The Way Forward

Challenges and Solutions to Assuring Quality Index Insurance

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Workshop on Agricultural Insurance in Tanzania
Dar es Salaam, 19 July 2018

The Challenge

- Evidence that insurance can work
- But uptake of index insurance is often low:
  - Low quality (failure-prone)
  - High price
  - Lack of trust in providers
  - Lack of information on a complex, novel technology (learning difficult)
  - Cash constraints to purchase
  - Behaviorally oddities (ambiguity aversion)
- Index insurance remains work in progress

Elements for a Solution

- Our goal is to look forward & specifically focus on advances that might solve these problems:
  - Quality standards & certification to help create a viable insurance market
  - Ground-truthing contracts & employing technological advances to create high-quality insurance indices

The Index Insurance Quality Problem

- A quality index insurance contract is one that:
  - Adequately protect farmers against income fluctuations; and,
  - Can achieve the objectives we seek in offering insurance to developing country farmers (before & after)
- Like hybrid maize seeds, quality of index insurance :
  - Is a hidden trait (that is, the farmer cannot look at the contract paper & tell if it will protect her)
  - High quality is more costly to develop and supply high quality than low quality
- Unlike certified hybrid seeds:
  - No defined & enforced quality standards (akin to germination & yield tests for seeds)
  - Takes many years for farmers to discern quality (even harder than for maize seeds)
- Given these characteristics, economic theory suggests unregulated market can reach a junk equilibrium with low quality insurance and low demand

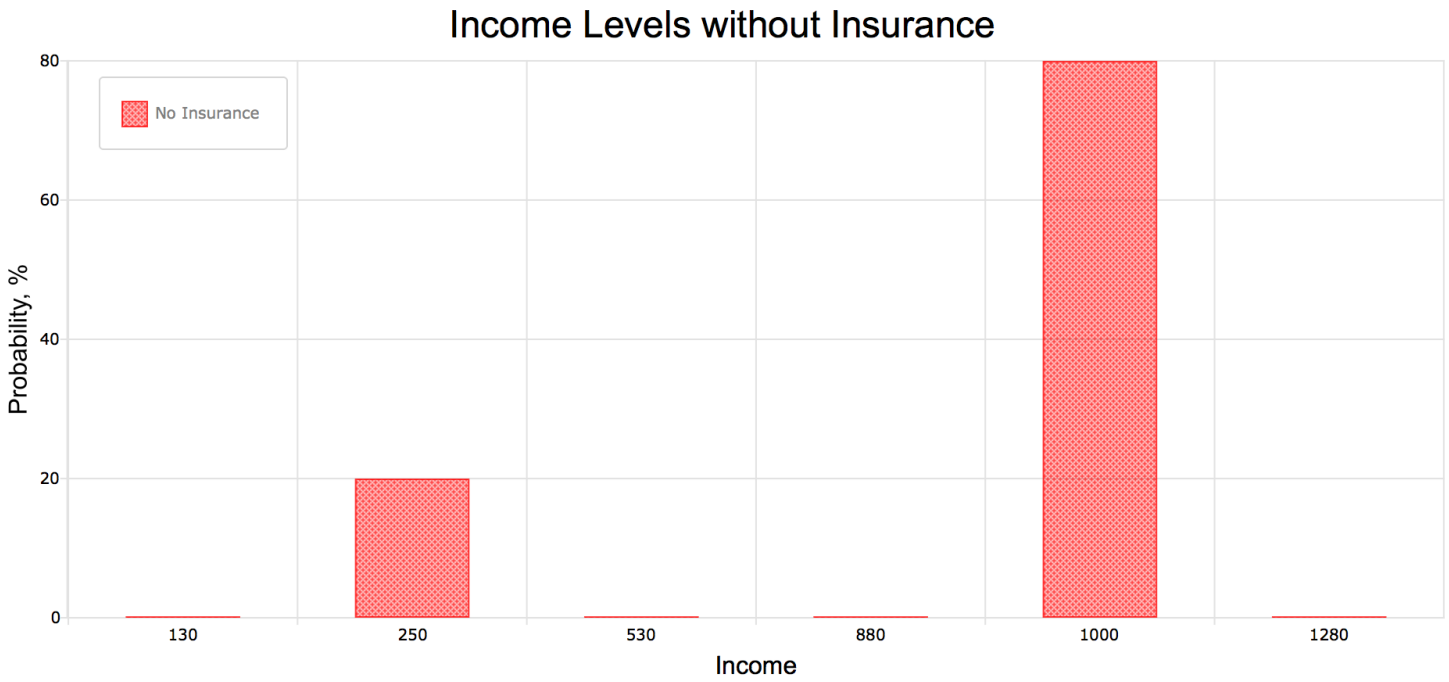
Defining Index Insurance Quality

- Whether quality is certified by insurance regulatory authorities (like maize seed) or whether it is certified by an independent private lab (akin to the Underwriter Labs for electrical devices), we need clear, conceptually sound minimum quality standard
- Define the Minimum Quality Standard (MQS) as:
  - The expected economic well-being of the insured is no lower with the insurance than without the insurance
  - More formally, the 'certainty equivalent' of the insured's income stream with insurance is no lower than the certainty equivalent of her income stream without insurance
- First, use a simple numerical example to explain the quality problem and a minimum quality standard
- Later give a real world examples of measuring and testing to see if a contract meets the MQS

A Stylized Agricultural Setting

- Let's assume that a farm household can experience either a good year or a bad year:
  - Good years happen 80% of the time and the household earns \$1000
  - Bad years happen 20% of the time and the household earns only \$250
- The farm household can either go it along and absorb this risk, or it can buy an insurance contract designed to pay the family \$400 in bad years
  - Let's initially assume a perfect insurance contract that always works, never fails and has zero basis risk
  - The "pure" or "actuarially fair" premium for this insurance will be the probability a payment is made (20%) times the amount paid (\$400): 20% x \$400 = \$80
  - Let's assume that the market price of the insurance after a 50% markup (reinsurance, taxes, marketing and admin costs) will be 150% x \$80 = \$120

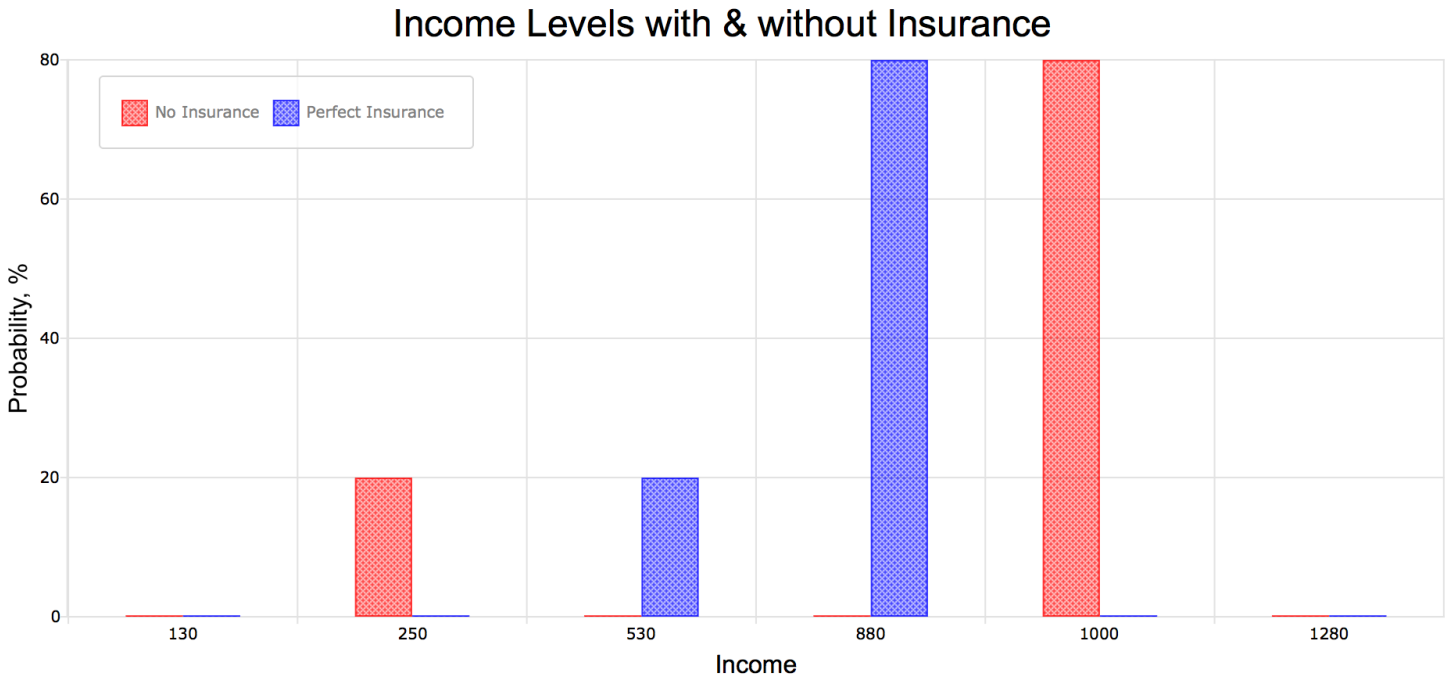
Stylized Agricultural Setting



Go It Alone or Buy Insurance?

- The question we want to ask is:
  - *Would the farm household be better off going it alone without insurance, or would they be better off with insurance?*
- If the household would be better off economically buying insurance, then we will say that the insurance contract meets the Minimum Quality Standard (MQS)
- Let's look at a picture to fix ideas:

Go it Alone or Buy Insurance?

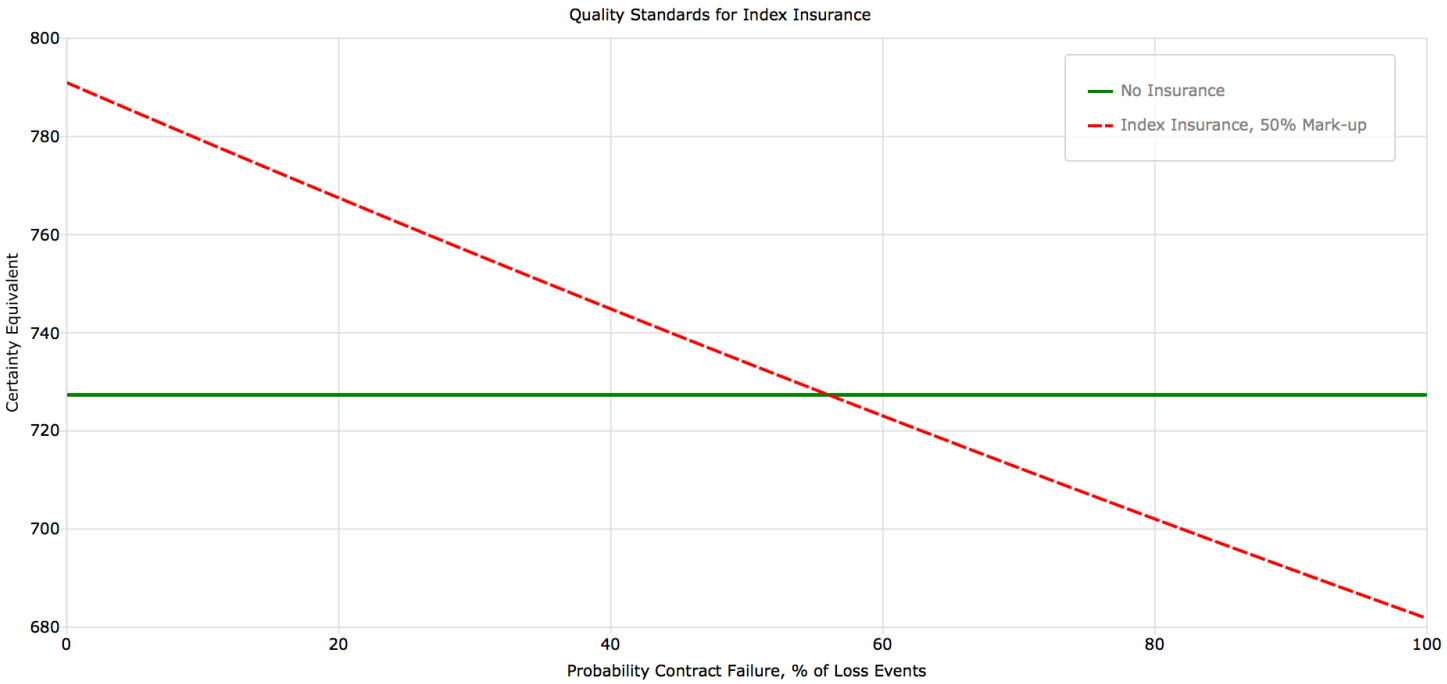


- Note that without insurance, average household income will be $850
- With perfect insurance, average income will be $810 (a ~5% decrease)
- *Is the stabilization effect of insurance worth this lower income?*

Go it Alone or Buy Insurance?

- *Is the stabilization effect of insurance worth the lower income?*
  - It can be if a dollar in times of stress is worth more than a dollar in times of plenty?
  - In this case, will a farmer give up a $1.50 in times of plenty to have $1 in times of stress?
- Economists have a standard way of thinking about and measuring this: a person with higher "risk aversion" is willing to give up more in times of plenty to have that $1 in times of need
- Using our stylized agricultural economy, we can answer our core question for perfect insurance assuming a moderate level of risk aversion:

Perfect Insurance Exceeds the MQS!

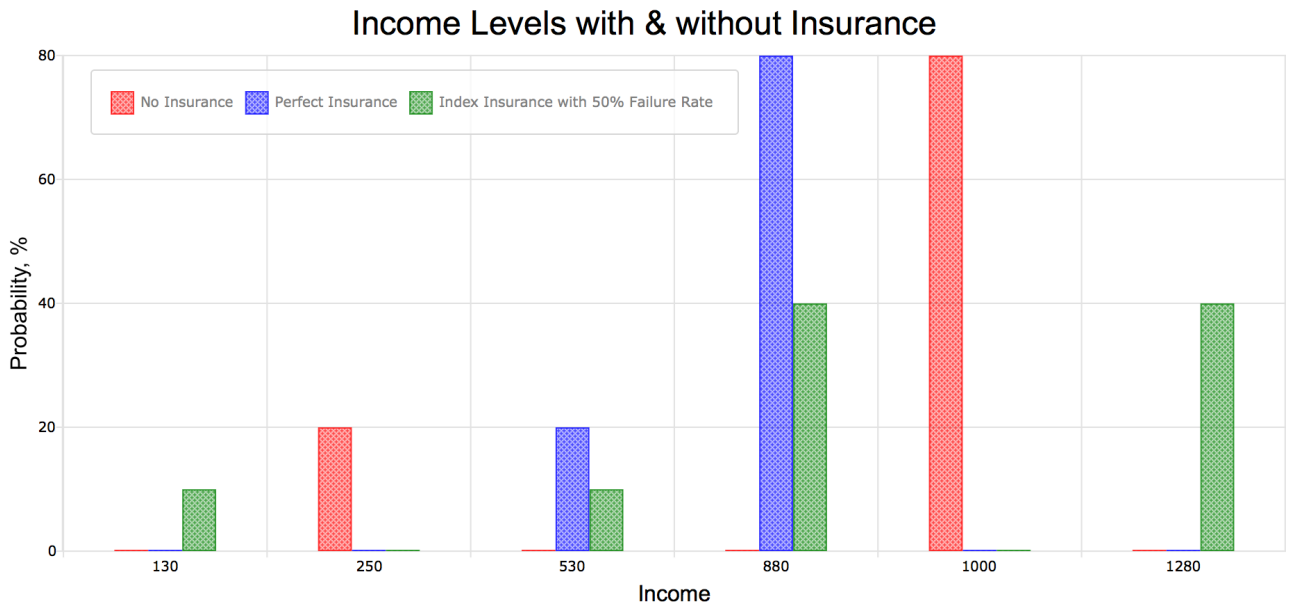


- Perfect insurance has zero failure probability
- Measured well-being in certain income equivalent (*e.g.*, the go it alone strategy has an average income of \$850, but its risk-discounted certainty equivalent is only \$730)

What about Index Insurance?

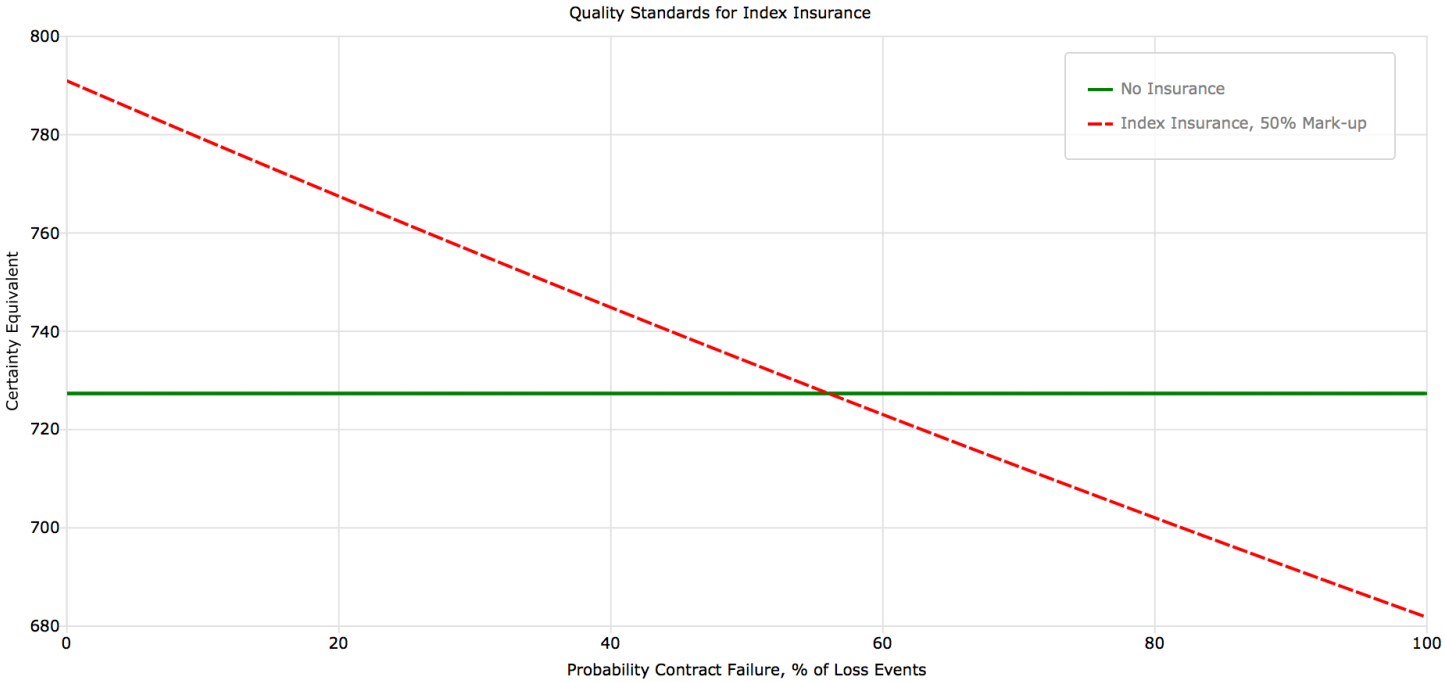
- Index insurance can be a great tool because it reduces administration costs that make conventional (loss-adjusted) insurance infeasible for small-scale farmers
- But, its achilles heal is that it sometimes fails farmers, not paying when the farmer truly has a loss that is not due to farmer negligence (*false negative*)
- It can also pay farmers when they have not had a loss (*false positive*)
- To keep things simpler, we will assume that the false negative probability equals the false positive probability
- We have seen that a risk averse farmer will be better off with perfect insurance rather than going it alone, even when insurance is marked up by 50%
- Let's examine whether a farmer would rather go it alone or have index insurance as we increase the failure rate for index insurance:

Go it Alone or Buy Index Insurance?



- Note that the worst thing that can happen gets worse with index insurance
- Note also that money is transferred from high value bad years to low values good years
- This is not free money! The farmer paid $1.50 for every dollar received, with a fraction of the dollars coming in bad years when the farmer really needed that money
- *So Is lower income worth the stabilization effect of INDEX insurance?*

Index Can Exceed the MQS if Failure Rate Not Too High



- In this example, if failure rate approaches 50%,, the farmer is better off going it alone
- Is 50% a high failure rate–not in the world of rainfall contracts
- Certification of MQS is needed

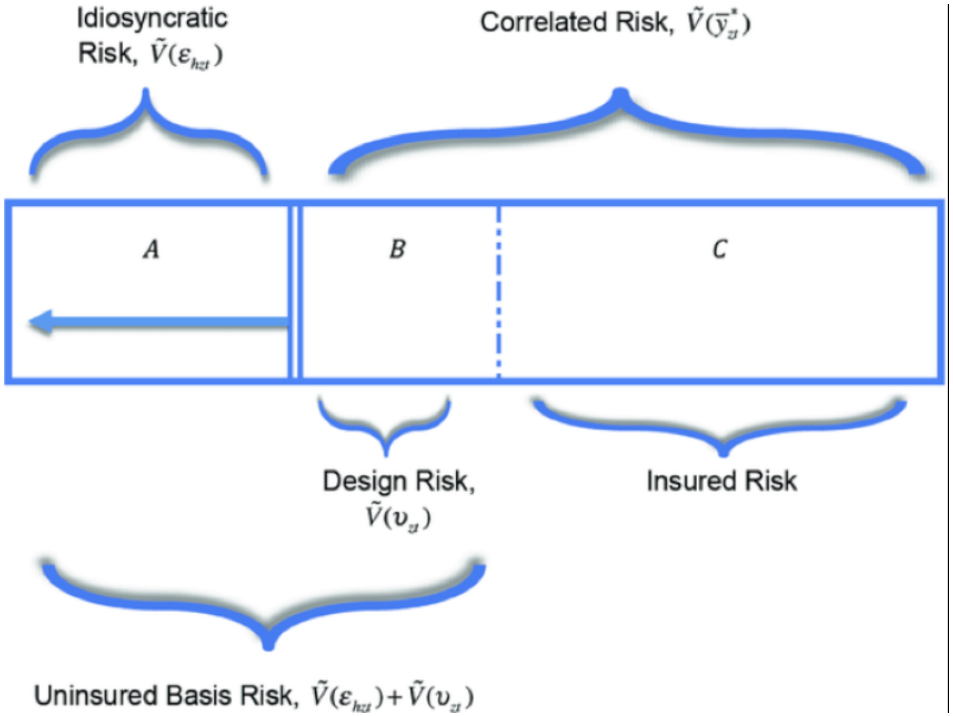
Moving Forward Quickly with QUIIC

- Lest we despair, we will return later to discuss contracts that bring down the failure rate and increase the economic value of insurance
- If we believe that risk matters that insurance can enhance development, then we must get serious about MQS lest a perfectly good tool and market get destroyed as the bad contracts drive out the good.
- Currently working to raise funding to establish a Quality Index Insurance Certification (QUIIC) in East Africa
- Examples of private and public certification & branding

So What Are Sources of Contract Failure?

- Disappointed (angry) farmers & what are sometimes called "Basis Risk Events" have punctuated the importance of designing contracts that protect farmers
- Sources of uninsured risk are two:
  - *Design risk* occurs when an insurance index is poorly correlated with *average* losses in the insurance zone covered by the index; and,
  - *Idiosyncratic risk* occurs when the individual's losses differ from the average losses in her insurance zone.

Insured & Uninsured Risk under Index Insurance

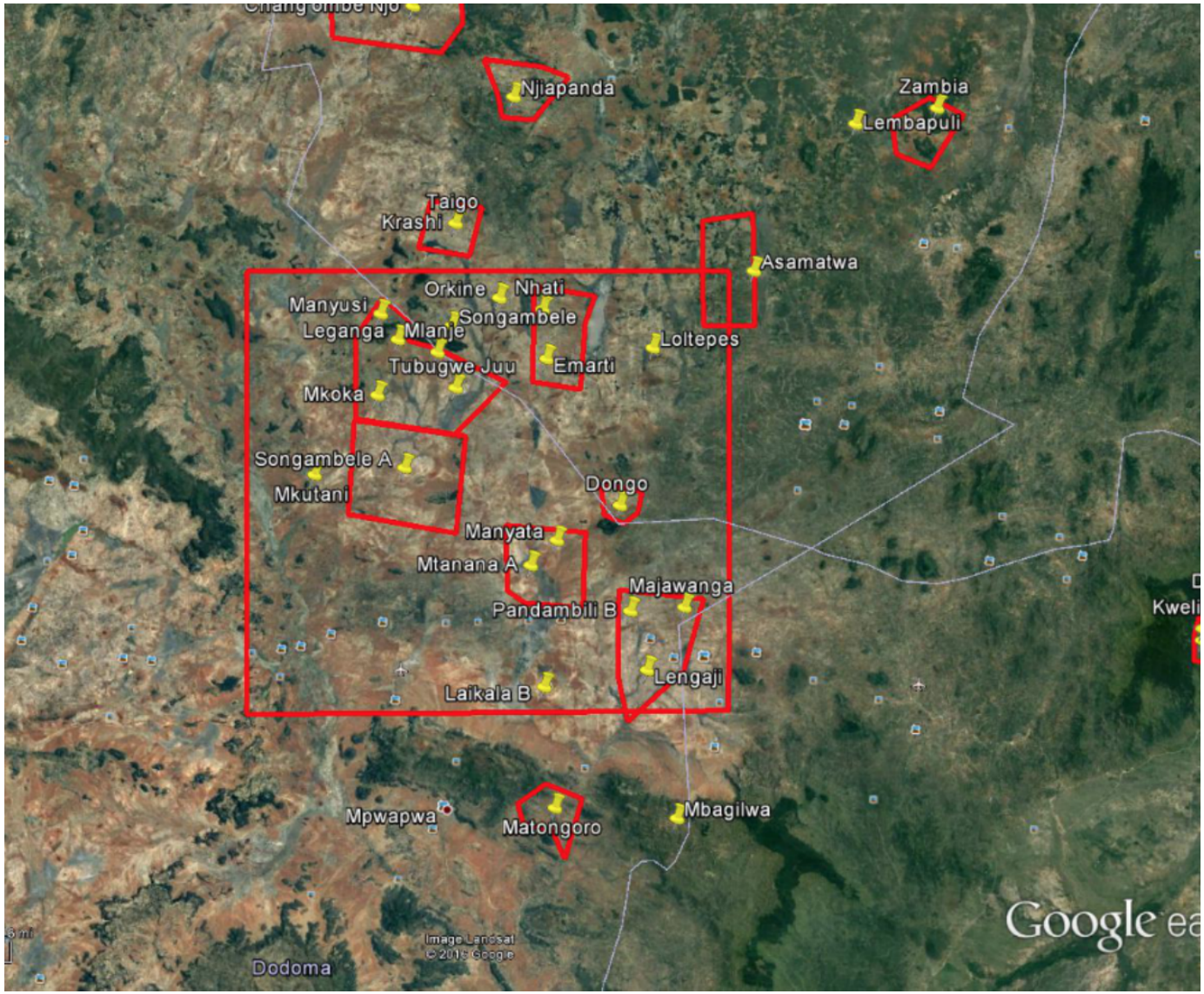


- Design risk can be minimized by improved contract design
- Idiosyncratic risk can be minimized by downscaling contract (subject to moral hazard constraints)
- Examine a recently implemented contract in Tanzania & Mozambique to illustrate design and implementation of a high quality contract

Contract Concept & Design

- Ongoing project in Tanzania and Mozambique is exploring the complementarity between index insurance and drought tolerant (DT) maize seeds that offer some protection against mid-season drought.
- Goal was to design a contract that offered protection against:
  - Early season rainfall deficit; and,
  - End of season yield deficit
- To this end, we collected current and retrospective maize yield data that would allow us to design a quality contract based on two satellite indices:
  - Estimated rainfall data to detect early season drought
  - NDVI (a bio-mass or "greenness" index) to measure yield deficit
- Measure each of these at the level of "contract zones, which comprise roughly 3 villages

Insurance Zones, Dodoma



Index Design

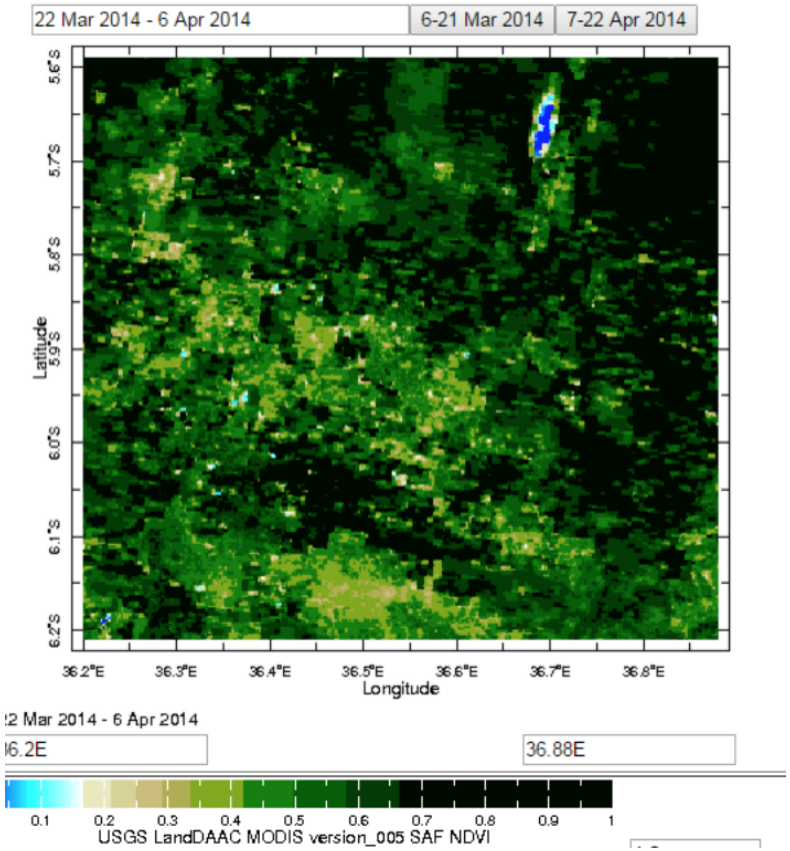
- Data for ground-truthing, testing & (eventually) certifying insurance index is crucial
- Early season rainfall deficit trigger:
  - 5x5 kilometer (25 square kilometer) resolution
  - Data at 10-day (dekad) frequency
  - Use data to estimate planting date and then detect early season drought
  - Contract triggers payment if estimated rainfall below 90 mm over the first 40 days of the growing season

Index Design

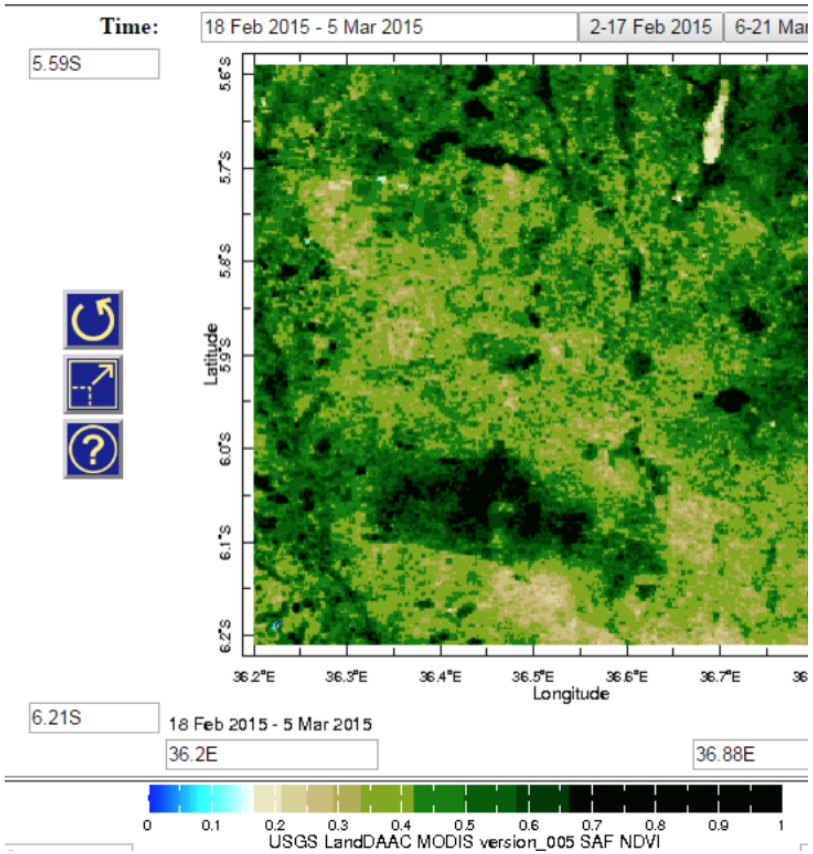
- Yield shortfall trigger based on Normalized Difference Vegetation Index (NDVI)
  - Measures biomass growth over the maize growing season
  - Data available on 250 m x 250 m grid (6 hectares) since 2002
  - Crop masking used to discard pixels that are not maize
  - Contract Triggers if predicted yields are less than 65% of their long-term average
- Optimized statistical model explains 80% of zone variation in yields (still some design risk)
- Scope for improvement with downscaling & ultra-high resolution data from Planet Labs (3mx3m)

Index Design: NDVI

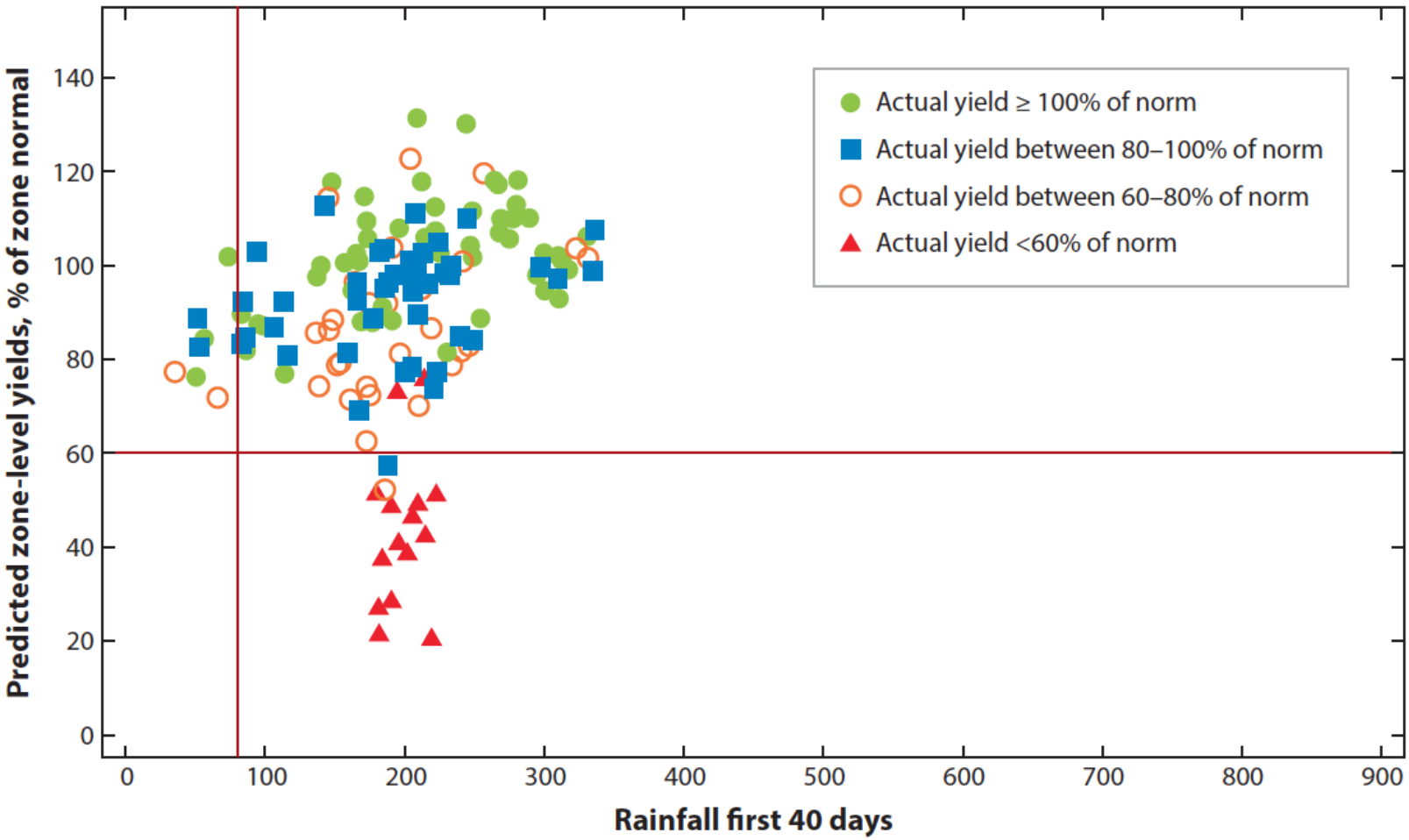
2014 (Planting 11 Jan, 2013)



2015 (Planting 1 Dec, 2014)



Overall Contract Performance



Fail-Safe Audit

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- An on-farm audit can occur if farmers experience yield losses that are not predicted by the satellite data:
  - Farmers are notified 100 days after planting if insurance payout will occur in advance of harvest;
  - Farmers may then call for an audit if they believe the insurance did not properly cover their losses
- Audit triggered if at least 50% of farmers complain
- Camera-based audit is conducted by a team trained by CIMMYT crop officers from the Ministry of Agriculture

Summary of Steps to Design for Quality

- Scale down insurance zones to smallest level possible given technology & moral hazard problems (including reliance on double trigger contracts as with cotton contracts)
- Use ground-truthing & technology to eliminate design failure
- Consider fail-safe audit to definitively eliminate design failure
- Beware that in some environments index insurance may never work because intrinsic idiosyncratic risk is too high

In Conclusion

- Problems of risk & resilience more powerful than ever
- Time to neither praise nor bury index insurance
- Technological frontier is exciting, but we need more attention to the designing contracts for quality
- Governments & the private sector can support the development and certification of quality standards
- Can also promote portfolio thinking which flexibly that combines financial and agronomic risk management technologies in flexible ways that evolve over time for individuals

Extra Slides

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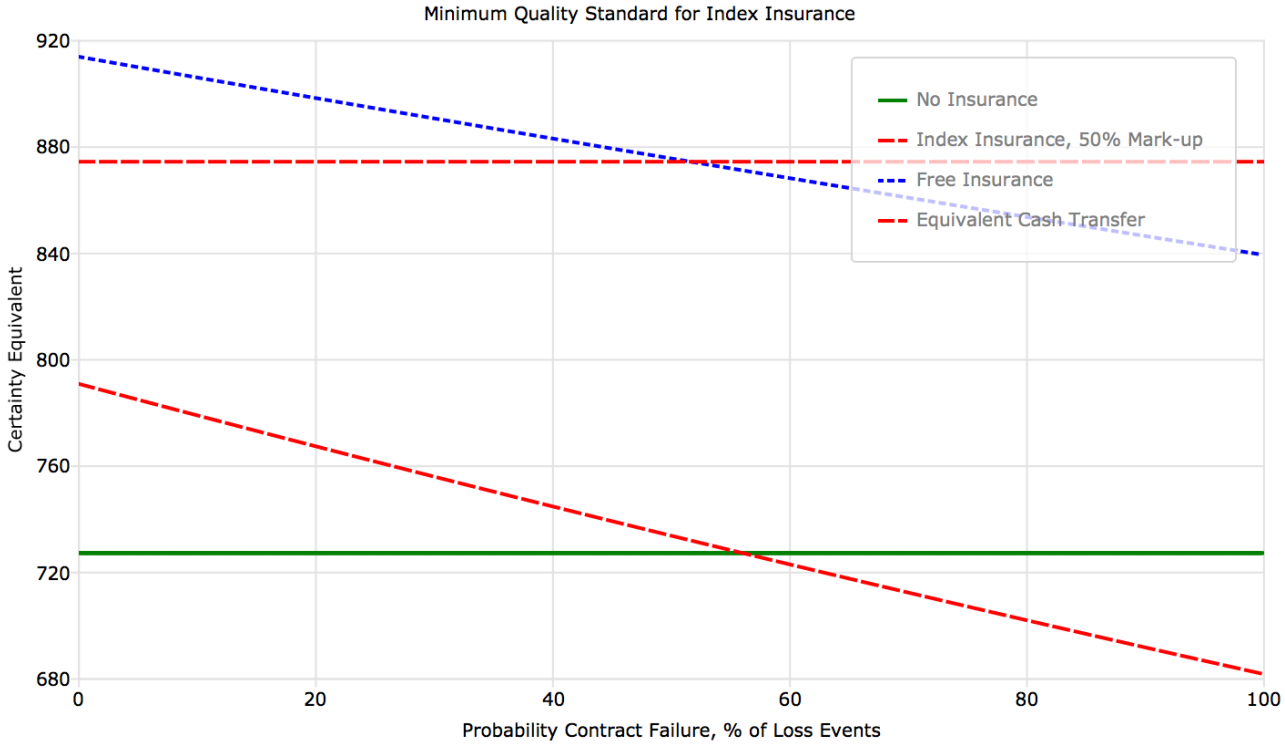
What about Subsidies?

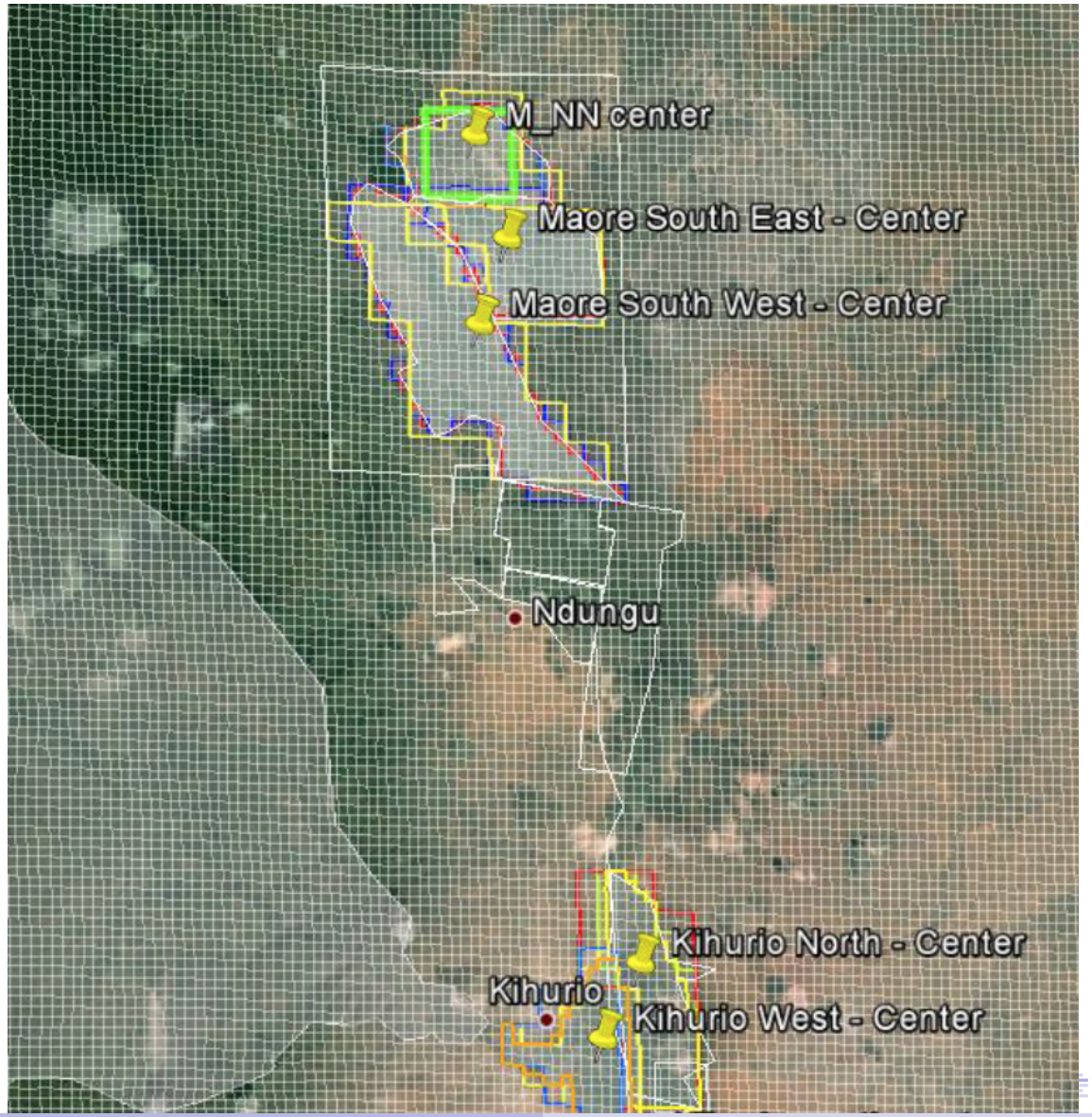


- Easy to say that who cares about MQS if the farmer does not pay because the insurance is subsidized
- That intuition is wrong
- Consider the following experiment: *would farmers rather have failure-prone insurance for free or be given the cost of the failure-prone insurance as an annual transfer?*
- Implications for smart public policy

Another Practical Application of MQS

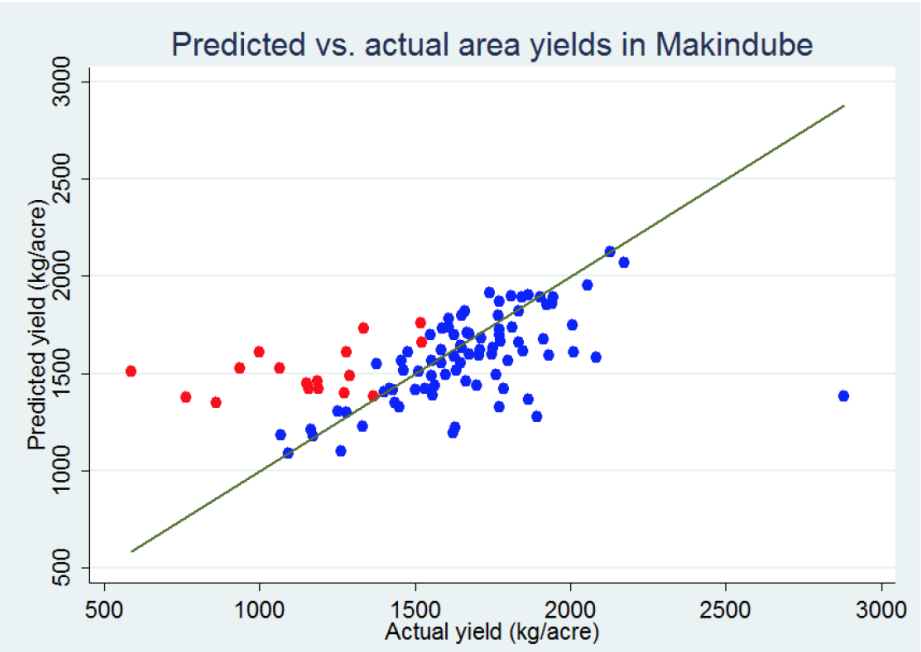
- We looked at a stylized agricultural economy to explain MQS
- How do we do it in real life?
  - Farm (or at least insurance zone) level data on farmer outcomes across some number of years and farms/zones
  - Ability to retrospectively say if a contract under consideration would have paid in the past in each of those zones and years
  - Plug that information in the MQS spreadsheet
- Let's look at an example

Measuring Insurance Quality for Rice farmers in Northern Tanzania



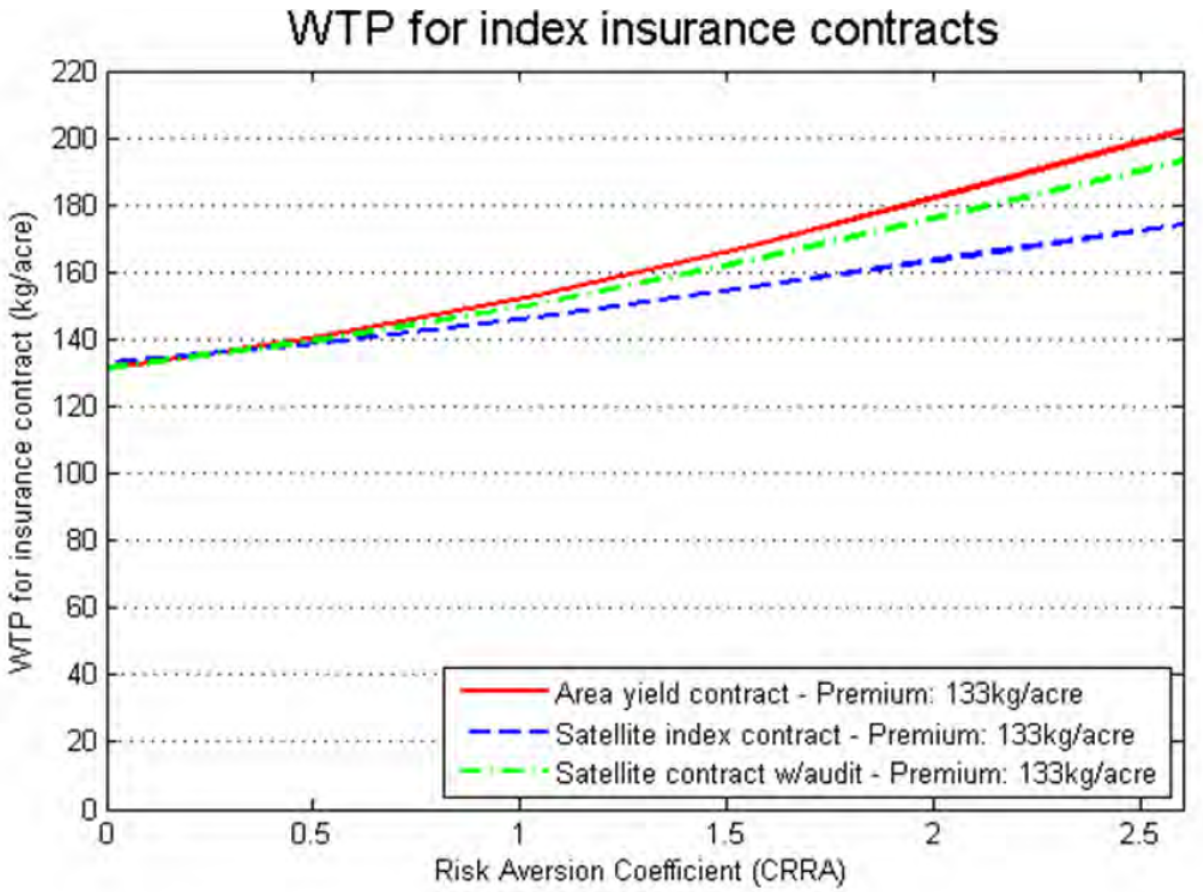
Backfitting the Contract

- For each small area ("village"), we collected 10 years of retrospective data on yields
- Best satellite predictor of village yields proved to be based on 'Gross Primary Production' (based on EVI, FPAR & LAI)
- Let's compare this (cheap to administer) satellite based index with an (expensive) village-level area yield contract:



MQS in Action

- Actuarially fair prices for these contracts are 130 kg of rice per-hectare insured
- Unrealistically, assuming no local risk sharing
- MQS equivalent to WTP > Market Price of Contract



Interlinkage & Meso-level Insurance

- Low insurance demand by individual farmers has encouraged the development of interlinked & meso-level products:
  - An interlinked contract is one in which insurance is bundled with another service, such as an agricultural loan through a bank or an agricultural value chain (*e.g.*, required as a condition of a loan) and the creditor has first claims on insurance payoffs to cover debts
  - A meso product is where the insurance is purchase directly by the bank (or other meso-level institution) as portfolio protection
- By linking insurance with credit and an expansion in opportunity, can avoid the tradeoff that more stable income comes at the cost of lower average income

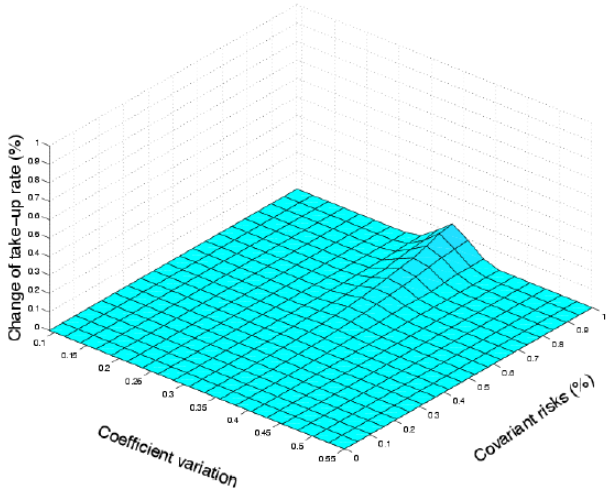
Interlinkage & Meso-level Insurance

- Important to emphasize two things about interlinked & meso-level insurance:
  - Index quality remains paramount as large design risk (common risk that is NOT covered adequately by the contract) will sink even a meso-level contract
  - If a goal of insurance is to enable farmers to prudentially invest more in their agriculture, knowledge, understanding and protection under the meso-contract remain important

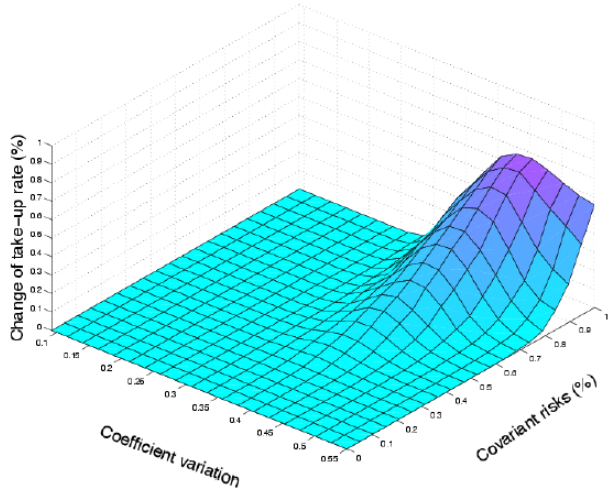
Interlinkage & Meso Insurance

- An interlinked contract is one in which the creditor has first claim on insurance payouts to cover farmers' debt obligations
- Interlinkage makes most sense in environments where loans are undercollateralized
- When loans are undercollateralized, lender bears drought and other risk
- Often the case in value chain finance where a standing crop partially collateralizes the loan
- Let's look at results from a theoretical analysis (Carter et al.)

Interlinkage & Collateral



(a) Standalone Insurance



(b) Interlinked Insurance

- In low collateral environments, standalone insurance contracts will have minimal impact on investment profitable activities
- Requiring standalone insurance can reduce investment!
- Interlinked insurance interlinked can crowd in investment if:
  - The loan market is competitive and the lender reduces interest rates on interlinked loans
  - Farmer knows that she is only liable for residual loan liability not covered by insurance payouts
- Note also that even interlinked insurance will have zero impacts if contract quality and, or total risk are low

Evidence on Interlinkage

- Mixed experience with interlinked credit:
  - High insurance uptake (30-70%) in value chain/loan programs in Kenya (sugar cane) and Mali (cotton), with significant investment impacts in Mali
  - Minimal uptake in Ethiopia (grain crops) and Burkina Faso (cotton), largely because of complex implementation problems
  - In Ghana, presence of interlinkage increased loan approval rates for male farmers (a supply-side effect), and yet for at least women farmers, insurance demand higher when insurance payments went directly to them (non-interlinked) rather than to the lender