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THE IMPACT OF A GOVERNMENT RISK POOL AND AN OPT-OUT FRAMING
ON DEMAND FOR EARTHQUAKE PROTECTION

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ABSTRACT

This paper describes the design and analysis of a web-based choice experiment that examines how the demand for earthquake protection in Quebec and British Columbia is influenced by the default option and the structure of the insurance plan. Homeowners in both provinces were given the opportunity to purchase protection against earthquake losses when presented with one of the following options: the current private insurance plan, a high deductible private insurance plan, and a proposed public-private risk pool. The default frame was changed so the homeowner could either opt-in by purchasing this coverage or opt-out of being given this protection and receiving a premium discount. Assigning participants to a public-private risk pool rather than the current private insurance plan increases the likelihood of purchasing earthquake protection by 151%. The opt-out frame leads to a likelihood greater than 1.6 of purchasing coverage relative to the opt-in frame when given the same plan structure. The policy implications of this finding are discussed.

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1. Overview

This report describes the design and analysis of a hypothetical choice survey experiment with homeowners in Quebec and British Columbia (BC) examining how their propensity to purchase earthquake protection on a property is influenced by the default option and the structure of the insurance plan they are asked to consider.

The report is organized as follows. Section 2 provides a brief background on the policy context and academic literature motivating the main hypotheses of interest. Section 3 describes the design of the experiment to test these hypotheses and details the study procedures. Section 4 presents the results of the study. The concluding section discusses the main takeaways from our empirical findings.

2. Background and Hypotheses

Many Canadians own homes exposed to an earthquake hazard and much of the risk of costly residential damages from a severe quake is concentrated in Quebec in the East and British Columbia (BC) in the West—regions where high population density and seismic activity overlap.

Historically, many different types of earthquake disasters have occurred in Canada. One way to characterize the severity of an earthquake is by measuring its magnitude (M), the amount of energy released by the earthquake.¹ Major earthquakes in western Canada include the 1700 ($M9$) Cascadia mega-thrust subduction earthquake off Vancouver Island, the 1918 ($M6.9$) and 1946 ($M7.3$) shallow crustal earthquakes on Vancouver Island, and the 2001 ($M6.8$) Nisqually deep inslab earthquake centered in Washington, United States. In eastern Canada, major damaging crustal events between $M6$ and $M7.5$ occurred in the Charlevoix seismic zone (in 1663, 1860, 1870, 1925, and 1971), while moderate earthquakes occurred in the Western Quebec seismic region (in 1732, 1935, 1944, and 2010) (see Cassidy et al., 2010 for review of major events).

¹ The United States Geological Survey (USGS) describes earthquakes as *minor* ($M3.0 - 3.9$), *high* ($M4.0 - 4.9$), *moderate* ($M5.0 - 5.9$), *strong* ($M6.0 - 6.9$), *major* ($M7.0 - 7.9$) and *great* ($M8.0$ or higher). For more details on the severity of earthquakes see <http://geology.teacherfriendlyguide.org/index.php/hazards-w/hazards-earthquakes-w>

A study commissioned by the Insurance Bureau of Canada and conducted by AIR Worldwide examined hypothetical earthquake scenarios for Quebec and BC to provide insight on the anticipated scale of damages should significant earthquakes occur today (Insurance Bureau of Canada & AIR Worldwide, 2013). While the likelihood of these scenarios occurring in any given year is very low, they illustrate the extent of losses that are likely to be borne directly by homeowners from severe seismic events after insurance payouts and public aid. Should an M7.1 earthquake occur at shallow depth about 100 km north of Québec City, the report projects that only about 3% of residential property losses would be covered by insurance. After these payments and projected government assistance, roughly \$10 billion would be borne by homeowners. While a higher share of homes in BC have some earthquake insurance coverage (44% based on 2020 CatIQ data ²), if an M9 subduction event occurred at shallow depth off the coast of Vancouver Island, the report estimates that only about 20% of residential losses would be recouped through insurance, leaving roughly \$20 billion in uninsured losses.

The potential outcomes from earthquake disasters in these two provinces motivate the need for changes to earthquake protection programs in Canada that would achieve higher homeowner participation and fund a greater share of projected losses from future seismic events. This study examines how a proposed public-private risk pool that auto-enrolls homeowners could boost residential take-up rates for earthquake protection without requiring a compulsory government program.

2.1 Alternative Insurance Structures for Residential Earthquake Risk

This report estimates homeowner demand for different earthquake protection plans for representative houses in Quebec and in BC. The top panel of Table 1 details the property value, earthquake hazard, and potential damage for a house in Quebec in the first column and BC in the second column. The bottom panel of Table 1 specifies the annual price of protection and the deductible for three voluntary earthquake protection plans that covers damage to these houses. The baseline plan is “*Status Quo Private*”, an earthquake insurance policy covering the property value of the home with a deductible and annual premium reflecting typical policies currently sold in each province based on 2020 CatIQ data. The Quebec policy has a \$15,000 deductible (3.75% of home value) and a \$200 annual premium while the BC policy has a \$50,000 deductible (6.67% of home value) and a \$650 annual premium.

[INSERT TABLE 1 HERE]

² See <https://public.catiq.com/>

The baseline plan is compared with a *Public-Private Risk Pool* that would cover earthquake damage above a \$1,000 deductible, with an annual premium that is lower than *Status Quo Private* (\$100 for Quebec, \$400 for BC). While we leave a fuller discussion of the *Public-Private Risk Pool* to the forthcoming ICLR report, the innovation reducing its premium and deductible is a publicly funded risk pool for the first \$100,000 in damage above the \$1,000 deductible combined with private insurance for damages over \$100,000. It is designed to provide well-defined public disaster assistance through the risk pool and incentivize more homeowners to purchase insurance so that rebuilding their house after suffering earthquake damage would be covered. The third plan, *High Deductible Private*, is designed to represent the private component of the *Public-Private Risk Pool* with the same annual premium and a \$100,000 deductible.

Our main interest is determining whether more homeowners would purchase earthquake protection through the *Public-Private Risk Pool* than through private insurance currently offered in Canada. Today, public post-disaster assistance in Canada is not clearly defined *ex ante* and is not contingent on insurance coverage. We hypothesize that the *Public-Private Risk Pool* will be preferred to both private coverage options due to having a lower deductible and an annual price less than or equal to either private plan. [Hypothesis H1a]

Expected utility theory would predict greater demand for the *High Deductible Private* plan than the lower-deductible *Status Quo Private* due to a lower risk premium and a decrease in substituting market-based coverage to self-insurance (Ehrlich & Becker, 1972). However, empirical evidence on actual property and casualty insurance markets suggests that many households have a preference for lower-deductible (higher event probability) insurance plans, which is inconsistent with expected utility maximization for plausible levels of risk aversion (see e.g. Sydnor, 2010 on home insurance deductible choices) and research documenting a general tendency to prefer lower-deductible health insurance plan options in a similar experimental context (Kunreuther & Pauly, 2021). Based on these findings, we expect to observe higher take-up of earthquake coverage for the *Status Quo Private* plan since it has a lower deductible than *High Deductible Private* and both insurance policies reflect typical pricing in the current market as shown by Hypothesis H1b.

Hypotheses 1 [H1]:

1a. *A higher proportion of homeowners will choose to purchase EQ coverage when this involves participation in the proposed **public-private risk pool** than when it involves the **status quo private** coverage structure.*

1b. *A higher proportion of homeowners will choose to purchase EQ coverage when this involves the **status quo private** coverage rather than a **high deductible (HD) private** coverage plan.*

2.2 Opt-Out Enrollment

For any choice between two or more options, the default is the alternative that does not require any action by the decision maker. With respect to residential property insurance for a specific hazard like earthquake, the typical default is non-enrollment (i.e., a home insurance plan without any protection against losses from earthquake damage). The consumer could then decide whether to purchase an earthquake insurance rider (i.e., *opt-in* to coverage). An alternative frame would automatically enroll all homeowners in an insurance plan that covers earthquake damage with the consumer deciding whether or not to remove that aspect of coverage in return for a lower annual premium (i.e., *opt-out* of coverage) (Meyer and Kunreuther, 2017).

While neoclassical economic theory assumes that such a change in the default should not affect participation in a given insurance plan, empirical research has demonstrated that default options substantially influence even high stakes economic choices. In general, empirical studies show that opt-out enrollment increases take-up of an option relative to opt-in enrollment across diverse domains from health insurance prescription drug plans (Brot-Goldberg et al., 2021) to retirement saving (e.g., Madrian & Shea, 2001; Choi et al., 2004) to organ donation (Johnson & Goldstein, 2003). Empirical research has also shown that variation in the default plan across U.S. states also impacts the decision on what automobile insurance policy to purchase (Johnson et al., 2003). Opt-out enrollment increases the take-up of property insurance against natural disaster risk in surveys with hypothetical purchase decisions (Robinson et al., 2020). These findings motivate our hypothesis that making EQ coverage for Canadian homeowners' an opt-out feature of their home insurance rather than an additional feature that they can opt-in to would increase its take-up.

Hypothesis 2 [H2] *A higher proportion of homeowners will choose to purchase EQ coverage when it is presented as a default component of their home insurance plan which they can **opt-out** of rather than an extra type of coverage that they can **opt-in** to purchasing.*

2.3 Propensity to take up earthquake protection and underlying hazard

Given the lower likelihood of an earthquake in Quebec than BC and the small percentage of homeowners purchasing earthquake insurance in Quebec relative to those residing in BC, we anticipate Quebec respondents in our study will also be less likely to purchase private earthquake insurance or join the risk pool than BC respondents. We are also interested from a policy perspective in how preference for EQ insurance differs between homeowners in these two provinces when we change the default option and the nature of coverage (i.e., risk pool vs. status quo and high deductible private insurance). Given that there is greater interest in EQ insurance in BC we specify the following hypothesis:

Hypothesis 3 [H3] *A larger proportion of homeowners will purchase EQ coverage among **BC** homeowners facing the higher-hazard **BC** scenario relative to **Quebec** homeowners in the lower-hazard **Quebec** scenario.*

3. Methods

We conducted a web-based survey experiment in which Canadian homeowners from Quebec and BC were given a hypothetical scenario where they own a house in the province in which they currently reside and asked to decide whether or not to purchase earthquake coverage in the context of a specific earthquake protection plan. To test the hypotheses described in the prior section, we randomly assigned study participants to one of six experimental conditions by varying the insurance plan and default purchase option, and compared the proportion of respondents who chose to purchase EQ coverage across these conditions.³

3.1 Study Set-Up and Procedures

The web-based experiment was developed and implemented on the Qualtrics online survey platform and participants were recruited through the Leger Opinion panel. Following Leger's standard procedures, email invitations without details on the study topic, were sent to panel members who owned a home in either Quebec or BC and invitees could choose to participate by following an enclosed link to the survey. As the study includes French-speaking Quebec residents and English-speaking British Columbia residents, invitees could select between these two language options on the first page of the survey.

After answering a few brief screening questions on age, homeownership, country and province of residence to confirm eligibility and completing an attention screen to make sure they were reading task instructions correctly, those participating in the experiment were asked to assume the role of someone who owns a house with a typical property value (\$400,000 in Quebec and \$750,000 in BC) in the province in which they currently lived. They were then provided with information on the likelihood of a property-damaging earthquake in their province over the next 50 years, the average damage from such an earthquake and the likelihood that their house would be destroyed. (See Appendix A for the full text of the scenarios).

³ The pre-registered experimental design and analyses are available through AsPredicted at: <https://aspredicted.org/blind.php?x=6y3uw5>.

3.2 Experimental Design

The study featured a between-subjects design with equal probability of assignment to one of six conditions: 3 earthquake coverage plans (status quo private, public-private risk pool, or high deductible private) x 2 default choice frames (opt-in or opt-out). Figure 1 depicts this design schematically, showing the differences in background information given to Quebec and BC participants in Panel A, randomly assigned plans in Panel B, and default assignments in Panel C.

[INSERT FIGURE 1 HERE]

Earthquake Coverage Plans: Participants made a purchase choice for one of the three possible insurance coverage plans summarized in Table 1, Panel B: The *Status Quo Private* plan reflects typical current residential earthquake insurance policies in the Canadian private market with a moderate deductible of \$15,000 for Quebec and \$50,000 for BC with associated premiums of \$200 and \$650, respectively. The *Public-Private Risk Pool* has lower annual premiums (\$100 in Quebec, \$400 for BC) and a low annual deductible of \$1,000, after which the Canadian government covers the first \$100,000 in damage combined with private market insurance coverage for damages over \$100,000. The *High Deductible Private* plan offers only insurance covering damages over \$100,000 with the same annual premium as the public-private structure.

After respondents decided whether to purchase earthquake protection under a given insurance plan, some were then asked to consider a second plan and determine whether they wanted this type of coverage. Specifically, participants who were initially asked whether they wanted to participate in the *Public-Private Risk Pool* if this was their only choice were then asked if they would purchase *Status Quo Private* coverage if this were the only available plan. Those asked initially whether they would purchase *Status Quo Private* coverage were then asked if they would want protection from the *Public-Private Risk Pool* if this were the only plan available to them. Our prespecified analysis plan was to pool data from these two choices if there were no order effects. We did observe order effects, so these additional choices are not included in our primary analysis.

Default Choice Frame: Participants were randomly assigned to one of two default frames: In the *Opt-in* frame, participants read that they do not currently have earthquake coverage on their house and could choose whether or not to purchase coverage. In the *Opt-out* frame, participants read that they currently have earthquake coverage and could choose whether to opt out of this insurance and face a lower premium. Our main outcome measure is the proportion of participants in each experimental condition who chose to purchase earthquake protection.

3.3 Post-Choice Survey Measures

After making their insurance purchase decisions based on the relevant scenarios and plans, participants were directed to a post-choice survey module where the following measures of participants' perception of the earthquake hazard were obtained:

- an estimate of the cost to the homeowner if the property was damaged by an earthquake (either a dollar estimate, or “I did not think of a damage estimate”),
- a measure of how worried a participant would be about experiencing earthquake damage to their hypothetical house over the next 50 years on a scale from 1 (not at all worried) to 6 (extremely worried),
- an estimate of the likelihood that the house in the scenario would be damaged by an earthquake in the next 50 years ranging from “Less than a 1 in 1 million chance” to “Greater than a 1 in 10 chance” with 5 categories between these two extreme probability estimates. For respondents who selected one of the five intermediate likelihood ranges, we also elicited a fine-grained estimate of the likelihood within that range using a sliding scale with the lowest and highest probabilities at the two ends of the slider.

We also elicited the following background characteristics on the respondents:

- whether they had previously experienced earthquake damage to a house in which they lived (yes/no and the most recent year if an earthquake was experienced),
- whether they had previously purchased earthquake insurance
- their risk-taking tendency using a 10-point Likert scale ranging from 1 (extremely unwilling to take risks) to 10 (extremely willing to take risks).
- socio-economic characteristics: gender, highest level of school completed, categorical range of prior-year household income and their 6-digit postal code.

After respondents completed the survey, we determined a measure of their actual home's seismic hazard based on Peak Ground Acceleration (PGA) from the 2015 Geological Survey of Canada using the first three digits of the participant's postal code. The houses were assigned to a value on a seven-point scale with PGA ranging from 0.0 g (lowest measure) to 0.7 g or greater (highest measure) based on 0.1 g intervals where g is gravitational acceleration.

3.4 Participant Sample and Recruitment

Using panelists from the Leger survey, 1,201 Quebec homeowners and 1,199 BC homeowners were recruited for the experiment.⁴ Participants were assigned randomly to one of the six conditions at the provincial level. Table 2 summarizes the demographic characteristics and background of the full sample in the leftmost column and the two provincial subsamples in the next two columns. This table offers some insight into the generalizability of findings from our sample to the broader population of Canadian homeowners in the two provinces. Overall, 53% of the sample reported 2020 household income of over \$80,000, which is broadly consistent with 2018 median household incomes of roughly \$84,000 in Quebec and \$88,000 in BC⁵. As expected, given home-buying patterns, our sample skews substantially older than the total population average of around 42 years for both provinces in 2020 data.⁶ The average age in our sample is 57 years, quite consistent with a 2018 census study on housing in three provinces showing an average age of 56 among residential property owners in British Columbia.⁷

The last two rows of Table 2 show that 4% of the overall sample reported having experienced earthquake damage to a home in which they lived (3% among Quebec and 4% among BC respondents) and 34% reported that they currently have or previously had earthquake insurance. While the latter question does not map perfectly to data on current take-up (as it includes prior coverage at any residence), we can gain insight into differences between the provinces by comparing these statistics. Consistent with current CatIQ data showing a much higher share of homeowners with some EQ coverage in BC (44%) than in Quebec (3%), in our sample BC respondents were significantly more likely to report having purchased earthquake insurance (50%) compared with only 19% of the Quebec subsample.⁸

[INSERT TABLE 2 HERE]

⁴ This targeted sample size of $n=400 \times 6$ experimental conditions was determined based on a power analysis with 81% power to detect a true difference in take-up across two conditions with an effect size of 0.20 or more. Separate quotas for each province ensured comparable sample sizes in each condition.

⁵ Census Table: 11-10-0009-01 accessed at

<https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110000901&pickMembers%5B0%5D=1.9&cubeTimeFrame.startYear=2014&cubeTimeFrame.endYear=2018&referencePeriods=20140101%2C20180101>

⁶ See Census Table 17-10-0005-01 accessed at

<https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000501&pickMembers%5B0%5D=1.6&pickMembers%5B1%5D=2.1&cubeTimeFrame.startYear=2016&cubeTimeFrame.endYear=2020&referencePeriods=20160101%2C20200101>

⁷ “Homeownership, income, and residential property values.” <https://www150.statcan.gc.ca/n1/pub/46-28-0001/2019001/article/00002-eng.htm>

⁸ A chi-square test of proportions revealed that there was a significant difference between the purchase rate in the two provinces ($p < 0.01$).

Appendix Figure A1 illustrates this difference between the provinces in greater detail by plotting reported prior coverage among respondents and CatIQ average current coverage across respondent 3-digit postal codes ordered by increasing seismic hazard (PGA) and within each province. This plot also shows the larger gap between Quebec self-reports (dashed green) and actual province-wide take-up (solid green) than the same comparison for BC (dashed and solid blue). It further indicates that the gap between these measures in Quebec does not vary across respondents in postal codes with varying objective seismic hazard. However, we note that this difference between the correspondence of Quebec survey reports and actual take-up likely reflects broader confusion about EQ coverage than in BC. For example, a 2015 Insurance Bureau of Canada survey showed that roughly a third of the surveyed Quebec homeowners believed their policy already covered earthquakes relative to a 4% actual coverage rate at the time.⁹

4. Results

4.1 Overview of Results

The data from the web-based experiment were analyzed using logistic regressions. Our basic model (M1) predicts EQ take-up as a function of indicator variables capturing random assignment to one of the two default conditions, to one of the three insurance plans, and whether the participant lived in British Columbia (BC=1) or Quebec (BC=0). We estimate the following equation for the full sample, pooling both provinces:

$$\ln \frac{p}{1-p} = \beta_0 + \beta_1 * optout + \beta_2 * riskpool + \beta_3 * hdprivate + \beta_4 * BC \quad (M1)$$

where p captures the probability of purchasing EQ coverage so that $p/1-p$ is an odds ratio. The base conditions are *opt-in* for the default frame ($optout=0$) and *status quo private* for the insurance plan ($riskpool=0$, $hdprivate=0$).

To assess the robustness of the estimated effects of M1 to the inclusion of non-experimental controls, logistic regressions were undertaken for two additional models. M2 is identical to M1 with additional variables based on post-choice survey responses in the last term:

$$\ln \frac{p}{1-p} = \beta_0 + \beta_1 * optout + \beta_2 * riskpool + \beta_3 * hdprivate + \beta_4 * BC + \gamma'X \quad (M2 - M3)$$

where X is a vector of the following socio-economic characteristics of the respondents (age, gender, university education, and whether reported household income is above the sample-median of \$80k), self-assessed degree of risk-taking propensity (1-10 increasing), prior experience of residential earthquake damage (1,0), and currently or previously purchasing earthquake insurance (1,0).

⁹ See “Quake Coverage” *Canadian Underwriter*, October 14, 2016 at <https://www.canadianunderwriter.ca/features/quake-coverage/>

M3 is identical to M2 with one additional control variable in X that reflects the seismic hazard denoted by PGA at the respondent's actual home post code. The PGA variable examines whether differences in respondents' earthquake hazard in the house in which they are currently living affects their propensity to purchase insurance in the scenarios presented to them in the web-based experiment.

For each of these three models, we also estimated two logistic regressions for the subsamples of respondents from Quebec and from BC (Note: the coefficient β_4 in both equations drops out in these analyses). Table 3 presents the results from this series of regressions, with the three columns showing exponentiated coefficient estimates—that is, odds ratios—for M1, M2, and M3, respectively, for the full-sample models (columns 1-3) for the Quebec subsample (columns 4-6), and for the BC subsample (columns 7-9).

[INSERT TABLE 3 HERE]

To facilitate the comparison of the main estimates of interest across regression models, Figure 2 plots the odds ratio estimates of the opt-out default frame, insurance plan structures relative to the baseline of *Status Quo Private*, and respondent's province with 95% confidence intervals for M1, M2 and M3 (M1 estimates denoted by blue circles, M2 by red diamonds, and M3 by green triangles). The dashed vertical line at an odds ratio of 1 corresponds to no difference in the take-up outcome as a function of the variables in the logistic regression. The high odds ratios for the *Public-Private Risk Pool* indicates that respondents strongly preferred this insurance plan over the other two plans. The high odds-ratio for the default frame indicates that there was an increase in EQ insurance purchase if respondents were told they could opt-out of the plan rather than asking them whether they wanted to opt-in by purchasing the plan. BC respondents were more likely to purchase EQ insurance than those residing in Quebec and there was a slight preference for the *HD Private Coverage* than *Status Quo Private*.

[INSERT FIGURE 2 HERE]

4.2 Evidence on Earthquake Coverage Take-Up Hypotheses

Below, we discuss the evidence relating to each of our hypotheses in greater detail.

H1a. Risk Pool Take-Up > Status Quo Private Take-Up. The results of the study strongly support H1a that *Risk Pool-Private Coverage* will be more appealing to homeowners than *Status Quo Private*. As shown in the bottom panel of Figure 3, only 44% of participants assigned to a *Status Quo Private* plan purchase earthquake coverage compared to 66% of those assigned to the *Risk Pool-Private Coverage* plan. This difference is reflected in the logistic regressions coefficients for M1 (column 1) in Table 3.

Controlling for the choice frame and province, assignment to the risk pool is associated with being 2.51 times as likely to take-up of EQ coverage than if a participant was assigned to the status quo ($p < 0.01$). The full-sample models with additional controls, M2 (column 2) and M3 (column 3), show slightly higher but qualitatively similar odds ratio estimates.

The provincial models for Quebec (columns 4-6) and BC (columns 7-9) reveal that homeowners in BC are predicted to be at least 2.90 times as likely to take-up insurance coverage with the risk pool relative to the status quo, while those in Quebec are at least 2.15 times as likely to follow suit ($p < 0.01$ for all comparisons).

H1b. Status Quo Private Take-Up > High Deductible (HD) Private Take-Up

Pooling respondents from both provinces (M1) in Figure 3 reveals that there is no evidence of a statistically significant difference in take-up of earthquake coverage between the two private coverage plans with 44% take-up of those assigned to *Status Quo Private* and 48% take-up for those assigned to the *HD Private Coverage* plan. Consistent with this finding, M1 (Table 3, column 1) shows a slightly higher odds ratio of take-up for the *HD Private Coverage* plan compared to *Status Quo Private* but the difference is not statistically significant (odds ratio = 1.16, ns). This result is similar for M2 and M3.

[INSERT FIGURE 3 HERE]

When we compare the two private insurance plans within the Quebec and BC subsamples, as shown in Figure 4 (Panels A and B) there are very different effects. With respect to the Quebec sample (Panel A), a much larger proportion of homeowners preferred the *Status-Quo Private* (58%) than *HD Private Coverage* (36%) in the opt-out conditions and there was a slight increase in preference for *HD Private Coverage* in the opt-in condition (30% vs 36%). On the other hand, in the British Columbia sample (Panel B), there was a strong preference for *HD Private Coverage* for participants in the opt-in condition (65% vs 43%) and a weaker preference in the opt-out condition (48% vs 40%).

[INSERT FIGURE 4 HERE]

Turning to the logistic regressions (Table 3), the basic model (column 4) yields significantly lower predicted odds of take-up for those assigned to *HD Private Coverage* relative to *Status Quo Private* (0.71 odds ratio, $p < 0.05$), which is consistent with *H1b*. In contrast, column 7 estimating the same model on the BC subsample shows 84% greater likelihood (odds ratio = 1.84, $p < 0.01$) of taking up the HD plan relative to the status quo plan, contrary to *H1b*.

BC respondents' greater interest in a high deductible plan than the Quebec respondents may relate to ways the price menus differ in the two provinces. First, their reactions may stem from BC respondents perceiving the \$100,000 deductible as being a smaller proportion of the BC scenario's typical home value (\$750,000) than the typical home in the Quebec scenario (\$400,000). Another potential reason for this difference in relative preferences for the status quo and a high deductible plan for the two provinces is the dramatic 567% increase in the deductible for Quebec (\$15k to \$100k) and only a 100% increase in the deductible for BC respondents' (\$50k to \$100k). Third, affordability concerns may have a larger impact on BC respondents' relative preference for the cheaper High Deductible plan since respondents have similar actual incomes in both provinces, but BC respondents face steeper price increases from adding EQ coverage to a \$1,300 cost of coverage for other hazards in their scenario (50% price increase for Status Quo, 30% for High Deductible). In contrast, Quebec respondents face more modest price increases relative to the \$1000 premium for other hazards (20% price increase for Status Quo, 10% for High Deductible plan).

H2: Opt-Out Take-Up > Opt-In Take-Up. Consistent with H2, participants assigned to an opt-out default are significantly more likely to take up earthquake coverage than those assigned to an opt-in default. As shown in the dashed horizontal reference lines in the first panel of Figure 4, 58% of participants in the opt-out conditions (N=1,260) decide to take-up coverage, 11% higher than the 47% take-up rate in the opt-in condition (N=1,140). Turning to our main logistic regression model in column 1 of Table 3 where we are separately controlling for assigned plan structure and home province, we estimate an odds ratio of 1.64 ($p < 0.01$) for opt-out, indicating that a participant is 64% more likely to take up the coverage if they are assigned to an opt-out condition compared to an opt-in condition. The subsample models show similar estimated effects within each province, with slightly larger estimated effects for Quebec (columns 4-6: 1.80-1.81 odds ratios) than BC (columns 7-9: 1.40-1.49 odds ratios).

4.3 Non-Experimental Predictors of Earthquake Coverage Take-Up

H3: British Columbia (BC) take-up > Quebec take-up. As hypothesized, there is a lower take-up of earthquake coverage in the experiment among Quebec respondents overall (47%) than among BC respondents (58%), pooling across the experimental conditions as shown in Figure 3. In our main estimate, the logistic regression model controlling for experimental conditions (Table 3, column 1) shows that a BC participant is predicted to be 54% more likely to purchase coverage relative to a Quebec participant assigned to the same condition (1.54 odds ratio, $p < 0.01$).

In addition to offering robustness checks on our experimental design effects, the models (M2 and M3) that include non-experimental controls provide insight into relationships between respondent

characteristics and insurance take-up choices. Of particular interest, we can look at how variation in real-life experiences of earthquake hazard across participants relate to propensity to take up insurance in the experiment. As shown in Table 3 columns 2-3, M2 and M3 reveal that prior earthquake damage and purchase of earthquake insurance are associated with a higher propensity to take-up coverage in the experiment (odds ratios = 2.26-2.98, p 's < 0.01) with a much higher odds ratio in BC than in Quebec, as one might anticipate given that more severe earthquakes have occurred there in recent memory and more commonly felt events may offer physical reminders increasing the salience of the threat.

M3 reveals that the seismic hazard measure for respondents' home postal codes also predicts likelihood of take-up in the experiment. Specifically, we see that a 0.1 unit increase in the Peak Ground Acceleration (PGA) measure that captures variation in earthquake hazard across postal codes is associated with a 24% increase in the likelihood of purchasing earthquake coverage in the experiment. Interestingly, the estimate for BC in the full-sample models is still significant, with modestly attenuated magnitude when moving from the basic model to those in columns 2-3 where the additional controls capture the higher earthquake hazard for BC respondents and their greater likelihood of prior earthquake experience and current or prior earthquake insurance coverage. This indicates that homeowners facing the same physical hazard in BC and Quebec behave differently. Goda et al. (2020) investigated the relationship between earthquake insurance take-up rates in Canada and seismic risk indicators. Their analysis revealed that take-up rates in BC are proportional to earthquake risk levels while those in Quebec are consistently low irrespective of exposed hazard and risk levels.

We can compare the amount of variation in take-up decisions explained by the physical hazard measure relative to other variations between provinces by looking at the increase in pseudo- R^2 when moving from a model controlling only for the experimental condition (pseudo- R^2 = .038) and adding the control for PGA (pseudo- R^2 = .046) and then also for province (pseudo- R^2 = .057).¹⁰ This exercise indicates that each measure explains roughly one additional percent of variation in take-up decisions, implying that other provincial differences are as important in influencing take-up decisions as geographic variation in seismic hazard. These other differences between the provinces could be due to homeowners' risk perceptions, expectations about public disaster assistance, possibly exacerbated by decision-making heuristics like "herding" behavior in the province.

Consistent with economic theory, our 10-point survey measure of risk preference shows that a one unit increase toward the risk-loving end of the scale is associated with about a 10% lower chance of taking up insurance.¹¹ There is no evidence of significant differences in take-up by gender, age, or

¹⁰ Pseudo- R^2 is a model statistic between 0 and 1 interpretable as the share of total dependent variable variation in the sample explained by that model

¹¹ The risk-taking measure is entered as a continuous linear measure in the models presented.

household income, though we do see that respondents with a university degree are modestly more likely to purchase the insurance than their counterparts with lower education (odds ratio = 1.24-1.27).

4.4 Order Effects: Evidence from Secondary Coverage Choices

The estimates discussed above incorporate the decisions of only the primary insurance coverage choice because we observed differentially lower take-up of *Status Quo Private* among respondents who considered this plan after determining whether they want to participate in the *Public-Private Risk Pool*. This order effect is depicted in Figure 5, which compares the average share of respondents purchasing earthquake coverage in primary choices in light gray bars relative to secondary choices in dark gray bars. Here we see that only 38% of respondents purchase status quo insurance after considering the risk pool option, a significantly lower share than the 44% who take up the status quo insurance option when this is the first plan described to them (i.e., the null hypothesis of equal proportions is rejected with $p < 0.01$). In contrast to this finding, there is no order effect on take-up of the risk pool option when it is presented as either a first choice primary (66%) or secondary choice (65%) (i.e., $p = 0.50$).

[INSERT FIGURE 5 HERE]

The negative order effect for the less popular *Status Quo Private* plan is consistent with prior research comparing choices made when the decision maker can jointly evaluate two options relative to evaluating each of these options separately. Studies indicate that the joint evaluation mode tends to lead to greater differences in preference between two options than two separate evaluations of each option because it is easier for decision-makers to evaluate attributes that vary across options (Hsee et al., 1999). This literature also shows that for unfamiliar domains, the ability to jointly evaluate options produces a larger difference. Given that earthquake insurance is unfamiliar to many homeowners—particularly those outside of British Columbia—increasing consumer awareness of the possibility of a *Public-Private Risk Pool* would increase preferences for this option over the *Status Quo Private*, which is what we found. The negative order effect on the status quo plan and absence of a positive order effect on the *Public-Private Risk Pool* plan suggests that learning that *Status Quo Private* is a relatively bad deal first is more likely to influence demand for the *Public-Private Risk Pool* than learning that the risk pool option is a relatively good deal first. This behavior is consistent with loss aversion where losses loom larger than equally-sized gain (Kahneman and Tversky, 1979; see O'Donoghue & Sprenger, 2018 for a detailed review of the economic literature on reference-dependent preferences).

5. Conclusions and Policy Implications

Homeowners in Quebec and British Columbia were given the opportunity to purchase protection against earthquake losses in a web-based choice experiment where they were presented with the following options: a typical private insurance plan in the current market, a high deductible private plan, and a proposed public-private risk pool. The default frame was changed so the homeowner could either opt-in by purchasing this coverage or opt-out of being given this protection and receiving a premium discount.

Comparing earthquake coverage that resembles the current private market offerings for Canadian homeowners to a unified public-private risk pool dramatically increases the percentage of homeowners demanding earthquake protection. Controlling for other variations in the experiment, when a participant is assigned to the *Public-Private Risk Pool* rather than the *Status Quo Private* insurance plan, the likelihood of purchasing earthquake protection increases by 151% (odds ratio 2.51). Furthermore, opt-out enrollment substantially increases take-up of earthquake protection relative to opt-in enrollment. We estimate that the opt-out frame leads to a likelihood greater than 1.6 of purchasing coverage relative to the opt-in frame when given the same plan structure. This positive effect of opt-out enrollment does not differ significantly between the two provinces. Taken together these findings implies that the share of homeowners choosing earthquake protection in our full sample doubles from 35% under the status quo structure with opt-in enrollment to 71% under the proposed public-private risk pool with opt-out enrollment.

The results of this study have two important implications for policymakers and insurance practitioners interested in encouraging more homeowners to purchase earthquake protection against future losses. First, offering the proposed public-private risk pool that provides homeowners full coverage of damages after a \$1,000 deductible for a discounted annual price (\$100 for Quebec, \$200 for BC) subsidized by the publicly funded risk pool for the first \$100,000 in damages with private insurance covering additional losses would significantly increase the demand for earthquake protection relative to typical existing private insurance plans in both provinces. Second, independent of the available plan, providing homeowners with coverage against earthquake losses and allowing them to opt-out of this protection is likely to significantly increase their interest in protecting their house against future financial losses than if homeowners were asked if they would like to purchase insurance to cover earthquake losses to their property.

Table 1. Earthquake and Insurance Information in Experiment Choice Task

		Quebec	British Columbia
<u>Panel A. Earthquake Risk Information</u>			
<i>Constant across experimental conditions</i>			
	Likelihood of damaging earthquake, 50 yrs.	1 in 10	1 in 3
	Average damage amount damage	\$115,000	\$115,000
	Likelihood of full house value lost damage	1 in 13	1 in 19
	Full value of house	\$400,000	\$750,000
<u>Panel B. Earthquake Coverage and Prices</u>			
<i>Varied across experimental conditions</i>			
Status Quo Private Coverage			
	Annual Price	\$200	\$650
	Deductible	\$15,000	\$50,000
Public-Private Risk Pool			
	Annual Price	\$100	\$400
	Deductible	\$1,000	\$1,000
High Deductible Private Coverage			
	Annual Price	\$100	\$400
	Deductible	\$100,000	\$100,000

Note: This table summarizes the earthquake risk and insurance coverage and prices in the experiment's choice task. The first column displays information relating to the Quebec version of the scenario, which all Quebec homeowner participants were assigned to view, while the second column displays the analogous information for the British Columbia scenario and participants. All units are in \$CAD except for odds.

Table 2. Summary of Sample Overall and by Province

	<u>Overall Mean</u>	<u>Means by Province</u>		<u>Difference in means</u>
	All	Quebec	British Columbia	p-value, chi-sq or t-test
<u>Sample size</u>				
N	2400	1201	1199	--
<u>Demographics</u>				
Male [1,0]	0.47	0.46	0.48	0.35
Age [Years]	57.3	55.8	58.7	<0.01
University degree [1,0]	0.49	0.45	0.52	<0.01
HH income $\geq$ \$80k [1,0]	0.53	0.54	0.52	0.29
<u>EQ Damage and Insurance Experience</u>				
Have Had EQ Damage [1,0]	0.04	0.03	0.04	0.19
Have Had EQ Insurance [1,0]	0.34	0.19	0.50	<0.01

Table 3. Logistic regressions predicting EQ take-up [1,0] by experimental factor (default, structure)

Exponentiated coefficients (odds ratios); Standard errors in parentheses

Sample indicated in each column (All, QC only, or BC only)

Four specifications run with each of these three groups: study design IVs only, + respondent characteristic controls collected in study, + respondent postal code hazard from GSC, Removes EQ damage and insurance prior experience from (3)

		Full Sample			Quebec Subsample			BC Subsample		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<u>Experimental Factors (Level indicators)</u>										
Default (base = opt-in)										
	Opt-Out	1.64*** (0.14)	1.57*** (0.14)	1.59*** (0.14)	1.81*** (0.22)	1.80*** (0.22)	1.81*** (0.22)	1.49*** (0.18)	1.40*** (0.18)	1.41*** (0.18)
Structure of coverage (base = status quo private)										
	Risk Pool	2.51*** (0.26)	2.60*** (0.28)	2.59*** (0.28)	2.15*** (0.31)	2.21*** (0.33)	2.22*** (0.33)	2.91*** (0.43)	2.92*** (0.46)	2.90*** (0.46)
	High Deductible Private	1.16 (0.12)	1.11 (0.12)	1.12 (0.12)	0.71** (0.10)	0.69** (0.10)	0.70** (0.11)	1.84*** (0.27)	1.75*** (0.27)	1.75*** (0.27)
<u>Province in scenario</u>										
	British Columbia (BC=1, Quebec=0)	1.54*** (0.13)	1.25** (0.12)	1.33*** (0.13)						
<u>Respondent characteristics (survey responses)</u>										
	Prior experience of EQ damage [1,0]		2.98*** (0.81)	2.96*** (0.80)		2.01* (0.75)	1.97* (0.73)		3.91*** (1.61)	3.94*** (1.63)
	Prior experience purchasing EQ insurance [1,0]		2.40*** (0.24)	2.26*** (0.23)		1.53*** (0.25)	1.54*** (0.25)		3.37*** (0.44)	3.16*** (0.43)
	Risk-taking tendency, increasing (1-7)		0.87*** (0.02)	0.87*** (0.02)		0.89*** (0.03)	0.88*** (0.03)		0.85*** (0.03)	0.85*** (0.03)
	Male [1,0]		0.94 (0.09)	0.93 (0.09)		0.75** (0.10)	0.76** (0.10)		1.19 (0.16)	1.18 (0.16)
	University degree [1,0]		1.27*** (0.11)	1.24** (0.11)		1.33** (0.17)	1.30** (0.16)		1.19 (0.16)	1.17 (0.16)
	HH income above \$80k (sample median) [1,0]		1.09 (0.10)	1.07 (0.10)		1.15 (0.15)	1.13 (0.15)		1.02 (0.14)	1.01 (0.14)
	Age (10-year bins, base=<30)		1.00 (0.00)	1.00 (0.00)		1.01 (0.00)	1.01 (0.00)		0.98*** (0.00)	0.99*** (0.00)
<u>Respondent post code seismic hazard</u>										
	PGA (2015 GSC) binned in .1 intervals [1-7]			1.24*** (0.09)			1.30* (0.18)			1.13 (0.10)
N		2400	2397	2395	1201	1200	1198	1199	1197	1197
Pseudo-R ²		0.045	0.093	0.096	0.051	0.077	0.080	0.039	0.125	0.127

Exponentiated coefficients; Standard errors in parentheses. The seismic hazard measure is based on PGA (Peak Ground Acceleration) at the post code level from the Geological Survey of Canada (2015) given in units g (9.81 m/s²) that has been binned in .1 intervals [1-7]. * p<0.10 ** p<0.05 *** p<0.01

Figure 1. Experimental Design

Figure 2. Logistic Regression Odds Ratio Estimates Across Models Predicting EQ Coverage Take-Up

Figure 3. Share of Participants Purchasing Earthquake Coverage by Experimental Condition

Figure 4. Earthquake Protection Take-Up Across Experimental Conditions, by Province

Figure 5. Order Effects on Earthquake Coverage Take-Up

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Appendix A.

Figure A1 reports prior coverage among respondents in the Quebec (QC) and British Columbia (BC) surveys and CatIQ average current coverage across respondent 3-digit postal codes. It is followed by the **Web-Based Experiment Instrument for Quebec homeowners**

Appendix Figure A1. Shares of Reported Prior EQ Insurance Coverage and Current Observed Coverage across FSAs Ordered by Seismic Hazard, by province

Web-Based Experiment Instrument for Quebec homeowners

[Italicized text in brackets denote information about questions that were only displayed to some respondents based on experimental assignment or prior responses.]

Page Break

Would you prefer to view this survey in English or French?

Préférez-vous répondre à cette enquête en anglais ou en français?

☐ English. ☐ Français

Page Break

Thank you for your interest in participating in this research. This survey was designed by researchers at the University of Pennsylvania and the Institute for Catastrophic Loss Reduction (Canada) to better understand how individuals make decisions relating to earthquake insurance. It should take you 5 to 10 minutes to complete.

Please review the following information:

Your Participation is Voluntary

Your participation in this survey is voluntary. You may discontinue participation at any time during the survey by exiting the survey.

Confidentiality

We will make every effort to keep all the information you provide us during the study strictly confidential, except as required by law. Your name and other identifying information will not be connected with the responses you provide, so no one will be able to identify you in any publications that result from this research.

Payment and Benefits

Beyond the payment you receive for survey completion through LEO there will be no direct benefits of the study.

Questions

If you have questions regarding this research or your participation in it, please contact the researchers at lynnp@wharton.upenn.edu. If you have questions about your rights as a volunteer in this research study, you can contact the University of Pennsylvania Office of Regulatory Affairs at 215-898-2614.

Please confirm the statements below and click "Next" to proceed.

	Yes	No
I am age 18 or older.	☐	☐
I have read and understand the information above.	☐	☐
I want to participate in this research and continue with the task.	☐	☐

Before proceeding to the study instructions, we have a few quick questions about you.

1. What is your birth year?

2. What is your current living situation?

☐ I am a homeowner ☐ I am a renter ☐ other

3. In which country do you currently reside?

Page Break

4. In which province do you currently reside?

Page Break

Please consider the following situation and rate the items below: This is an attention check. Simply select the number 4 for each of the 5 items below.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
	1	2	3	4	5
Work colleagues	☐	☐	☐	☐	☐
Parents	☐	☐	☐	☐	☐
Siblings	☐	☐	☐	☐	☐
Family friends	☐	☐	☐	☐	☐
Acquaintances	☐	☐	☐	☐	☐

Page Break

In this survey, we will ask you to consider information and answer questions related to earthquake risk and insurance.

On the next page, you will read about a hypothetical scenario and make decisions related to insurance. Please read the information carefully and make your choices as you would if you faced the situation in real life.

Page Break

Hypothetical Scenario: Assume that you own a house in Quebec that would cost \$400,000 to rebuild if significantly damaged by an earthquake. There is a 1 in 10 chance of an earthquake that will cause damage in Quebec during the next 50 years. If an earthquake were to damage your home, the average cost to repair the damage is \$115,000 with a 1 in 13 chance the house would have to be completely rebuilt at a cost of \$400,000.

Reminder of Hypothetical Scenario: Assume that you own a house in Quebec that would cost \$400,000 to rebuild if significantly damaged by an earthquake. There is a 1 in 10 chance of an earthquake that will cause damage in Quebec during the next 50 years. If an earthquake were to damage your home, the average cost to repair the damage is \$115,000 with a 1 in 13 chance the house would have to be completely rebuilt at a cost of \$400,000.

[If Assigned Insurance Plan Structure = Status Quo Private & default frame = Opt-In]

You currently have home insurance that covers theft losses and fire damage at a cost of \$1,000 a year. Suppose the only available way to cover earthquake damage is private home insurance. Should you decide to purchase earthquake coverage on your home insurance policy, you would be responsible for the first \$15,000 in damage and insurance would cover damage exceeding \$15,000.

Would you pay an additional \$200 to purchase earthquake insurance?

☐ Yes ☐ No

[If Assigned Insurance Plan Structure = Status Quo Private & default frame = Opt-Out]

Suppose you have a home insurance policy covering theft, fire damage and earthquake damage to your home at a total cost of \$1,200 a year. For earthquake damage you would be responsible for the first \$15,000 in damage and your insurance policy would cover losses that exceed \$15,000.

Would you choose to remove earthquake coverage and reduce the annual cost of home insurance by \$200?

☐ Yes ☐ No

[If Assigned Insurance Plan Structure = Risk Pool & default frame = Opt-In]

You currently have home insurance that covers theft losses and fire damage at a cost of \$1,000 a year. Suppose the government and private insurers develop an earthquake risk pool that covers earthquake damage to your house that exceeds \$1,000. You would be responsible for the first \$1,000 in damage. The risk pool would cover losses that exceed \$1,000.

Would you pay an additional \$100 to participate in the earthquake risk pool?

☐ Yes ☐ No

[If Assigned Insurance Plan Structure = Risk Pool & default frame = Opt-Out]

Suppose you have a home insurance policy covering theft and fire damages. The government and private insurers develop an earthquake residential risk pool that covers earthquake damage to your house. For earthquake damage, you would be responsible for the first \$1,000 in damage. The risk pool would cover losses that exceed \$1,000. This coverage has been appended to your home insurance policy, but you have the option of removing it. The total cost of protection against fire, theft and earthquake damage is \$1,100.

Would you remove earthquake coverage from your home insurance by not joining the earthquake risk pool and reduce your annual cost by \$100?

☐ Yes ☐ No

[If Assigned Insurance Plan Structure structure = High Deductible Private & Default frame = Opt-In]

You currently have home insurance that covers theft losses and fire damage at a cost of \$1,000 a year.

Private insurers offer earthquake insurance that will cover any earthquake damage over \$100,000 to your

house.

Would you pay an additional \$100 to purchase earthquake insurance?

- ☐ Yes ☐ No

[Assigned Insurance Plan Structure = High Deductible Private & Default frame = Opt-Out]

You currently have home insurance covering theft, fire damage and earthquake damage to your home above \$100,000 at a total cost of \$1,100 a year.

Would you choose to remove earthquake coverage and reduce the annual cost of your insurance by \$100?

- ☐ Yes ☐ No

Page Break

This next group of questions relate to the house in the scenario you just considered.

Please answer these questions with reference to the information you had in mind while making choices in the scenario.

In the event that the house in the scenario is damaged by an earthquake, what was your estimate of the total damage amount?

☐ Damage Estimate: \$

☐ I did not think of a damage estimate

Page Break

How worried were you about an earthquake damaging the house in the next 50 years?

Not at all worried A little worried Somewhat worried Moderately worried Very worried Extremely worried

- ☐ ☐ ☐ ☐ ☐ ☐

Page Break

How likely did you think it was that the house in the scenario would be damaged by an earthquake in the next 50 years?

Please select the category that contains your estimate of this likelihood

- ☐ Greater than 1 in 10 chance ☐ Between 1 in 10 and 1 in 100 chance
- ☐ Between 1 in 100 and 1 in 1,000 chance. ☐ Between 1 in 1,000 and 1 in 10,000 chance
- ☐ Between 1 in 10,000 and 1 in 100,000 chance ☐ Between 1 in 100,000 and 1 in 1,000,000 chance
- ☐ Less than 1 in 1,000,000 chance

Page Break

[Displayed if prior question response="Between 1 in 100,000 and 1 in 1,000,000 chance"]

For that same estimate of the house's likelihood of being damaged by an earthquake in the next 50 years:

Please indicate your best estimate of damage likelihood on the slider below within the range you selected from 1 in 1,000,000 chance of occurring up to 1 in 100,000 chance.

Low
1 in
1,000,000

High
1 in
100,000

Page Break

This next group of questions are all about your real life

Have you ever experienced earthquake damage to a home in which you lived?

☐ Yes ☐ No

Page Break

[Displayed if prior question response=Yes]

What is the most recent year that you experienced earthquake damage to your home?

Page Break

What types of insurance have you had before?

Please select ALL that apply.

- ☐ Flood insurance
- ☐ Homeowner's insurance
- ☐ Auto insurance
- ☐ Health insurance
- ☐ Earthquake insurance
- ☐ None of the above

Page Break

In general, are you a person who is more willing or unwilling to take risks?

Extremely unwilling to take risks										Extremely willing to take risks
	1	2	3	4	5	6	7	8	9	10
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Page Break

What is your gender?

☐ Male ☐ Female ☐ Other

What is the highest level of school you have completed?

- ☐ Less than high school
- ☐ High school
- ☐ Some university
- ☐ University degree (e.g., Bachelor or Associate degree)
- ☐ Advanced degree (e.g. Masters, Doctoral, or Professional degrees)

What was your total household income last year?

Please think of income from all sources in 2020 before taxes.

What is your postal code?

Page Break

You've completed the study, thank you for participating!

Please click "**Submit**" to record your responses and be redirected to LEO.

Let us know below if you experienced any problems with the study or have questions or comments [Optional].