Depressed Demand for Crop Insurance Contracts, and a Rationale Based on Third Generation Prospect Theory

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Depressed Demand for Higher Coverage Crop Insurance Contracts, and a Rationale Based on Third Generation Prospect Theory

Abstract: When actuarially fair insurance for a major risk is available then standard economic theory posits that those subject to the risk should insure. In agriculture, it is common for producers to decline contract offers where pre-subsidy premiums just cover average losses and subsidies are substantial. This paper seeks to shed light on why demand is curtailed. In a mail survey of U.S. corn and soybean producers we solicited Willingness to Pay (WTP) for actuarially fair insurance at different coverage levels. We find demand to be so low that median WTP is no larger than fair premium when adjusted down by current subsidy rates, which pay for one half or more of most premium charges. WTP as a share of the fair rate is especially low when risk of loss is high. There is limited evidence that respondents appreciate the convex relationship between coverage level and expected indemnity payoff. Third generation Prospect Theory is shown to be consistent with observed findings. In particular, a strong distaste for paying premium can be rationalized by loss aversion. Furthermore, when high revenue outcomes are more likely than not, i.e., negative skewness, then higher loss aversion, greater decision weight distortions and greater risk aversion will decrease WTP.

Keywords Agricultural policy; Behavioral economics; Counterfactual outcomes; Information processing; Risk management; Third generation Prospect Theory; Under-insurance.

JEL classification D8, D9, Q18

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1 Introduction

> "We didn't buy crop insurance because as thin-spread as we are, we couldn't take that gamble. It's not worth it."
>
> "I've only bought crop insurance for one year, (but) I didn't need it. Thank God I got a crop in that year, and I got a good crop out of it."

Quotes from a row crop farmer who didn't use subsidized insurance contracts and was subsequently prevented from planting by Spring-time rains, as reported in Galloway (2019).

Risk is a pervasive feature of human existence. We are subject to many risks, but the most widely studied form is financial. Because money is fungible, if the deductible is removed from consideration then financial recompense for a financial loss can generally make the recipient whole by way of some risk management arrangement. This is in contrast with health, food safety, legal and many other risk types where financial recompense is incommensurable with the loss incurred. Yet, as the quotes above indicate, academic understanding of financial risk management choices is limited. Kunreuther et al. (2013) and others document a wide variety of insurance-related anomalies that include contexts in which excessive insurance, or insufficient insurance, or the wrong sort of insurance is taken out.

Although private insurers throughout the world have long offered crop loss indemnification, protection has generally been limited in geography, crops and perils covered. From the perspectives of administration and rate setting, crop insurance presents major problems to insurance companies. Losses can be frequent and systemic risk is generally large, limiting opportunities for diversification offsets in a book of business. Notwithstanding systemic risk, production decisions do matter in determining indemnity levels. Different crops may be chosen while crops in the same district may be planted at different times, to different varieties, on different soils and under different management practices. The markets were long afflicted by adverse selection (Just et al. 1999) and possibly also moral hazard concerns (Babcock and

Hennessy 1996; Smith and Goodwin 1996; Fadhliani et al. 2019). Technological innovation further diminishes an insurance company's capacity to rate by way of loss experience. This is especially so when insurance companies have fragmented loss experience files.

Due largely to subsidies of one form or another, crop insurance has become available to growers in many parts of the world (Glauber 2015). Commencing before World War II, both Canada and the United States have provided continuing public support to insurance for agricultural crop producers. This support has expanded over time. In the United States the support has taken several forms, designed so that premium receipts (before subsidies) equal average indemnity payouts. One form has been to cover administration costs, done through making payments to the crop insurance marketing companies whose business is to deliver and service contracts that are priced by the Federal government. Another has been to provide substantial public infrastructure, including investments in data collection and consolidation, data analysis, contract design and rate setting capacity, in the quest for actuarially fair rate-setting. The third major form of support has been large subsidies on these rates.

Standard conceptual economic analysis, invoking expected utility or related theories, holds that risk averters who face financial risks and have actuarially fair risk management contracts available to them will seek to fully offset their risk exposure. However, evidence from the United States and elsewhere is strong that growers do not seek to do so (Tadesse et al. 2016; Du et al. 2017; Huo et al. 2018; Bulut 2018; Che et al. 2019). Crop insurance is not unique as an instance of user sub-optimization, see, e.g., Choi et al. (2011). Nor is it unique as an instance of low demand such that government intervention is felt necessary. Flood insurance is another example (Michel-Kerjan and Kunreuther 2011).

We define depressed crop insurance demand to arise when Willingness to Pay (WTP) for the product is lower than the contract's actuarially fair value. The intents of this paper are to better characterize the nature of this depressed demand and to formalize a possible explanation.

Our point of departure is to scrutinize data obtained with a mail survey instrument that solicited WTP from corn and soybean growers in the United States Midwest. While our view is that growers have risk preferences that are more involved than preferring lower income variability, the demand shortfall could possibly arise because growers form subjective beliefs that do not reflect objective reality. Working with data from apple producers in Northern Italy, Menapace et al. (2012) show that risk aversion and subjective beliefs about risk exposure interact. In order to set aside concerns about risk perception and its effects on preferences, we provide our subjects with objective data on risk exposure.[1]

Although our data are based on hypothetical WTP responses, the scenarios presented allow for clarity in regard to the effect.[2] One concern with evidence on depressed demand based on empirical data is that in practice no insurance contract is perfect. It is known that modest amounts of residual risk, referred to as basis risk, can dramatically reduce demand (Vargas Hill et al. 2013; Elabed and Carter 2015; Clarke 2016). This basis risk could arise for many reasons, including uninsured price risk, disallowed losses or use of a yield index that differs from true yield. In our analysis these effects are absent and so removed as source of low demand for insurance.

The most widely posited alternative characterization to Expected Utility Theory is the suite of models labeled as Prospect Theory (PT). These models share several features, where the most important for our purpose is to assume a reference outcome against which a prospect's gains and losses are computed. The models also allow for separate valuation of gains and losses, assume risk aversion in gains and risk seeking in losses, and impose 'loss aversion' by requiring

[1] A lively debate is ongoing about whether preferences over risk are stable and whether they adapt to experience, see Carter (2016). These are certainly relevant for the matter that we study, but at a deeper level than we have data to shed light on.
[2] WTP in our context differs from the WTP in some environmental economics contexts. There WTP pertains to unfamiliar non-market services or goods, such as improved water quality. In our context, WTP is for products that most respondents have had years of experience to become familiar with, having to make crop insurance purchasing decisions.

the adverse value of a loss to exceed the positive value of a comparable gain. Finally, probabilities used in evaluating prospects are allowed to differ from true probabilities.

There are at least three reasons why PT models may have appeal as an explanation for weak insurance demand. One is that preferences over losses are characterized as being convex so that removing downside risk (i.e., revenue variability when revenue is low), which is what crop insurance should do, might not be seen as valuable. It should also be recognized, however, that PT models incorporate probability re-weightings. When downside risks involve low probability events, as might be the case with a severe drought, then such events may possibly be over-weighted in evaluations (Chavas 2019), thus increasing demand for insurance. If, for the risk at hand, the first effect outweighs the second then demand for insurance will be lower than might otherwise be expected.

A second reason why PT theories might have appeal in explaining depressed insurance demand is the loss aversion attribute whereby the framework imposes higher disutility for a loss than utility for a gain of comparative magnitude. Loss aversion would discount harshly any events whereby premium was paid but no indemnity was received, an outcome known to vex many insurees (Kunreuther et al. 2013). Loss aversion might also explain the empirically observed strong dislike for paying high premiums (Du et al. 2017) even though they come with low deductibles. A third reason is the theory’s capacity to explain demand that is particularly weak for high levels of risk. Some of the risk increase may fall in the loss domain, in which case growers may prefer the increment in risk.

Crop insurance choices when viewed through the PT lens has been scrutinized elsewhere. Babcock (2015), Bougherara and Piet (2018) and Sproul and Michaud (2018) all make the Cumulative PT (CPT) assumption set (Tversky and Kahneman 1992), which extends PT by changing weights on the cumulation of objective probabilities rather than on state-specific probabilities. However, these works struggled with identifying the appropriate point of reference to use when computing gains and losses and they are not alone in this regard (Werner and Zank 2019). The works choose a variety of reference outcomes, including expected profit absent insurance. These reference points are constant, i.e., state-invariant.

A constant reference point is problematic because crop insurance choices are made before the state outcome is known. Insurance is intended to modify state outcomes so that the true reference outcomes should also be state-dependent. In short, a state-invariant reference outcome is not appropriately specified when risk management is at issue. In ignoring uncertainty in the reference outcome, such a specification cannot account for how an agent views gains and losses, which will in turn affect the demand for insurance. For example, in a year with drought, buying a crop insurance policy, and therefore being able to make a claim, is a ‘gain’ when the reference point is the situation without insurance. However, in a year with good growing conditions, the same insurance policy will be considered a ‘loss’ when compared to the reference situation without insurance. In such cases, recognizing the state-dependent nature of the gains and losses will help us derive a more realistic understanding of insurance decisions.

Schmidt et al. (2008) formally adapt CPT by comparing income outcomes in each state of nature in a PT specification that has come to be called Third Generation PT (PT3). Thus, as with the outcomes for the prospect to be evaluated, the reference outcome is allowed to be state-dependent. Lampe and Würtenberger (2019), which is the work closest to ours, has extended PT3 to address how basis risk affects insurance demand, showing a behavioral contrast between Indian farmers who were provided with education on how insurance hedges and those who were not. Those who received the education module display an inverse relationship between insurance demand and the size of an estimated loss aversion coefficient. The relationship does not emerge for those who did not receive the training.

Using a different part of the survey that we also use, Doidge et al. (2018) have applied PT3 in an endeavor to better understand preferences for low coverage levels in crop insurance when conventional reasoning holds that high coverage levels should dominate over lower coverage levels (Du et al. 2017). Higher coverage levels provide both higher mean income and less variable income. In this article we also ask whether TP3 can plausibly explain depressed insurance demand.

We will next lay out how standard analysis perceives demand for crop insurance at different coverage levels. We will then provide details on our survey instrument which, among other questions, asks respondents to value different contracts. Data relevant to our project are then explored, and implications for agricultural policy are considered. Having found evidence of depressed demand we show that PT3, when in combination with reasonable parameter choices, can rationalize our findings. In particular we suggest that strong loss aversion may explain a clear disinclination to purchase insurance. We conclude with some discussions about how our findings fit into the larger literature.

2 Standard View on Demand for Crop Insurance

Our goal in this section is to better understand demand for crop insurance contracts and in particular how demand should change with the deductible. To this end we apply the expected utility framework although many other models that place value on reducing income dispersion could demonstrate the points to be made just as well. Let $\tilde{R} \in [0,\infty)$ be the uncertain harvest revenue having cumulative distribution function $H(\tilde{R}) \in [0,1]$ and probability density function $h(\tilde{R}) \in [0,\infty)$ when viewed from the perspective of the time at which insurance is available. Expected revenue is given as $\bar{R} = \int_0^\infty \tilde{R} dH(\tilde{R})$. Specify $\phi \in [0,1]$ as the fraction of expected revenue that is to be insured. This is the only insurance contract parameter that varies in our setting. An alternative view on the meaning of ϕ is to take $1-\phi$ to be a proportional measure of the deductible.

The indemnity payment is given as $L(\tilde{R};\bar{R},\phi)=\max[\phi\bar{R}-\tilde{R},0]$, i.e., any shortfall below $\phi\bar{R}$ is made up so that the sum of harvest revenue and indemnity payment is

$$\tilde{R}+L(\tilde{R};\bar{R},\phi)=\begin{cases}\phi\bar{R} & \text{whenever } \tilde{R}<\phi\bar{R};\\ \tilde{R} & \text{otherwise.}\end{cases} \tag{1}$$

Payoff $L(\tilde{R};\bar{R},\phi)=\max[\phi\bar{R}-\tilde{R},0]$ should be a form familiar to growers because it is one version of the popular revenue insurance contract rated by the United States Department of Agriculture's Risk Management Agency and marketed through private sector companies.[3]

If the insuring producer has a standard twice-differentiable, increasing, concave utility of profit function $U[\cdot]$, pays production costs C and faces no other risk sources then WTP for the contract providing coverage ϕ will be given by the value $W(\phi)$ implicitly defined in

$$\int_0^\infty U\left[\tilde{R}+L(\tilde{R};\bar{R},\phi)-C-W(\phi)\right]dH(\tilde{R})\equiv\int_0^\infty U[\tilde{R}-C]dH(\tilde{R}). \tag{2}$$

Here the right-hand side, being the default reference point of no insurance, does not involve coverage level ϕ. Any change in left-hand side value due to a change in coverage level will be completely absorbed by the value of the WTP function $W(\phi)$. Differentiating totally with respect to coverage level provides

$$W'(\phi)=\bar{R}H(\phi\bar{R})\times\frac{U'[\phi\bar{R}-C-W(\phi)]}{H(\phi\bar{R})U'[\phi\bar{R}-C-W(\phi)]+\int_{\phi\bar{R}}^\infty U'[\tilde{R}-C-W(\phi)]dH(\tilde{R})}, \tag{3}$$

where $W'(\phi)\equiv dW(\phi)/d\phi$ and the prime in $U'[\cdot]$ indicates the function's first derivative. Using utility function concavity, it is readily shown that

[3] This contract, which is commonly referred to as Revenue Protection with Harvest Price Exclusion (RPHPE), is not the most popular revenue insurance contract design. The more popular design, referred to as just Revenue Protection, attaches additional futures contract put options to the Revenue Protection design in order to help growers meet any forward contract payment obligations that they may have entered when seeking to place their crop with grain merchants. Arriving at an actuarially fair value for such contracts would challenge an actuary, and so we do not ask this of the survey subjects.

$$W'(\phi) \geq \bar{R}H(\tilde{R})|_{\tilde{R}=\phi\bar{R}} \geq 0. \tag{4}$$

The actuarially fair payment is the expected value of $L(\tilde{R};\bar{R},\phi)$, computed as

$$F(\phi) = \int_0^{\infty} L(\tilde{R};\bar{R},\phi)dH(\tilde{R}) = \int_0^{\phi\bar{R}} (\phi\bar{R} - \tilde{R})dH(\tilde{R}). \tag{5}$$

As $\tilde{R} + L(\tilde{R};\bar{R},\phi) - F(\phi)$ is less random than $\tilde{R}$ in the mean-preserving contraction sense (Rothschild and Stiglitz 1970), we can conclude from the concavity of $U[\cdot]$ that the $W(\phi)$ satisfying (2) must exceed $F(\phi)$ under the model assumptions, i.e.,[4]

$$W(\phi) > F(\phi). \tag{6}$$

This relationship, although inferred from standard theory, will be shown to be in stark contrast with our survey findings.

It is also readily apparent from (5) that

$$\begin{aligned} &(7a) \quad F'(\phi) = \bar{R}H(\tilde{R})|_{\tilde{R}=\phi\bar{R}} \geq 0; \\ &(7b) \quad F''(\phi) = \bar{R}^2 h(\tilde{R})|_{\tilde{R}=\phi\bar{R}} \geq 0; \end{aligned} \tag{7}$$

i.e., the actuarially fair premium is an increasing and convex function of coverage level. We make two comments about (7*a*)-(7*b*). The first is that (4) and (7*a*) together imply

$$W'(\phi) \geq F'(\phi) \geq 0. \tag{8}$$

Under risk aversion then the rate of change in WTP as coverage level increases should be no smaller than the rate of change in fair premium as coverage level increases. As with (6) above, we will provide evidence that the first inequality in (8) does not adhere in practice.

The second comment is that convexity relationship (7*b*) arises because coverage serves two functions when determining fair value. It determines probability of payout, which is why ϕ enters into the upper integral bound in $F(\phi) = \int_0^{\phi\bar{R}} (\phi\bar{R} - \tilde{R})dH(\tilde{R})$. It also determines extent of payout, as reflected in the integrand expression $\phi\bar{R} - \tilde{R}$. A higher coverage level increases both probability of payout and magnitude of any indemnity in the event that a payout is made. Because payout magnitude increases linearly, as in $\phi\bar{R} - \tilde{R}$, over all of $\tilde{R} \in [0, \phi\bar{R})$ the extent of convexity is determined by the rate at which set $\tilde{R} \in [0, \phi\bar{R})$ expands as coverage level changes. This rate is captured by density function $h(\cdot)$, hence its presence in (7*b*).

One purpose of our survey is to assess the extent to which respondents appreciate this convexity relationship. There is some reason to wonder whether the relationship is understood by growers. If it is not then growers are unlikely to adequately process the sets of alternative state-contingent payouts that changing coverage levels make available to them. One matter is that, although daily activities repeatedly present Bayesian updating problems to herbivores and carnivores seeking to feed and remain alive in the wild, *homo sapiens* remain dismally poor at intuitively updating expectations based on new information. Work by Edwards (1968) and others have shown that we systematically underestimate adjustments in expectations as we seek to incorporate additional data. More generally, linear adjustments are convenient rules of thumb when faced with complex problems. This is true even when the problem is not complex and can be re-posed so that linear adjustment is appropriate.

The 'Miles-per-Gallon Illusion', analyzed in Larrich and Soll (2008), illustrates the point. In a variety of ways the authors asked students and members of the public at large to compare cars that are identical in all ways except fuel efficiency as measured in miles per gallon (MPG) efficiency, labeled as *m*. Respondents were asked how *m* would affect both transportation costs and the environment. The MPG metric, although appropriate for ordering cars by fuel efficiency, is not quite what one needs to work with when calculating fuel costs. Larrich and Soll illustrate by considering the cost, as measured in gallons g, of travelling 10,000 miles. The gallon-cost would be $g = 10,000 / m$, i.e., the relation is hyperbolic. Gallon-cost is decreasing and convex in MPG. Linear approximation may be satisfactory for very small changes but

[4] A proof is available from the authors upon request.

consider when MPG changes from 10 to 20, and then to 30. Gallon-cost declines from 1,000 to 500 and then to 333. The first change saves 500 gallons whereas the second change saves, at the margin, one third of that. When pricing cars however, the study finds that respondents extrapolated linearly, expressing excessive WTP for the more fuel-efficient car.

Before introducing the survey, one feature of the United States crop insurance program warrants reflection. As presented to growers, there are two parts to the program. The catastrophic part, referred to as CAT, provides the grower with free coverage so long as an administrative fee is paid. The coverage is at 50% of reference yield or revenue and, in the case of yield insurance, is at a low assumed reference price. CAT is not considered to be a very attractive product and, as of 2019, only a small fraction of growers take it out.

The second part is the set of contracts that provide higher coverage. These are referred to as 'Buy-up' because the grower is said to buy-up from the endowed default CAT contract by paying the non-subsidy part of the premium. Thus there are what are referred to in Behavioral Economic jargon as anchoring, framing and choice architecture issues (Kahneman 2011; Thaler 2015). There is a large literature that documents and seeks to explain why people endowed with a particular object are reluctant to part with the object. Willingness to accept payment for parting with the object is generally found to exceed WTP to obtain it (Kahneman et al. 1991) among the inexperienced, but not among those experienced in a market (List 2004). The endowment matter is relevant for our inquiry as growers may have, through previous decisions, learned to take the view that CAT or lower coverage levels are theirs by right.

3 Survey

During the Winter of 2016-17 we surveyed farmers in the states of Iowa and Michigan who grew 100 acres or more of corn and/or soybeans during the 2016 growing season.[5] These states

[5] Further information can be found in Doidge et al. (2017). Recipients were asked to self-screen,

were chosen in part because they represent very different corn and soybean insurance program participation outcomes.[6] We asked that survey respondents provide the dollar value to them of an insurance contract that makes up crop revenue shortfall below a given reference revenue level. We asked them to do this for four reference revenue levels. In total, 2,586 contacts were initiated either by surface mail or email. The Center for Survey Statistics & Methodology at Iowa State University were contracted to conduct these surveys, using random sample purchased from a marketing company. In addition, a small number of responses were obtained through personal interviews during recesses at extension days in these two states. Four versions were randomly assigned to contacts. The survey versions differed in two dimensions that will be explained shortly.

Response rates, when calculated as a ratio of completed surveys to eligible sample, were 26.6% in Michigan and 31.1% in Iowa for a whole sample response rate of 29.0%. In all 614 responses were obtained although not all respondents completed all questions. In addition to farm and grower profile data, the survey asked farmers about their insurance choices and claims made over the previous five years. Our interest is in a section that posed the farmers with hypothetical revenue scenarios.

Two versions of the survey asked

> '*In this section, you will be asked to examine a hypothetical revenue scenario and indicate the maximum price you would be willing to pay for insurance policies with different coverage levels.*
>
> *Suppose you plant corn. The graph below shows your hypothetical corn revenues (yield multiplied by price at harvest) and the chance of the revenue over a 20-year period. For example, a revenue of $500 per acre may occur in 3 years out of 20.*
>
> *Average revenue is $515/acre.*'

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and to return the survey if they did not satisfy this acreage criterion.

[6] In excess of 90% of corn and soybean acres planted were insured in Iowa during 2018, which was 20% higher for each crop than in Michigan. Reasons for the difference are not readily apparent, as rate-setting procedures, the main contract specifications offered and subsidy terms are the same in both states. Crop insurance marketing infrastructure is better developed in Iowa while the futures price that indemnity payments are made on better reflects market conditions in Iowa than in Michigan.

The graph in question is provided as Figure 1, Panel A, and applies for versions I and II. Versions III and IV included instead Panel B. The wording for the second version set was the same except for the last sentence, which was revised to read as ‘*Average revenue is $513/acre.*’ The distinction between these discrete distributions is that the Panel B distribution may be thought of as, almost, a mean-preserving spread when compared to that in Panel A. Probability mass has been shifted up from $575 and $650 to $800 revenue and also down from $425 to $0. Given convexity in the indemnity payout, as explained in Eqn. (7*b*) above, the Panel B distribution should have higher fair premiums. Table 1 lays out fair premiums at the four coverage levels that will be of concern to us. We elected not to ask for the 70% coverage level so as not to unduly burden the respondent while also obtaining an adequate spread in coverage levels. For each version the slope between each coverage level is provided, where slopes rise with coverage level to reflect convexity.

Versions II and IV recipients were then asked

D1. Please mark an “X” on the horizontal line beside each coverage level to indicate the **maximum** price you would be willing to pay per acre for that Revenue Protection policy.

a. 85% coverage
(i.e. $436/ac guarantee) $0 $10 $20 $30 $40 $50 $60

b. 80% coverage
(i.e. $410/ac guarantee) $0 $10 $20 $30 $40 $50 $60

c. 75% coverage
(i.e. $384/ac guarantee) $0 $10 $20 $30 $40 $50 $60

d. 65% coverage
(i.e. $333/ac guarantee) $0 $10 $20 $30 $40 $50 $60

Versions I and III recipients were provided with a question set that was identical except that the bar was marked up from \$0 to \$80 but, as before, in \$10 increments. The distinction was to assess whether anchoring affected responses (Tversky and Kahneman 1974), where our analysis found no evidence of differential responses to markings.

Regarding data cleaning: an observation was removed for either of the following two reasons: *i*) all provided WTP are 0, or *ii*) an individual WTP value is missing for at least one of the four requested valuations. In total 163 observations were removed from the original sample of 614 observations, where 11 were for reason *i*) and 152 were for reason *ii*).

4 Analysis

Our main hypothesis is that WTP is lower than fair value. The hypothesis is consistent with empirical finding in Du et al. (2017) based on actual choice data for corn and soybean growers in the United States Interior, 2009, and in Huo et al. (2018) based on experimental data for vegetable farmers in Beijing area, China, 2017. Bear in mind that, consistent with (6), risk averse growers should express a risk premium. With WTP as $W(\phi)$, the assertion can be stated as inequality (6) in reverse:

H1: $W(\phi) \leq F(\phi)$.

Figure 2 compares WTP with fair values for the four coverage levels and each of versions I/II and III/IV. The differences are marked, and especially so for the more dispersed revenue distribution as given in Panel B of Figure 1. Table 2 documents the difference by contrasting at each coverage level the percent increase in fair value due to the increase in revenue dispersion with the corresponding percent increase in WTP. Fair value roughly doubles while WTP increases by about 5%. Furthermore, the percentage increase in WTP differs little across coverage levels and so fails to reflect the fact that the fair values most impacted by a more dispersed revenue distribution are at lower coverage levels. Table 3 provides details on the fractions of respondents for which H1 does not apply, i.e., the fraction whose responses comply with standard theory. Note too that for both version sets the fraction with WTP in excess of fair premium declines as coverage level increases. On the whole, our findings are consistent with earlier evidence of depressed demand.

Table 4 provides percent depression in demand as calculated by $-100[W(\phi)-F(\phi)]/F(\phi)$. The depression is in the 30-40% range for versions I/II and the 60-70% range for versions III/IV. The percent depression would appear to rise somewhat with higher coverage level for versions I/II but to decline somewhat with coverage level for versions III/IV. To provide a better sense on what the demand depression in Table 4 might mean for policy purposes, note that premium subsidies in the standard United States Federal crop insurance programs are 59% of premium for the 65% coverage level, 55% for the 75% coverage level, 48% for the 80% coverage level and 38% for the 85% premium. Subsidies are more generous when measured as a percent for lower coverage level premiums but, as Du et al. (2017) have shown, are almost certainly more generous in $ terms for higher coverage levels. The point to be drawn here is that current subsidies are of comparable magnitude to our estimates of demand depression.

In order to develop on this point and in the manner of Price et al. (2019), Figure 3 provides a box and whiskers comparison of the difference, WTP less subsidy-adjusted fair premium. The figure, which pools data from the versions, is intended to address how subsidies offset demand depression at the individual respondent level. The median difference is identified by the horizontal bar within each box while zero difference is indicated by the green oval on the vertical axis. For each coverage level the median respondent declares unwillingness to pay for the contract. However, a significant fraction is WTP and this is particularly so at low coverage levels. Table 5 shows that absent subsidies then the share WTP declines from 15% at 65% coverage to 4% at 85% coverage. With subsidies then the share WTP declines from 43% at 65% coverage to 25% at 85% coverage. Although costly, these hypothetical responses suggest that the subsidies are effective in promoting participation.

We turn now to how WTP responds to coverage, in comparison with fair premium. Stated another way, do respondents adequately recognize the value of incremental coverage? As laid out previously, empirical evidence leads us to suspect that they do not. Stated as an hypothesis, we write the reverse of the left inequality in (8):

H2: $W'(\phi) < F'(\phi)$.

Table 6 compares slopes for mean WTP and also for fair premium, where the latter has already been provided in Table 1. WTP slopes are uniformly lower than fair value slopes. The calculations confirm what we think is clear from perusing Figure 2. WTP expresses convexity at lower coverage levels but linearity at higher levels. Table 6 complements Table 5 and Figure 3 in shedding light on how the fraction of respondents who are WTP for higher coverage levels declines with an increase in coverage. Ignoring risk motives, respondents would appear not to recognize how rapidly the fair premium grows with coverage level, at least when the coverage level is high. Why there would appear to be some recognition when coverage level is low but not when high is not obvious to us.

5 Third Generation Prospect Theory

In this section we appeal to PT, the most prominent alternative to EUT, for a preference structure that might explain H1 and H2. PT has been proposed by Du et al. (2014, 2017) as an explanation for low crop insurance coverage choices for corn and soybeans in the United States. Both Babcock (2015) and Bougherara and Piet (2018) applied simulation analysis to assess the merits of the CPT variant for this purpose. Babcock found two assumptions to be central if PT is to explain depressed demand. One is the point-of-reference assumption and the other is whether gains and losses in one risky prospect are integrated with other income sources when evaluating that prospect (Kahneman and Tversky 1979). The alternative point-of-reference assumptions that Babcock made were insured outcome in comparison with one among (1) expected revenue per acre added to the premium per acre that the farmer paid; (2) only expected revenue per acre; (3) only premium per acre that the farmer paid.

The first comparison nets out premium cost and then compares with expected revenue. Here both premium cost and opportunity cost of the alternative revenue distribution are integrated into the comparison, but the revenue opportunity cost is represented by its expected value. This approach seeks to provide a broad frame (Sproul and Michaud 2018) in envisioning that the decisionmaker recognizes all foregone opportunities. However this broad frame does not allow insurance to provide risk management by counterbalancing prospect revenue with foregone counterfactual revenue. The second comparison ignores cost to the farmer while the third ignores revenue opportunity cost, as characterized by expected value. In ignoring parts of the counterfactual, these are narrow frame as indeed may be the decisionmaker's perspective. As with the first comparison, neither allows insurance to mage risk by offsetting revenue.

Following the PT3 model proposed by Schmidt et al. (2008), Doidge (2018) and also Lampe and Würtenberger (2019) have advocated for an alternative reference outcome. This reference outcome, that of the counterfactual revenue for each state of nature, is intuitive as it is the actual revenue foregone. That is, payoffs from different decisions are compared and valued for each state of nature. For instance, in a good state revenue with insurance is compared with revenue absent insurance and similarly for a bad state of nature. Then each state value is given a decision weight and averaged to provide the ex-ante 'anticipated' value of the choice relative to the counterfactual of no insurance.

PT3 is also simple to use from an analytical viewpoint as revenues will cancel in many states of nature and when they do not then it is because insurance has made a money payoff difference. Of course by the nature of the issue, insurance decisions, actual revenue is state-contingent and so the reference outcome should also be state-contingent if risk management motives are to be any part of the inquiry. Schmidt (2016) has provided a formal analysis of PT3 in the case of insurance for a two-state world with actuarially fair insurance. In what follows we adopt his approach to identify possible underlying reasons for depressed demand.

Given notation provided previously, revenue under insurance less WTP for insurance is

$$\begin{cases} \phi\bar{R} - W(\phi) & \text{for } \tilde{R} < \phi\bar{R}; \\ \tilde{R} - W(\phi) & \text{otherwise.} \end{cases} \tag{9}$$

Upon removing the reference revenue $\tilde{R}$ then gain/loss from insurance becomes

$$G(\phi) = \begin{cases} \phi\bar{R} - \tilde{R} - W(\phi) & \text{for } \tilde{R} < \phi\bar{R}; \\ -W(\phi) & \text{otherwise.} \end{cases} \tag{10}$$

In the above, since they arise both under insurance and absent insurance, farm costs net out and should be excluded. The central feature of PT3, as it enters (9)-(10), is that reference outcome $\tilde{R}$ depends on the realized state of nature. To insert instead some expectation as the reference, or counterfactual, outcome would be problematic because doing so would fail to acknowledge the risk management function of insurance.

To make the point in symbols, and hopefully with cymbals, suppose that $\bar{R}$ is held to be the reference outcome. Then we would have gain/loss as

$$G^*(\phi) = \begin{cases} \phi\bar{R} - \bar{R} - W(\phi) & \text{for } \tilde{R} < \phi\bar{R}; \\ \tilde{R} - \bar{R} - W(\phi) & \text{otherwise.} \end{cases} \tag{10*}$$

In contrast with (10), the states of nature under which insurance indemnities are paid out provides a gain that does not depend upon revenue. This should not be the case because the gain relative to the counterfactual should increase in the indemnity payout magnitude, $\phi\bar{R} - \tilde{R}$. Similarly, gain specification (10*) has that the states of nature under which insurance indemnities are not paid out provides a gain that does depend upon revenue. How should that be? In these states of nature the only difference between insuring and not insuring is the 'lost' premium payment as laid out in (10). Lampe and Würtenberger (2019) elaborate in the distinction between (10) and (10*) by noting that (10) requires at least some understanding about how insurance neutralizes adverse revenue outcomes, leading to their (supported) empirical test that those educated on the neutralizing point will behave as if (10) represents gains and losses whereas others would take (10*) to represent gains and losses.

As is standard, (Tversky and Kahneman 1992; Liu 2013; Bocquého et al. 2014), we posit the power form PT value function for gain/loss as laid out in (10) above:[7]

$$V[G(\phi)] = \begin{cases} [G(\phi)]^{\alpha} & \text{for } G(\phi) \geq 0; \\ -\lambda[-G(\phi)]^{\alpha} & \text{otherwise;} \end{cases} \tag{11}$$

with $\alpha \in (0,1)$ so that $-\lambda[-G(\phi)]^{\alpha}$ is an increasing and convex function on $G(\phi) < 0$ whenever $\lambda > 0$. Here λ is the loss aversion parameter and $\lambda > 1$ is assumed so as to reflect greater sensitivity to a loss than to a gain of equal magnitude. An observation relevant for later analysis is that limit point value $\alpha = 1$ reflects risk neutrality whereas α near 0 represents strong risk aversion.[8] This observation will be needed when we contemplate how growers weigh upside risk aversion against downside loss aversion.

The value function may be written as

$$\hat{v}[G(\phi)] = \begin{cases} [\phi\bar{R} - \tilde{R} - W(\phi)]^{\alpha} & \text{for } \phi\bar{R} - W(\phi) \geq \tilde{R}, & \text{(large indemnity);} \\ -\lambda[W(\phi) + \tilde{R} - \phi\bar{R}]^{\alpha} & \text{for } \phi\bar{R} > \tilde{R} > \phi\bar{R} - W(\phi), & \text{(small indemnity);} \\ -\lambda[W(\phi)]^{\alpha} & \text{for } \tilde{R} \geq \phi\bar{R}, & \text{(no indemnity).} \end{cases} \tag{12}$$

The relationship is depicted in Figure 4 and is partitioned into three segments based on the magnitude of realized revenue, $\tilde{R}$. When $\tilde{R}$ is very low then there is a large indemnity and so

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[7] Some versions of PT generalize to have distinct power indices for the gain and loss domains. Generalizing in that way would provide clarity on what risk aversion means, i.e., calling α a risk aversion parameter mischaracterizes its role in the loss domain. Otherwise, the main insights to follow would continue to apply except for some minor algebra adjustments.

[8] For $G(\phi) > 0$ then $-V''(\cdot)G / V'(\cdot) = 1 - \alpha$, i.e., the relative risk aversion coefficient is constant and it is high when α is low within its $(0,1)$ domain. Of course with PT3 as given by (11), what is risk averse in the gain domain is risk seeking in the loss domain.

the insurance decision provides a large gain. When indemnity is paid but is insufficient to cover the premium then a partial loss is acknowledged. Finally, when no indemnity is paid then the premium payment is viewed as being a total loss.

Value function (12) is continuous in $\tilde{R} \geq 0$ although it is not differentiable at two points. The kink points are at: 1) $\tilde{R} = \phi\bar{R} - W(\phi)$, where gain from insurance is zero and below which loss aversion appears; and 2) $\tilde{R} = \phi\bar{R}$, where indemnification ceases and below which loss relative to no insurances equals the state-invariant payment for insurance. With the exception of two features, Figure 4 is a repositioned version of the standard PT value function as represented in Kahneman and Tversky's (1979) Figure 3. One difference is that there is a floor on losses. The other is that, as explained in Schmidt (2016), insurance inverts what amounts to losses so that the function is decreasing in revenue $\tilde{R}$. The floor on losses is reached under no indemnification and the loss is equal to all of the premium. The value of the gain, relative to the counterfactual of no insurance, is greatest when indemnities are large.

To shed further light on how the PT3 value function in (12), complete with counterfactual reference outcome, affects insurance choices we will work with a very simple specification of $\tilde{R}$. For revenue we consider a two-point process, R_h with probability p and R_l with probability $1-p$ where $R_h > R_l > 0$. We rule out the 'small indemnified loss' outcome for this two-point distribution because it is not plausible under this distribution. Thus we rule out $R_l >$ $\phi\bar{R} - W(\phi)$ for then WTP would exceed the worst-case indemnity. For convenience we will write $\delta = R_h / R_l$ so that $\bar{R} = pR_h + (1-p)R_l = (p\delta + 1 - p)R_l$ where of course $p\delta + 1 - p > 1$. Furthermore we will write $W(\phi)$ as a fraction of $\bar{R}$, namely

$$W(\phi) \equiv \bar{R}\, w(\phi) \equiv (p\delta + 1 - p)R_l w(\phi) \tag{13}$$

where $w(\phi)$ is proportional WTP. Consequently, (12) may be revised to

$$\hat{v}[G(\phi)] = \begin{cases} \left\{[\phi - w(\phi)]\bar{R} - R_l\right\}^{\alpha} & \text{with probability } 1-p, \quad \text{(indemnity);} \\ -\lambda\left\{\bar{R}w(\phi)\right\}^{\alpha} & \text{with probability } p, \quad \text{(no indemnity).} \end{cases} \tag{14}$$

In the above, three key features of the PT paradigm have been accounted for: separate valuation of gains and losses; loss aversion as represented by $\lambda > 1$; decreasing marginal value of gain and decreasing marginal value of loss.[9] The fourth feature is probability re-weighting whereby objective probabilities are recoded into decision weights. This can be represented by the map[10]

$$p \to \Phi(p;\mu); \qquad 1-p \to 1-\Phi(p;\mu); \tag{15}$$

where decision weight $\Phi(p;\mu)$ satisfies $\Phi(p;\mu) \in [0,1]$ and $d\Phi(p;\mu)/dp > 0$.[11] Shift parameter μ determines how distorted the decision weights are when compared with objective probability p. Here the common interpretation of evidence is that when the high outcome event is likely, i.e., the distribution is negatively skewed, then moderate and high probability events are underweighted (Kahneman and Tversky 1979; Liu 2013; Bocquého et al. 2014; Bauermeister et al. 2018), i.e., $\Phi(p;\mu) < p$ and $1-\Phi(p;\mu) > 1-p$. For fertile soils and otherwise good general growing conditions, there is evidence to suggest that distributions are negatively skewed (Du et al. 2015). Crop revenue may well be positively skewed because in some years prices can be high due to global conditions even though production in a specific region is good.

Upon applying decision weights, the TPT prospect's evaluation is

$$V[\phi, w(\phi)] = \left\{[\phi - w(\phi)]\bar{R} - R_l\right\}^{\alpha}[1-\Phi(p;\mu)] - \lambda\left\{\bar{R}w(\phi)\right\}^{\alpha}\Phi(p;\mu), \tag{16}$$

which may be written as

[9] By 'decreasing marginal value of loss' we mean that the rate of decrease in value due to an increase in loss is itself decreasing with an increase in loss.
[10] Here it is assumed that the transformation has been renormalized so that re-weighted probabilities sum to 1, and that this renormalization is embedded in $\Phi(p;\mu)$.

$$V[\phi, w(\phi)] = \left\{ \frac{[\phi - w(\phi)](p\delta + 1 - p) - 1}{p\delta + 1 - p} \right\}^{\alpha} \bar{R}^{\alpha}[1 - \Phi(p;\mu)] - \lambda \left\{ w(\phi) \right\}^{\alpha} \bar{R}^{\alpha} \Phi(p;\mu). \qquad (17)$$

When the goal is to extract WTP then (17) may appear to pose tractability concerns. Recall however that WTP is the amount of money one should be willing to part with when compared with the counterfactual. The counterfactual is no insurance with non-premium gains and losses equal to $\tilde{R} - \tilde{R} = 0$ so that $w(\phi)|_{\phi=0} = 0$ and $V[\phi, w(\phi)]|_{\phi=0} = 0$. Therefore WTP will solve

$$V[\phi, w(\phi)] = V[\phi, w(\phi)]|_{\phi=0} = 0, \qquad (18)$$

so that (17) and (18) together provide

$$\begin{aligned} &(19a) \quad w(\phi) = \frac{(p\delta + 1 - p)\phi - 1}{(p\delta + 1 - p)\left\{ 1 + I[\lambda, \alpha, \Phi(p;\mu)] \right\}}; \\ &(19b) \quad I[\lambda, \alpha, \Phi(p;\mu)] \equiv \left(\frac{\lambda \Phi(p;\mu)}{1 - \Phi(p;\mu)} \right)^{1/\alpha}; \end{aligned} \qquad (19)$$

where $(p\delta + 1 - p)\phi - 1 > 0$ is synonymous with $\phi \bar{R} > R_l$ so that $w(\phi) > 0$ is assured.

Notice that in relationship (19*a*) the PT3 parameter set (λ, α, μ) are separated into a summary PT3 index, $I[\lambda, \alpha, \Phi(p;\mu)]$, on the right-hand side. So a closed-form solution is available for WTP and, furthermore, PT3 parameters act on WTP entirely through an aggregating index. This index summarizes how risk aversion parameter α, loss aversion parameter λ and the probability reweighting function affect WTP for crop insurance. Notice also that how α affects the PT3 index depends on the sign of $J(\lambda, p;\mu) \equiv (1+\lambda)\Phi(p;\mu) - 1$ because when ratio $\lambda\Phi(p;\mu)/[1-\Phi(p;\mu)]$ has value less than 1 then raising it to an higher power will decrease value while when the ratio has value greater than 1 then raising it to an higher power will increase value.

Remark 1: Summary PT3 index $I[\lambda, \alpha, \Phi(p;\mu)]$ is increasing in all of the loss aversion parameter λ, the true probability parameter p, and the value of the reweighting function

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[11] In this two-state environment it is unnecessary to capture the cumulative feature of CPT.

$\Phi(p;\mu)$. How the risk aversion parameter affects index value depends on the sign of $J(\lambda, p;\mu)$. When positive then higher risk aversion, i.e., lower α, increases the index value while the reverse applies when the sign is negative.

Remark 1 together with $dw(\phi)/dI[\cdot] < 0$ establish the following:

Remark 2: Under PT3, WTP for crop insurance is decreasing in the loss aversion parameter λ and any shift in μ that increases the value of the reweighting function $\Phi(p;\mu)$. How the risk aversion parameter affects WTP depends on the sign of $J(\cdot)$. When positive then higher risk aversion, i.e., lower α, increases WTP and the reverse applies when the sign is negative.

Now expected payout is $F(\phi) = (1-p)(\phi\bar{R} - R_l) = (1-p)[\phi(p\delta + 1 - p) - 1]R_l$, so that expected payout as a fraction of expected revenue is

$$f(\phi) \equiv \frac{F(\phi)}{\bar{R}} = (1-p)\left(\phi - \frac{R_l}{\bar{R}}\right) = (1-p)\left[\frac{(p\delta + 1 - p)\phi - 1}{p\delta + 1 - p}\right], \tag{20}$$

and WTP as a fraction of expected payout is

$$\frac{w(\phi)}{f(\phi)} \equiv \frac{W(\phi)}{F(\phi)} = \frac{1}{(1-p)\{1 + I[\lambda, \alpha, \Phi(p;\mu)]\}}. \tag{21}$$

We are now in a position to revisit **H1** and **H2**, which you will recall to be $W(\phi) \le F(\phi)$ and $W'(\phi) < F'(\phi)$, respectively. Regarding **H1**, the inequality implies that

$$\frac{p}{1-p} \le I[\lambda, \alpha, \Phi(p;\mu)] \equiv \lambda^{1/\alpha}\left(\frac{\Phi(p;\mu)}{1 - \Phi(p;\mu)}\right)^{1/\alpha}, \tag{22}$$

Schmidt's (2015) analysis of coverage choices under insurance identified a tension between the loss aversion parameter and the true probability parameter. In particular, when loss aversion is strong relative to the true probability of the high state then optimal coverage at a fair premium price will be zero. This is consistent with conditions for depressed WTP as provided in (22) above. Regarding risk aversion, the value of $J(\lambda, p; \mu)$ could be negative for several reasons.

Remark 3: Critical value function $J(\lambda, p; \mu)$ will be negative whenever the

i) loss aversion coefficient is low, or

ii) true probability p is low, or

iii) distortion parameter μ is either *iii-a*) sufficiently low when true probability p is on the low end or *iii-b*) sufficiently high when true probability p is on the high end.

In all these cases greater 'risk aversion', i.e., lower α, increases WTP. When conditions *i*) through *iii*) are reversed then greater 'risk aversion' decreases WTP.

In order to obtain a better sense for the condition in (22) we will study the trade-off between λ and α while fixing true probability and the decision weight distortion. In modeling decision weights we follow Bocquého et al. (2013) by choosing Prelec's (1998) weighting for a form such that $\mu > 0$, and $\Phi(p;\mu)|_{\mu=1} = p$ apply while $\mu \in (0,1)$ implies overweighting on low *p* and underweighting on higher *p*. The Bocquého et al. (2013) estimated all of (λ, α, μ) for mixed enterprise farmers in eastern France, and they estimated $\mu \approx 0.66$. We will use this as a benchmark.

Figure 5 depicts (α, λ) curves that support $W(\phi) = F(\phi)$. We label the curves in question as Actuarial Indifference Curves (AIC). In the figure the 'depressed demand' region is to the northeast in the positive quadrant. The figure is provided for two values of *p* and also two values of μ. Perhaps easiest to understand is when $p = 0.5$ because then the AIC is flat, see (22). In that case the threshold λ that supports $W(\phi) = F(\phi)$ is rather low, being about 1.2 when $\mu = 0.66$ and about 1.3 when $\mu = 0.5$. Any loss aversion parameter above these respective values will support depressed demand, in large part because of a preference against paying premium and receiving no indemnity. Loss aversion parameter estimates made in the literature are substantially above 1.3 (Abdellaoui et al. 2007), ranging between 1.43 at the low end (Schmidt and Traub 2002) to 4.8 at the high end (Fishburn and Kochenberger 1979). Bocquého et al. (2013) obtained 2.275 while Liu (2013), for cotton farmers in China, obtained the mean of parameter estimates as 3.47.

In the figure the λ threshold is higher when μ is lower because probabilities are underweighted at $p = 0.5$ and this underweighting becomes more severe when μ declines. Premium is 'lost' in the good state so when the decision weight on this 'loss' decreases then WTP will increase unless the loss aversion parameter increases to compensate for the change in decision weight.

When $p = 0.7$ then $p/(1-p) = 7/3$ and the threshold provided by (22) may be written as $\lambda = e^{\alpha \ln(7/3)}[1-\Phi(p;\mu)|_{p=0.7}]/\Phi(p;\mu)|_{p=0.7}$, thus providing the two upward sloping AIC in Figure 5. One may think of these positively sloped AIC as a tradeoff between loss aversion and risk aversion. The more loss averse one is then the less 'risk averse' one needs to be in order to be WTP the fair premium. The loss aversion parameter threshold increases as risk aversion becomes less severe because a high revenue state is more likely than not. So lost premium is quite likely. When the marginal effect of an increase in premium changes rapidly, as α is low, then the loss aversion coefficient must be low if insurance is to be 'worth it.'

Regarding **H2**, appeal to (19) and (20) shows that

$$W'(\phi) - F'(\phi) = \frac{\bar{R}}{1 + I[\lambda, \alpha, \Phi(p;\mu)]} - (1-p)\bar{R}. \tag{23}$$

Viewing (21), the condition for $W'(\phi) < F'(\phi)$ under the model is precisely that for $W(\phi) \leq F(\phi)$ under the model. In consequence depressed responsiveness to coverage level is also a reasonable outcome for the TP3 model.

6 Conclusion

We use hypothetical willingness to pay solicitations from a large sample of corn and soybean producers to provide evidence on two paradoxes. To the extent that producers are risk averse then they should be willing to pay more than fair value for crop insurance. Evidence, however, suggests that they are less willing to do so. In addition, producer WTP should be more sensitive to coverage level than should fair value whereas evidence suggests that the reverse is true. The first of these two inversions informs on the efficacy of subsidies to support a policy goal of having producers insure. If the goal is to have producers insure at higher rates then a subsidy will certainly work. Less clear is whether intervention is in any sense socially optimal. That depends on whether the choice model is to be taken as measuring true preferences or to reflect in part some behavioral failing. The second inversion implies that participation at higher coverage levels will be expensive, and especially so if large subsidies are provided at lower coverage levels. We also show that the two incongruities are not inconsistent with Third Generation Prospect Theory, which is the natural version of prospect theory in which insurance decisions should be assessed. If only because policy relevance, given the growing global importance of crop insurance policies as well as costly public interventions medical and flood insurance markets, we hope that others will develop the subject matter in both conceptual and empirical dimensions.

Perhaps, however, the focus in this general line of inquiry should broaden beyond preferences and reference points and toward another set of issues that are at least partly addressed in Prospect Theory frameworks. True probabilities are transformed when computing expected values because there is evidence that humans have difficulties in calibrating ‘very likely’ and ‘very unlikely’ events for the purpose of taking choices. Perhaps more emphasis should be placed on framing, including what happens before the insurance choice is made (Thaler 2015)? Johnson et al. (1993), Carter et al. (2015) and Serfilippi et al. (2019) have made interesting observations regarding implications of how the insurance choice is presented to the grower. Many other questions remain, including what available information is carried to the decision point and how such information is processed.

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Table 1. Fair premiums in $/acre for revenue insurance contracts based on the two distributions and evaluated at different coverage levels.

	$\phi = 0.65$	$\phi = 0.75$	$\phi = 0.80$	$\phi = 0.85$
Versions I/II	$9.73	$18.50	$23.65	$30.71
Slope		87.75	103	141.2
Versions III/IV	$26.22	$37.34	$43.75	$51.22
Slope		111.2	128.2	149.4

Note: Slope is given as value less value in column to left, all divided by coverage rate difference.

Table 2. Percent increase in fair value and in WTP, higher risk versions III/IV when compared with lower risk versions I/II.

	$\phi = 0.65$	$\phi = 0.75$	$\phi = 0.80$	$\phi = 0.85$
Fair value	169.6%	101.8%	85.0%	66.8%
WTP	3.5%	5.5%	6.0%	6.6%

Table 3. Percent of responses where WTP exceeds actuarially fair premium, together with *t* test of whether WTP is lower than actuarially fair premium.

	$\phi = 0.65$	$\phi = 0.75$	$\phi = 0.80$	$\phi = 0.85$
Versions I/II	29.4%	10.6%	11.9%	7.8%
Difference test, 5%	Reject	Reject	Reject	Reject
Versions III/IV	1.3%	0.9%	0.9%	0%
Difference test, 5%	Accept	Accept	Accept	Accept

Note: Versions I/II had 218 responses in all while versions III/IV had 233 responses in all.

Table 4. Evidence on percent depression in valuation by coverage level and version set, mean difference between WTP and actuarially fair premium as a percentage of fair premium.

	$\phi = 0.65$	$\phi = 0.75$	$\phi = 0.80$	$\phi = 0.85$
Versions I/II	29.3%	41.3%	37.4%	38.7%
Versions III/IV	72.9%	69.3%	64.1%	60.8%

Table 5. Overall percent of respondents willing to pay the actuarially fair premium, without and with current premium subsidies.

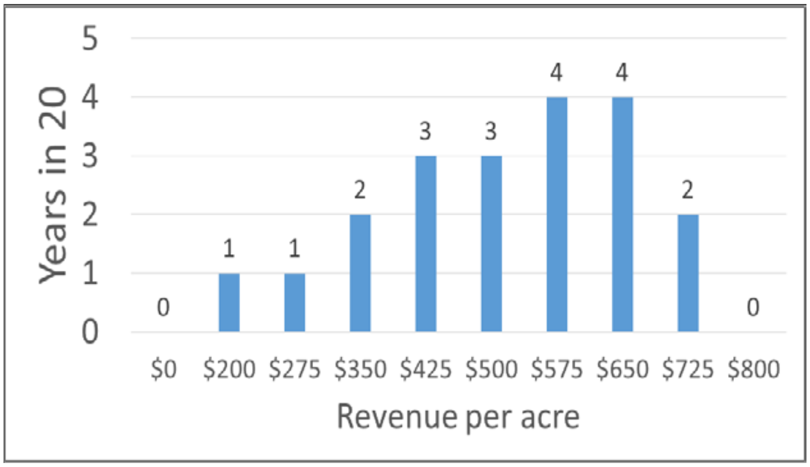
	$\phi = 0.65$	$\phi = 0.75$	$\phi = 0.80$	$\phi = 0.85$
Without	14.8%	5.5%	6.2%	3.8%
With	43.5%	41.2%	33.0%	24.6%

Table 6. Slopes of actuarially fair premiums for the two distributions at different coverage levels.

		$\phi = 0.65$	$\phi = 0.75$	$\phi = 0.80$	$\phi = 0.85$
Versions I/II	Fair premium slope	—	87.75	103	141.2
	WTP slope	—	39.82	79.07	80.08
Versions III/IV	Fair premium slope	—	111.2	128.2	149.4
	WTP slope	—	43.4	85	87.2

Note: Slope is given as value less value in column to left, all divided by coverage rate difference.

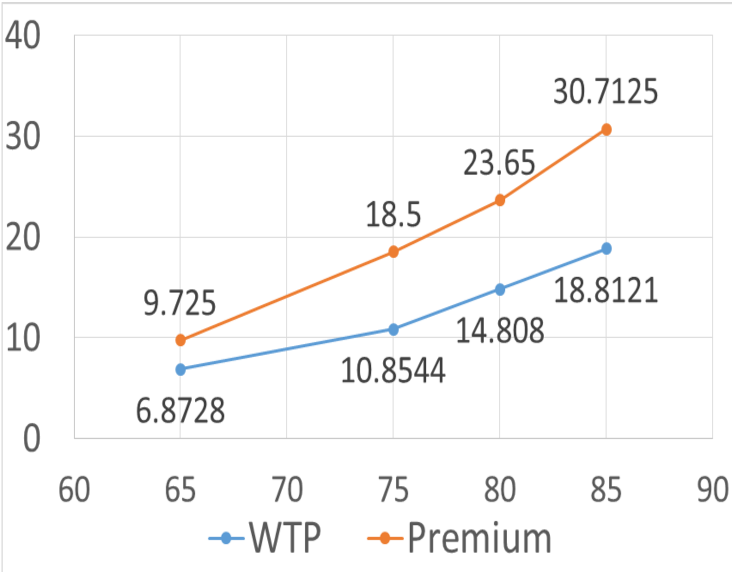
Panel A, Versions I/II



Panel B, Versions III/IV

Figure 1. Revenue distributions as provided to respondents.

Panel A, Versions I/II



Panel B, Versions III/IV

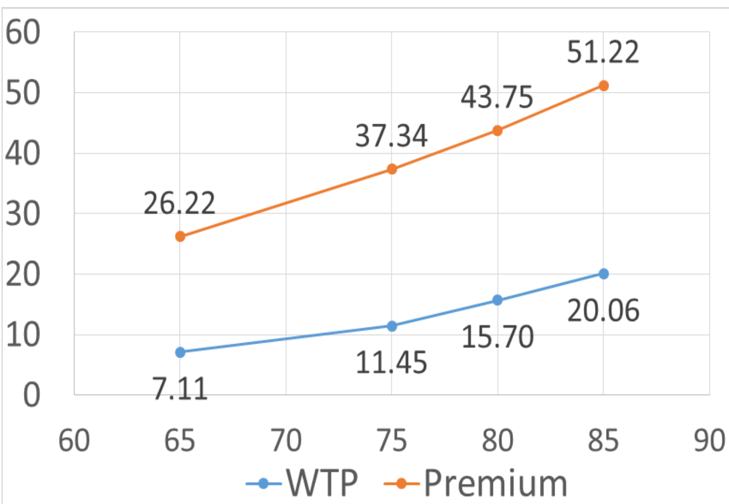


Figure 2. Fair premium and $ value of mean WTP by coverage level for each of two version pairs.

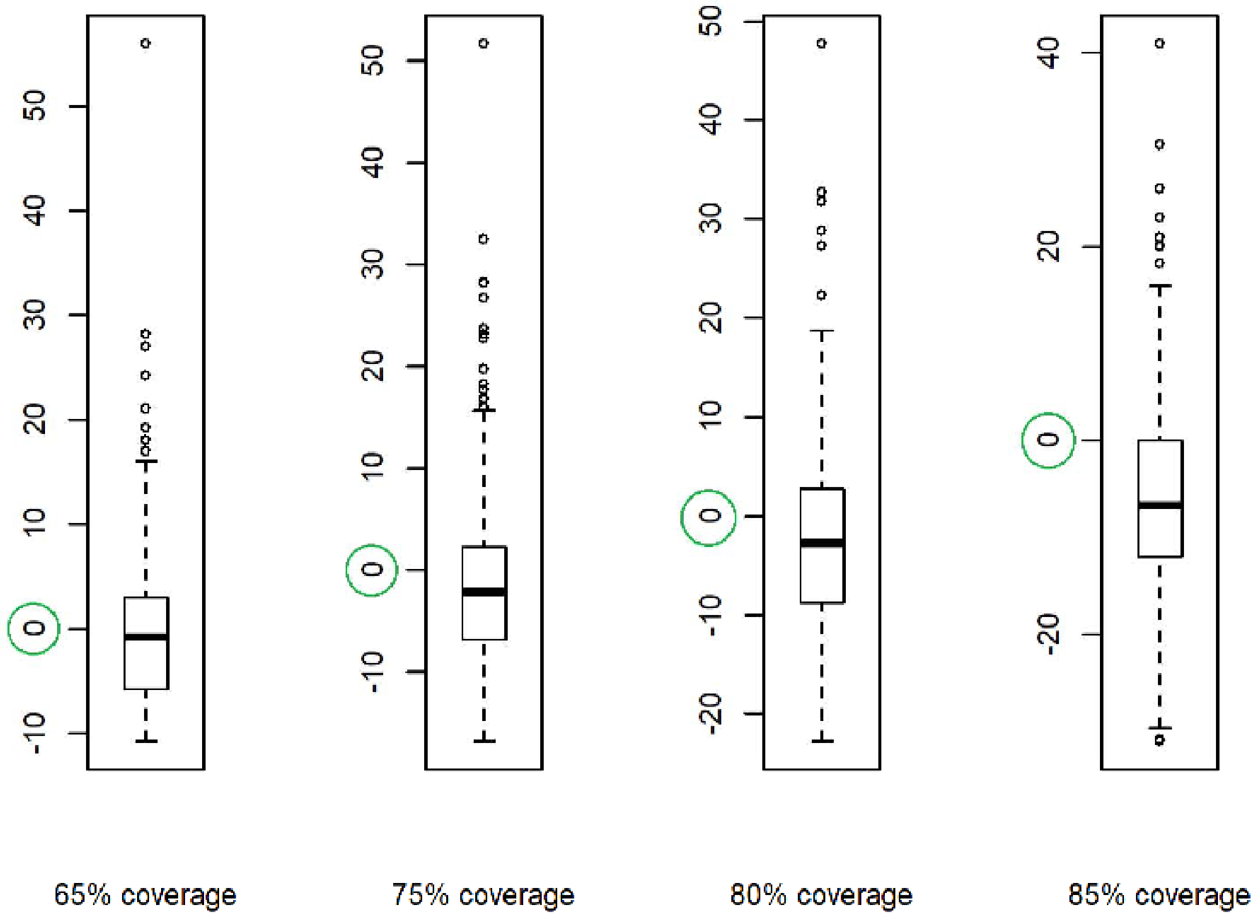


Figure 3. Box and whiskers plots of WTP less subsidy adjusted fair premiums.

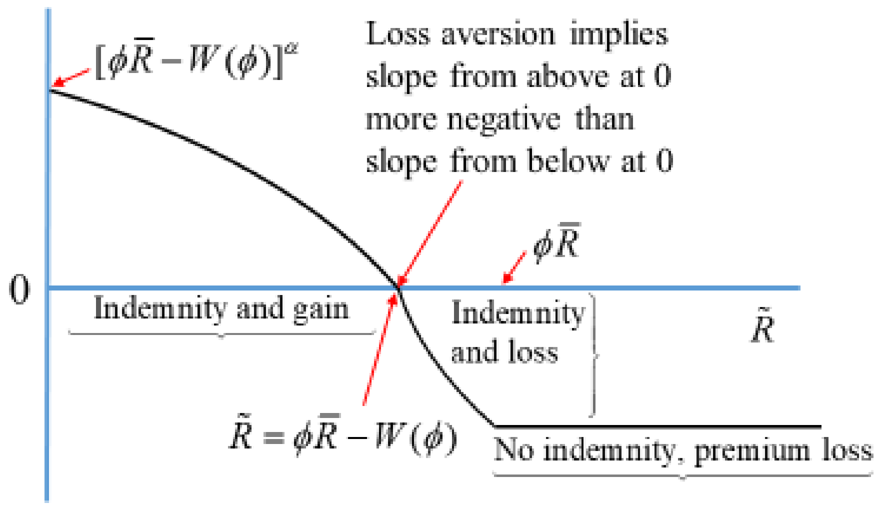


Figure 4. TP3 value as a function of revenue where counterfactual of 'no insurance' is reference outcome.

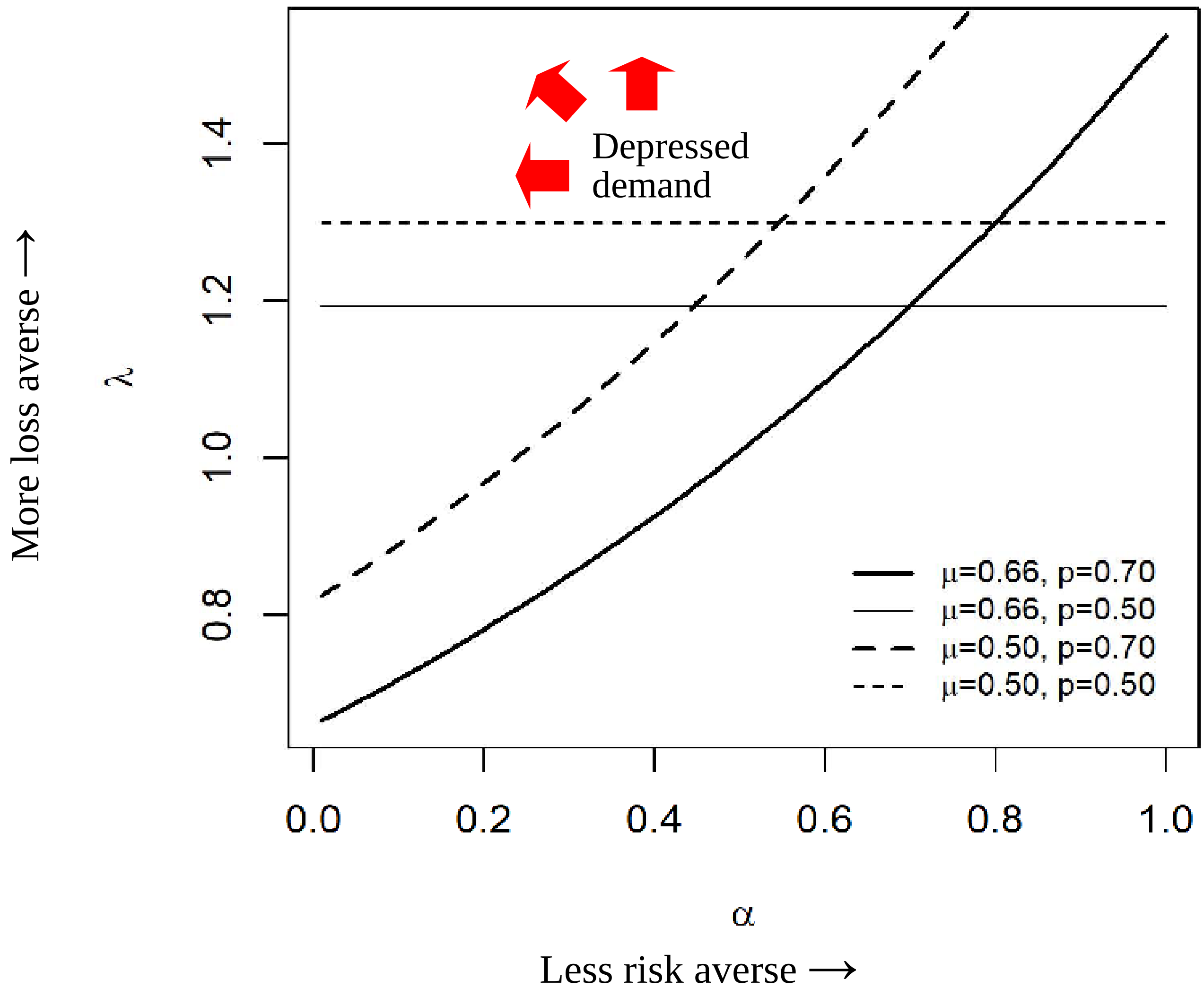


Figure 5. Graph of PT3 parameter values that equate WTP with actuarially fair value.