The narrative provided here draws heavily from our published works (Tsiboe and Turner 2023a; Tsiboe and Turner 2023b) as well as published martials that got generated during the review process but did not make it to the main text. Thus, citing Tsiboe and Turner (2023a) and Tsiboe and Turner (2023b) for the justification provided here should be sufficient

# Identification Strategy

As previously mentioned, a primary concern for identification is the fact that both cover crop use and crop insurance participation can both affect production risk, to varying degrees. Consequently, the underlying risk profile of a particular producer (i.e. the various moments that characterize their yield distribution) is likely to influence their decisions pertaining to participation in both planting of cover crops and purchase of crop insurance. Given that “risk” is not directly observable, a canonical case of endogeneity persists (i.e., due to omitted variables) that has the potential to bias parameter estimates unless explicitly dealt with.

To address endogeneity[[1]](#footnote-1) in our empirical framework, we follow past literature and define an instrumental variable that utilizes the premium rating framework inherent to the FCIP to generate exogenous variation in premium rates which can in turn directly influence crop insurance demand (Woodard and Yi 2020; Tsiboe and Turner 2023). Several policy parameters are internally defined each year by RMA using historical data from the FCIP. Notably, even though these parameters are defined using historic data (data which any individual producer may have contributed to), a single producer has negligible influence on their own premium rate due to the large number of producers that that contribute to the historic data series (Tsiboe and Turner 2023).

Temporal and spatial variation in policy parameters is further made exogenous by smoothing operations that RMA applies to limit sharp discontinuities in premium rates across adjoining county boundaries and catastrophic loading which is done to account for extreme tail events being sparsely represented in historic data (Coble et al. 2010). In effect, this means that variation in these policy parameters that govern premium rates shift the premium rate curve in a way that is exogenous to current individual farmer demand for insurance (i.e., which is also exogenous to the omitted “inherent farm risk” variables in the error term of equation 1). For a more detailed discussion on crop insurance rating methods as they relate to our instrumental variables, see the appendix.

Specifically, we make use of two policy parameters to define our instrument. The first being the county base rate which represents the starting premium for an individual choosing a 65%[[2]](#footnote-2) coverage level in county c and crop year t. Notably, , represents the premium rate before any characteristics of an individual producer are used to customize the premium[[3]](#footnote-3). The second is the catastrophic loading factor which as noted above is used to attenuate sampling error for sparsely observed catastrophic events. Our final instrument is defined as  which represents the initial premium a producer would face, prior to any information about a producer’s past production experience being used in the rating process. We refer to this instrument as the “initial rate”.

# Details on Exogeneity of Instrumental Variables

For our study, our instrument is only valid if it influences a producer’s crop insurance expenditures but has no direct bearing on cover crop decisions (other than through altering their crop insurance expenditures). The purpose of this appendix is to provide an overview of how the actuarial rating parameters that are used to construct our instrumental variable fit within the current premium rating framework utilized by the USDA Risk Management Agency and to discuss how these rating parameters satisfy the exclusion restrictions necessary to utilize them in an instrumental variable context.

As discussed by (Tsiboe and Turner 2023a), the continuous rating formula utilized by RMA to set premium rates consists of two sets of parameters; the first being an “endogenous” set of parameters that are directly influenced by the actions of a producer in either the past or current crop year. The parameters in the “endogenous” set include the producer’s choice of insurance unit structure (ex: basic vs enterprise units), their chosen coverage level (i.e. 50%, 55%, 60%, … etc.), their choice of production practices (e.g. certified organic, irrigation use). Finally, a producers’ history of realized yields (referred to as their “Actual Production History” or APH) is contained in this “endogenous” set of rating parameters. Because these components of the premium rating process are directly influenced by the actions of the producer, they would not satisfy the exclusion restrictions necessary for an instrumental variable. For example, if producer experiences yield effects from adopting cover crops (either positive or negative), this would influence their premium rate for the next year via altering the actual production history.

Alternatively, there are several actuarial parameters that directly influence a producers paid premium rate but are arguably exogenous to any one producers production decision (including their choices related to cover crop use). These parameters are referred to as the “policy parameter space” by (Tsiboe and Turner 2023a) and include the county base rate (), the continuous rating exponent (), the catastrophic loading factor () and the county average yield ().

With the exception of , which is a simple average of the historic APH of all producers in the same county producing the same crop, the other parameters are not updated on an annual basis but are instead subject to review every 3-5 years (Risk Management Agency 2008). Additionally, these parameters are updated in accordance with RMA’s practice of loss cost ratio rate making, which means these parameters are updated only to maintain the actuarial property that the loss cost ratio be equal to the expected indemnity rate.

Since these rating parameters are only updated in response to noticeable degradation of the actuarial performance of an insurance pool, many factors that influence a farmer’s yield (weather, changes in production methods, etc.) do not cause changes in these “exogenous” rating parameters since many of these events do not result in indemnity payments (due to deductibles being large)[[4]](#footnote-4). Even when indemnity payments do occur in response to these events, they must be widespread enough to meaningfully impact actuarial performance. In effect, this means that the actions of a producer have a trivial influence on the “exogenous” set of actuarial rating parameters they will face in the future. Even if a single producer was large enough to single handedly alter the actuarial performance of the county they are in, several rates making practices are employed by RMA to further limit the influence that any single producer has on the policy parameters they face in the future.

First, RMA employs what they refer to as “credibility weighting” which is their term for a spatial smoothing algorithm that seeks to attenuate large discontinuities in crop insurance pricing along county borders (Risk Management Agency [RMA] 2009; Coble et al. 2010). Credibility weighting also serves to down-weight the loss experience of counties that are highly variable (in which case the loss experience of neighboring counties is used more heavily in the rate making process). In effect, this means that a single producer’s county base rate is based on all producers within their county and all the producers in all adjoining counties. Consequently, the influence that a single producer has on the future base rate that they face is negligible.

A producer’s ability to influence the future policy parameters they face is analogous to a U.S. based homebuyer’s ability to influence their own mortgage interest rate. For example, a potential homebuyer could temporarily reduce their own spending to try to single-handedly lower national consumer spending metrics which in turn could cause the federal reserve to lower interest rates to restimulate the economy. This in turn will allow the potential homebuyer to purchase their home at a more favorable mortgage interest rate. In this case, the federal reserve interest rate is technically “endogenous” to this homebuyer’s behavior since their individual spending does technically contribute to national measures of consumer spending, but it would be unreasonable to think that an individual consumer’s behavior could manipulate national interest rates in a way that provides them with a financial advantage. Thus, in this case the federal reserve rate is exogenous to any single individual’s behavior by virtue of no one person having enough influence to alter consumer demand in a meaningful way.

The above example is somewhat extreme, but our own identification strategy operates on the same principle. The average number of crop insurance policies associated with a county-crop-year group (ex: policies associated with corn producers in a single county in Iowa during the 2018 crop year would constitute one group) between 2011-2021 is 128. This means there are 128 crop insurance policies that contribute to the average county’s loss experience that influences the county base rate. When credibility weighting is considered, the average county has an additional 669 policies in adjoining counties that can influence the county base rate. In other words, the purchasers of approximately 800 policies (or at least a large portion of those) would need to collude to intentionally influence their county base rate. However, even widespread collusion would not guarantee favorable rates for this potential group of coordinated producers.

In addition to credibility weighting which spatially smooths county base rates, when RMA subjects a particular county/crop pair to a rate review (which as noted above takes place on either a 3- or 5-year cycle), the historic loss experience data from the previous 20 years is utilized starting from two crop years before the current crop year. This imposes additional temporal separation between the decisions of a producer and the county base rate they face. Lastly, RMA retains the right to use their professional judgement to subjectively rate crop insurance policies in cases where they believe their standard rating practices are not adequate which provides an additional buffer between a producer’s behavior and their county base rate (Coble et al. 2010).

# References

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1. To some degree, simultaneity may also be a concern which further motivates the use of instrumental variables techniques. [↑](#footnote-ref-1)
2. The base rate for the 65% coverage level is used as it historically has been one of the most common coverage levels chosen I the FCIP. From 2001 to 2021, the 65, 70, and 75 percent coverage levels had made up 20, 23.5, and 21.5 percent of total policies purchased respectively. The 65% coverage level is also the base level used in RMA’s APH rating methodology (i.e. rates are set for the 65% coverage level then adjusted up or down to other coverage levels using a determined rate multiplier) (Risk Management Agency, 2008). [↑](#footnote-ref-2)
3. The “county base rate” is sometimes confused with the “target rate” (Risk Management Agency, 2008, Coble et al. 2010 ). Although similar, these two rates are very different from an instrumental variables perspective. The county base rate is estimated solely based on aggregate loss cost ratios while the “target rate” incorporates many of the characteristics one typically thinks of as influencing crop insurance premium rates (past yields, irrigation status, unit structure, etc). [↑](#footnote-ref-3)
4. For example, from 2011 to 2021, 77.6% of crop insurance policies sold had a deductible of at least 25%. [↑](#footnote-ref-4)