**Introduction**

Good afternoon everyone. My name is Francis Wang and I am from Group 10. Thank you for the opportunity for us to work with citigroup and we'd like to welcome you all to our presentation on Climate Change and the Insurance Industry.

Hello I am Shaoyang

Hi this is Manyi

Hello I’m Sam

**Slide 0 - Sam**

* We decided to look into wildfires because the severity of these disasters is a relatively new concern that receives a lot of media attention.
* Also, wildfires interestingly fuel global warming. Higher temperatures cause more fires which releases a ton of CO2 which in turn causes more trapping of greenhouse gasses. This is a vicious feedback loop we were interested in.
* From our econometric work we identified a profitable market that could not only benefit companies financially but have positive external effects on people, governments and the environment.
* Now manyi will go deeper into the problem.

**Slide 2 - Manyi**

* Wildfires are a growing problem, affecting health and livelihoods for tens of millions of people costing billions of dollars. Running a simple regression across the U.S, we can see there is an obvious increasing linear trend in acres burned in the last four decades, and we’ve estimated a 21% increase in average fires in next 10 years.
* It is noted that it costs California alone $400 billion on wildfires in 2018. The costs are mainly associated with business infrastructure, destruction of homes, and firefighting costs.
* Our analytics are trying to find factors that can do harm induction and save money caused by these wildfires. By looking at these important factors causing wildfires, insurance companies, homeowners and at-risk businesses can invest in order to cut loss from future uncontrolled damage.

**Slide 3 - Manyi**

* This picture shows that the wildfire in recent years killed a number of people and caused huge amounts of losses for businesses. Frequent wildfires have already attracted the attention of insurance companies as more and more insurances claimed.
* It’s clear the largest stakeholders in preventing wildfires are insurance companies. *For example* one fire caused 8 and a half billion in insurance premiums to be paid out.
* Thus, prevention of wildfires would be very important to the insurance industry, which could offset their future insurance payouts.

**Slide 4 - Francis**

* Thank you Manyi!
* One of the most important variables we found from our wildfire analysis is called prescribed burn. It is a planned fire; also sometimes called “prescribed fire,” and it is used to meet management objectives. A prescription is a set of conditions that considers the safety of the public and fire staff, weather, and probability of meeting the burn objectives.
* A scientific prescription for each fire, prepared in advance, describes its objectives, fuels, size, the precise environmental conditions under which it will burn, and conditions under which it may be suppressed. An effective prescribed fire can smartly divide an entire forest into smaller regions so the fire cannot spread past the previously burned area, ultimately leading to containment and less acres burned.
* Prescribed burn is one of the most important tools used to manage fire today. Since 2018, California has begun to increase the use of prescribed burn to lower the damage caused by wildfire.

**Slide 5 - Francis**

* For this page, we have listed fire seasons for different states. For each of them, fire season might not come simultaneously. In this way, we have adjusted the issue in our model and projected one year’s wildfire based on last year’s fire season for each state.

**Slide 6 - Francis**

* In our model, we have a series of variables used for wildfire analysis and future disaster prevention. They include monthly raining data, monthly temperature data, monthly Palmer Drought Index (which is a relative dryness indicator estimated by available temperature and precipitation data [-10:dry & +10:wet]), previous year’s total acres of wildfire burn data, and prescribed burn data from 2003 to 2018. All of these data applies to five states including: California, Colorado, Nevada, Oregon and Utah.
* We analyzed variables coming from the preceding year of fire season, in order to make this model predictive.
* Next, I will pass time to Shaoyang to have a closer look at our analysis method.

**Slide 7 - Shaoyang**

* Thank you Francis
* We generate a panel dataset with 16 years and 5 states and mainly use the vector autoregressive model. Under the stable condition, the VAR model is consistent with the least square estimation, but it does better in identifying the dynamic relationship between variables, which also are convenient for prediction, interval estimation, and model diagnosis.
* Based on the stationarity of the series, we run the granger causality test between prescribed burns, which is RXburns, and actual burned area. In other words, this statistical hypothesis test could help determine how the previous changes of RXburns effectively explain the change in actual wildfire. We can see the example of Utah: a certain number of increase of Rxburns could significantly cause the decrease of wildfire acres by 2.7 times.
* To get the reliable model and also avoid overfitting problems, we re estimate the model by cross validation method. We remove some data and process the Rotation Estimation. Similar train and test scores turns out there’s little overfitting problem.(mean squared errors no crazy jump)

**Slide 8 - Shaoyang**

* Let’s take Colorado for instance. First, we run the granger causality test between acres and RXburns. It turns out that prescribed burn could reduce the burn acres under 5% significance level.
* Therefore, we could run all the subsets regression which is forced in RXBurns. And we chose six significant weather features to construct the model which could explain 97.55% of the variance in wildfires as seen by the R-squared. And the p value of the model and coefficients are nearly zero implying very strong statistical significance.
* To be specific, The temperatures of January and April could greatly reduce the wildfire next year, also for rain in April, September and December. If the rain in December increases 1 inch, the wildfire next year would decrease nearly 37 thousand acres. If we manage one more acre of prescribed fire, the natural wildfire would reduce 4 times and next Sam will show how worthwhile this investment is.

**Slide 9 - Sam**

* So we repeat this method for each state: removing the fluctuation due to weather patterns to extract the causal effect controlled burns have on acres burned by wildfires we estimate beta for each state.
* The interpretation of these Betas: For every 1 acre of controlled burn we see a *beta* decrease in uncontrolled acres burn during fire season
* A larger magnitude implies a bigger effect of controlled burns we have in this state.
* All of which were statistically significant and robust to cross validation.
* CA you may notice is below 1, meaning it’ll take more burning of land to save less. However: controlled fires cause no damage to property, human lives e therefore no premium s tc. and
* And we believe these betas can be higher if controlled burns were done more strategically.
* So now, looking at the average per acre cost to perform a prescribed burn. We can calculate the inverse of these betas. The cost to **save** one acre of wildfire damage with preventative methods.

**Slide 10 - Sam**

* This can be seen in yellow.
* We aggregate all the data we could find for insurance premiums and divide by the associated acreage burned. Putting all of this into 2018 dollars we estimate an average cost to Insurance companies for each acre burned; seen here in red. Comparing these per acre costs preventively in yellow and reactively in red makes it clear most states preventative measures will generate a very high ROI.
* Further, we did the same averaging for fire department costs per acre. If insurance companies helped alleviate some of this cost from the government there would no doubt be subsidies in place.
* Our actionable insight is that privatization of prescribed burns is highly profitable. And will increase well being for all. This is an entirely new market that has never been capitalized on.
* Next, back to Shaoyang for some improvements

**Slide 12 - All of us**

* When it comes to the future works, we think we could improve in four aspects.
* 1(Shaoyang)- Once we have got a large amount of data, we could use machine learning methods to prove the causal inference of prescribed burn and saved resources. Specifically, we could use the Structural Causal Model for proof which is more robust than a granger test.
* 2 (Manyi) - Furthermore, if we had access to more comprehensive data provided by insurance companies, we could forecast future wildfires and wildfire insurance premiums by state because of the high correlation between the fires and premiums.
* 3 (Sam) - There is detailed weather data available for counties. Really rooting through the fire data to determine which fires were in which county would allow this analysis to be done on a more granular level. Along with the finer insurance data. We could give a much more targeted plan.
* 4 (Francis) - As we have a chance to get access to more variables, we can also apply Machine Learning methods such as Principal Component Analysis (PCA) in our model. With dimension-reduced data using the PCA method, the most influential variables can be found and noise can be largely eliminated so that it turns out to be a more accurate model.

**Slide 13 - Manyi**

* Conclusions: We’ve proved that Privatization of controlled burns is a profitable industry
* There is a large case to be made this industry could receive subsidies as it will save fire departments lots of money, reduce loss of life and infrastructure and help reduce greenhouse emissions
* Finally, there is more work to be done in the strategy and execution of this plan. Thank you