’s response is a function of $p$. This equilibrium cannot be sustained either as high-risk opportunistic producers will have an incentive to deviate and send a high coverage signal.