A Nuffield Farming Scholarships Trust

Report

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Getting Stable: making uncertain farming futures a thing of the past

Richard Counsell

July 2017

NUFFIELD UK

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A

Nuffield (UK) Farming Scholarships Trust Report

"Leading positive change in agriculture.
Inspiring passion and potential in people."

Date of report: July 2017

Title	Getting Stable: Making uncertain farming futures a thing of the past
Scholar	Richard Counsell
Sponsor	John Oldacre Foundation
Objectives of Study Tour	To investigate and propose a new price risk management solution to help family farms manage volatile prices and input costs.
Countries Visited	USA, Ireland, France, Belgium, Germany, Switzerland, Portugal, Channel Islands.

Messages

- Volatility will continue to play a big role in the future of British farming and more must be done to manage it.
- Current risk management tools are too complex, risky and expensive for family farms.
- Agriculture needs more risk management and finance products that are designed and built from the ground up for farmers, rather than for financiers.
- Government has a role to play in managing volatility. However modern financial technology could deliver effective risk management to farmers, without requiring public subsidy.

EXECUTIVE SUMMARY

Farming income is inherently volatile. Volatility is not new and will remain a constant risk because:

- Supply is price inelastic in the short term (it takes a year to grow most crops)
- Demand is price inelastic (food is essential)
- Supply can vary due to climatic conditions, policy and conflict.

While these macro influences appear abstract, the impact of volatile prices on an individual family farm can be very personal. Effects range from a lack of confidence, under investment and borrowing restrictions to a lack of succession and wider solvency issues.

The focus of this report is almost entirely on Financial Risk Management tools and the potential for modern insurance technology, sometimes abbreviated as 'Insurtech,' to deliver a new market-led solution that could help family farms around the world to manage price volatility in a simpler, more affordable and low risk way.

The harvest year 2015/16 was a period when volatility as a topic was rarely out of the farming press. Politicians, unions, the media and farmers themselves were united in the view that something must be done to address its impact. After an initial flurry of activity, little or no progress was made. There is clearly no 'silver bullet' to helping farmers manage volatile prices, but this report proposes a solution that could in time make a small contribution to an industry we all care so deeply about.

Historically, most traditional farms were mixed and could use diversification to protect or 'hedge' themselves against low prices in one particular commodity. The writer, AG Street, memorably coined the term 'Up Horn, Down Corn' to describe this effect. If he had been a statistician instead of a writer, he would have said 'individual farm prices can display low correlations within a 1 year period'. With farm businesses increasingly specialising in fewer commodity enterprises to capture economies of scale, this advantage has largely been lost. This report examines how emergent 'Big Data' technology could bring the benefits of this "diversification effect" back to family farms in the 21st century.

Financial organisations like the Chicago Board of Trade/CME can offer stability and liquidity; yet financial technology 'start-ups' present the most likely source of new solutions to old problems. Developments like Smart Contracts, Machine Learning and Chatbots enable us to imagine and design new ways of delivering financial risk management that may be much better suited to the reality of family farms.

Brexit is clearly a time of considerable uncertainty; but it also offers a significant opportunity to rewrite the rulebook for British farming. This report proposes an innovative way for the Government to further help British Farmers with volatile prices, that doesn't require public subsidy.

Overall, the report was an opportune time to reconsider financial risk management for farmers and ask, 'What would we build now, if we could start from scratch?'

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Chapter 1. Introduction

My name is Richard Counsell. I'm a farmer's son from Wells, in North Somerset. I live on a farm with my wife Pippa and our three children, George, Henrietta and Tilly.

Like many farmers' sons of my generation, an early career away from the farm was seen as a good move for the future. I spent some time selling wine to other people, near Bath, and then spent time in the City, drinking wine and selling currency swaps.

Source: Own Image

After an early career slightly lacking in any form of recognisable 'plan', I found myself increasingly drawn to software and the excitement and seemingly boundless opportunities for 'tech start-ups'. The sheer speed and scale was breath taking. It was everything farming wasn't at that time. There were so few barriers and the possibilities were endless; as Mark Zuckerberg from Facebook espoused, just 'move fast and break things'. This was ironic, as it was eerily similar to how Dad used to describe my tractor driving.

It was intoxicating to a farmer's son from Somerset and I jumped in with both feet, for almost 15 years. This culminated in working with Skype and eventually to running an international software company that was headquartered in Chicago and with operations all over the world.

Farming Ties

Many people with alternative careers, but with a farming background, will understand the soft gossamer threads that subconsciously bind you to farming. These threads seem fragile and are easily ignored when you're younger; but they are far stronger than they might appear. Being part of a farming family is like being cast in a long-running play that includes walk on roles for your grandfather, cousins twice removed and an intricate cast of characters that have twisted and turned over generations to create a community that largely ignore each other most of the time, but at the same time are deeply connected by family, friendship, location and shared experience.

As I got older (and contemplating another year in aeroplane seats that I didn't quite fit into), I realised I wanted to audition again for a role in farming that would connect me back to a world that I instinctively understood, yet felt increasingly distanced from.

An article in the Farmers Weekly mentioned a Nuffield Farming Scholarship and I was intrigued at the chance to spend time studying a subject in farming that could advance our understanding, or help the industry improve in some way. In effect it was my line in the sand and an opportunity to change direction and head back towards an industry that I could ignore no longer. But first I needed a subject to study and in software terms, a genuine problem to solve.

Chapter 2. Background to my study

While working in Chicago, I often met Commodity traders and would talk to them about hedging and how farmers used the commodity markets to manage the risk of volatile prices. These conversations would usually involve me asking them to explain how it all worked over and over again. Futures, Derivatives, Options, Sigma, Gamma and spreads…the language and complex jargon was bewildering.

I knew the Chicago Board of Trade was originally built to help farmers of the Mid West gain more certainty for the price of their crops. But the industry I was trying to understand today felt miles away from the reality of European farming, with its millions of small family farms.

During this time, the news from the UK was focused on the problems in the dairy industry and volatile prices across the industry. Being brought up in Somerset, I was aware of how deeply woven the dairy industry is into the very fabric of local life. My local area has several family dairy farms and it is hard to imagine them not being there.

In 2016 there were 10,500 dairy farms across England, Scotland and Wales.
Ten years earlier, that figure was closer to 21,000.

The abstract nature of statistics sometimes fails to make an impact on our busy lives, but the scale and speed of this change really struck home. Behind that figure are thousands of families that had to choose (or were forced) to give up on a life that they knew and loved.

Doing nothing was no longer an option and I realised that Price Risk Management was an area that I'd like to know more about. It was clear that if it could be simplified somehow, it had real potential to help family farms, like my own, to manage volatile prices and build a stable income.

This need for simplification chimed with work I'd previously done in mobile technology. Small mobile phone screens require a lot of planning and design work to simplify and minimise complex software down to something that can be used on your phone. This felt like a moment in my life where my farming background and software experience could, for once, be a useful combination

My Nuffield Scholarship subject became clear at last. *How could we simplify financial risk management, so it could be more accessible and useful to family farms?*

Live Export

After a nervous wait and the customary tough interview with the Nuffield selection panel, I was incredibly proud to be offered a Scholarship in 2016. The Scholarship process began with a Pre CSC in London, followed by Scholars from around the world gathering together for an inspiring week in Cavan, Ireland.

Before we knew it, Nuffield had ear tagged, weaned and commenced the annual live export of Scholars.

It was a tremendously exciting time, with all of us filled with a missionary-like enthusiasm to travel the world and bring back knowledge that could make a difference to our industry.

While my technical knowledge of Financial Risk Management may have been lacking, it was an advantage to start with no bias or preconceptions and approach the problem like a farmer. I instinctively knew that any genuine progress would only be possible if a totally new solution was designed and built from the ground up for farmers, rather than financiers.

Because of my software background, I challenged myself to research the subject of Price Risk Management and build a new solution designed for family farms during my Nuffield Scholarship. This simultaneous plan sounds overly ambitious, but it made more sense for me to approach my Scholarship in this way.

Like one of my children playing with Lego, I find it easier to understand if I can break something down and try and build it myself. Returning to the UK from Chicago, I had both the time and the commitment to try and make a difference.

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The process was of course embarrassingly harder than I thought, and I spent months making no progress whatsoever, despite enlisting the help of some stellar academics and former software colleagues. It took over a year to make any real progress. Here I've attempted to share the story of the ups and downs of both sides of my project (Research and Development) along the way.

The breakthrough, when it eventually came, started as a simple idea inspired by A.G. Street's adage 'Up Horn, Down Corn' *(see photograph above).*

After a great deal of research and development, it has morphed into an initiative that now includes over 200 farmers, global insurers, the Universities of Liverpool and Lisbon and some of the world's finest mathematicians, economists and software engineers. I hope my report gives a small insight into what a privilege it has been to be part of this adventure.

It is ironic that I applied to Nuffield to reconnect to the farming industry and then managed to complete a Nuffield Farming Scholarship, without stepping foot on a farm!

While my fellow Scholars were enjoying trips to the African Savannah or South American Pampas, I spent a considerable amount of time in grey offices, wondering why I didn't choose to study the intricacies of coconut production.

While the scenery wasn't quite what I had in mind, the experience, contacts and insights gained was life changing.

Chapter 3. My study tour

Having worked in Chicago, the USA was central to my Nuffield Research. It is the country with the largest Crop Insurance programme in the world in terms of acreage, home to the Chicago Board of Trade and where all my software contacts were based, so was the natural place to start.

My study was built on a comparison between US and European agriculture and the way price risk is managed.

As such, most of additional countries outside of the US, were European.

Price Risk Management for Agriculture is heavily influenced by regulation and government policy, so I was often pulled back towards Brussels, Dublin and London in a European and UK context.

The European cities of Paris, Munich, Hannover, Zurich, Dublin and Lisbon (as well as the Channel Islands), were where most progress was made with insurance and financial experts.

January 2016	USA: Illinois, Wisconsin
February 2016	USA: Chicago, Texas, New York
March 2016	Belgium, France and Switzerland
July 2016	USA: Chicago, Florida, Georgia, Carolinas, Virginia, Washington
November 2016	Brussels, London, Dublin, Edinburgh
December 2016	France and Switzerland
April 2017	Portugal, Channel Islands and Spain
June/July 2017	France, Portugal, Germany and Italy

Chapter 4. Risk and productivity

Family farms are exposed to a bewildering array of risks. The risks stem from three main areas of uncertainty, with various subsets below them.

1. Climate and its link to yield
2. Disease
3. Market price

Farmers tend to be practical people, who are well used to 'rolling their sleeves up' and solving problems. Through hard work and good husbandry, the risk of low yield and disease can be reduced. Farmers can take action to improve their position with practical steps that can manage the impact of yield and disease on their farm finances.

Market price is different. The UK's farming industry is economically fragmented and made up of a large number of (mostly) small businesses. Even larger-scale farm businesses are generally price takers for both their inputs and their outputs. Farmers have little influence over the prices they buy or sell at. This is manifested in the often-distrustful perception of the supply chain, with farmers often blaming merchants, processors and retailers for the low prices they receive.

4.1 Productivity

The main thing that farmers *can* do when faced with volatile commodity prices is to increase their output compared to the cost of inputs. i.e. increase productivity. Improving productivity relative to other farmers creates a powerful competitive advantage and increases resilience to volatile prices. But, as Chart 1 shows, British farming's productivity is woefully low when benchmarked against our competitors, despite our historic advantages in climate and world-renowned R&D facilities. This lack of productivity means that it will become increasingly harder to compete globally in a post-Brexit environment.

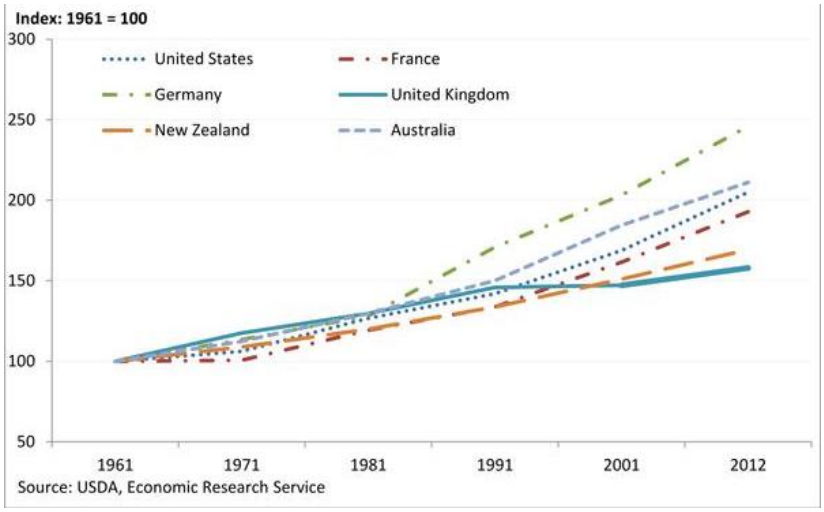


Chart 1: Total Factor Productivity average annual growth 1961-2012

The effect of stalling productivity is well illustrated in Chart 2 below, which illustrates the wheat margin between 1997-2017.

You will see that after 20 years the farm margin per hectare remains at a similar point. But, the Retail Price Index has risen by 67% in the same period.

A farmer, looking to achieve the same profit margin in real terms, would require the farm to operate in a fundamentally different way.

Feed Winter Wheat - £ per hectare	1997	2017
Output:		
Yield (i) 7.7 tonnes per hectare @ £97 per tonne	747	
(ii) 9.0 tonnes per hectare @£120 per tonne		1,080
Variable Costs:		
Seed	54	47
Fertiliser	106	146
Crop Protection	121	230
Sundries	11	25
Gross Margin	**455**	**632**
Overhead Costs* (before rent and finance)	**427**	**536**
Net Farming Margin (before R & F)	**28**	**96**
Support (Arable Area Aid / BPS)	**257**	**209**
Farm Margin	**285**	**305**
** Mainly Cereals farm – 'large' size category*		*Source: ABC*

Chart 2: Feed Wheat Margin,
published in Andersons Outlook 2017

4.2 Agricultural Technology 'Agtech'

In the last few years there has been much talk about 'Agtech' and the potential for a technology-led productivity renaissance in British farming. Using technology to produce 'more from less,' offers probably the best chance for British farming to achieve a much-needed boost in real-term productivity.

The key areas of Agtech to increase productivity revolve around the following:

Robots: Self-steering tractors have existed for some time now and using GPS or precision tools to spread fertilizer or plough land has become commonplace. The next generation of tools will include solar powered machines that can identify individual weeds and kill them with a dose of fertilizer or lasers. In addition, harvesting robots are being developed that have the ability to identify ripeness and then carefully pick the product.

Drones: Advances in drone and satellite technology benefits farmers with high quality images that can predict future yields and provide advance warning of disease outbreaks.

Internet of Things (IoT): The ability to connect physical products with the connectivity of the Internet will enable even smarter products and efficiencies in the future, from monitoring herd health remotely, to smarter irrigation, the possibilities are almost endless.

> *'Investors across the world have taken note of a growing world population and the increasing awareness of scarce resources. Investment in Agtech companies rose from just $500,000 in 2012 to $4.6bn in 2015.'* Source: Agfunder 2015

The potential benefit to UK agriculture is very significant, but Agtech investors and inventors are overlooking one fundamental hurdle to their ambitious plans:

> **how can family farms invest in Agtech when the overall levels of farm profits are low and volatile prices remove the certainty required for a significant capital investment?**

UK farmers received £2.1bn in direct subsidies and a further £600m in rural development payments in 2015. The direct payments made up 55% of farmers' incomes. *Source FT.com 7/8/16*

I believe the farming industry has the greatest opportunity for decades to transform its low levels of productivity, but farmers need more predictable and profitable income to fully take advantage of the opportunities of 'Agtech.'

In investment terminology, farmers perhaps need the benefits of 'Fintech' (Financial Technology) to help them invest in 'Agtech' (Agricultural Technology). Financial technology can remove costs and enhance profits by delivering financial services to farmers free of technical aging systems that require higher overheads to maintain.

Recent examples of efficient 'Fintech' operations from the wider business community include Crowd based lenders (ZOPA), money transfer services (Transfer Wise), peer-to-peer marketplaces (Market Invoice) and Insurers (Lemonade). While these examples are not remotely related to farming, they do highlight the potential of software-led innovation to create new ways to save farmers money or improve the efficiency of supply chains using technologies like Block Chain, Smart Contracts and Peer-to-Peer Marketplaces.

My Nuffield Scholarship enabled me to meet some of the world's best mathematicians, data scientists, investors, economists and software engineers to find out more about these technologies and share ideas about how they can be used to help agriculture.

My own proposal is just one idea that has emerged from this new space that connects 'Fintech' to Agriculture. I'm certain that many more will follow.

Chapter 5. Agricultural price risk

5.1 What is volatility?

Volatility 'σ' is a measure of how much and how quickly a value changes over time.

While this may seem an obvious statement, a complete definition of volatility is harder than it looks as in economic theory, volatility combines two distinct concepts: *variability* and *uncertainty*.

We know from the constant balancing of demand and supply, fluctuating prices are both normal and essential to provide the necessary price signals to ensure a market operates efficiently.

However, there is an indistinct tipping point when normal market fluctuations transition into volatility. This occurs when price movements are increasingly uncertain and subject to extreme swings over an extended period of time. A good real-world example of this is the UK milk price, which fell almost 30% in a 12-month period from 2014-15 causing widespread problems for the dairy industry.

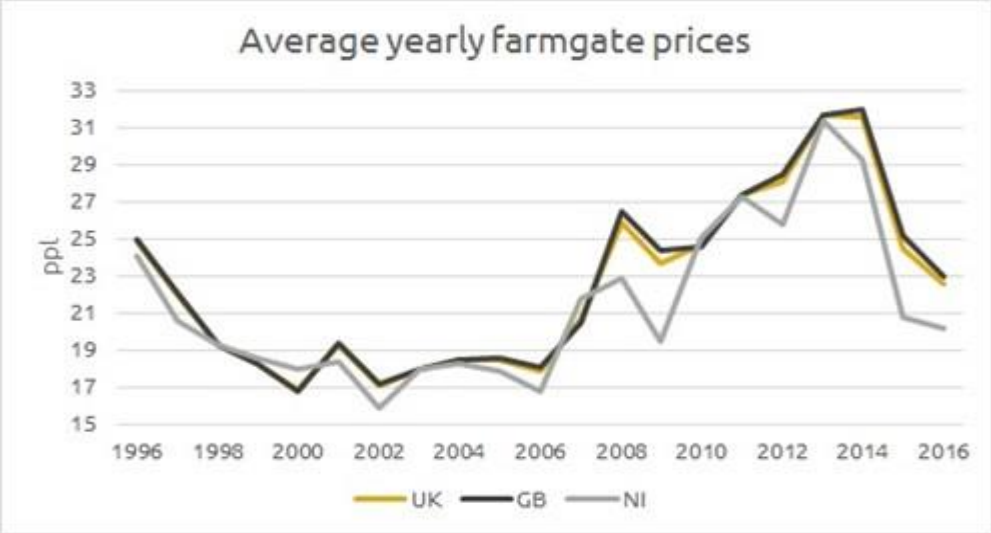


Chart 3: Annual farmgate milk price
Source DEFRA

Aside from milk, the volatility of most agricultural commodities has been particularly high in the last decade. Rapid increases in global food prices in 2007-2008 and 2010-2011 were followed by recurring periods of sharp corrections. The unpredictable price volatility in the last decade caused significant problems for European farmers in particular.

5.2 Causes of volatility

The root cause of volatile farm prices begins with a fundamental economic observation.

"The demand and supply of agricultural commodities is inelastic."

5.2.1 Supply inelasticity

The length of most agricultural production cycles, ranging from a few weeks for poultry to multiple years for beef, results in a time lag between when a farmer makes a production decision and the time a product can be sold. If demand is unexpectedly high for a crop, it is often a full year before the farmer can respond by increasing supply. Or, as shown in Chart 4, when supply increases by a small amount, perhaps a good harvest, the effect can be a dramatic fall in price.

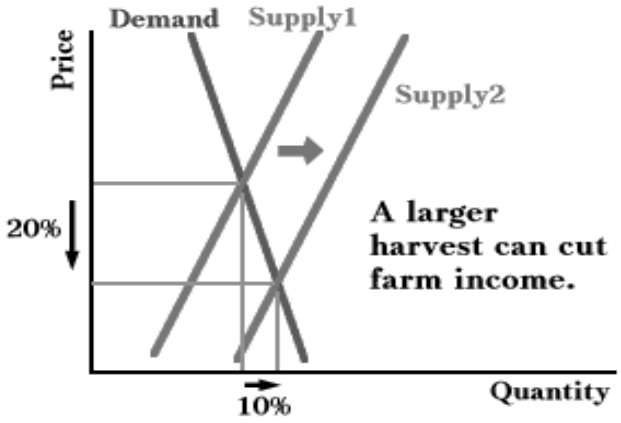


Chart 4: Inelastic Demand and Supply
Source: Economics Online

5.2.2 Demand inelasticity

The market price for agricultural commodities is particularly sensitive to unexpected supply changes because the demand for food is largely unresponsive to price. This lack of demand responsiveness means any changes in the level of supply for a particular commodity requires a relatively large change in price to regain a balance in the market. It is those market corrections that cause so many problems for farmers looking for a stable environment to invest in scale, or productivity.

Exposure to inelastic supply and demand is not constant across agricultural commodities. Most arable crops, such as grains and pulses, can be preserved and stored which creates more flexibility for the farmer who can sell at an optimum time to maximise income. Milk as a commodity for example, suffers from being expensive to store at farm level and being highly perishable.

It is an unavoidable fact that market prices are volatile and vary within each year and from commodity to commodity. While farmers historically had mixed farm enterprises, they could spread their risk profile across a range of commodities. As modern farms increasingly focus on one enterprise to cut fixed costs (economies of scale), this makes them more exposed to volatility on the single commodity they are relying on for their income.

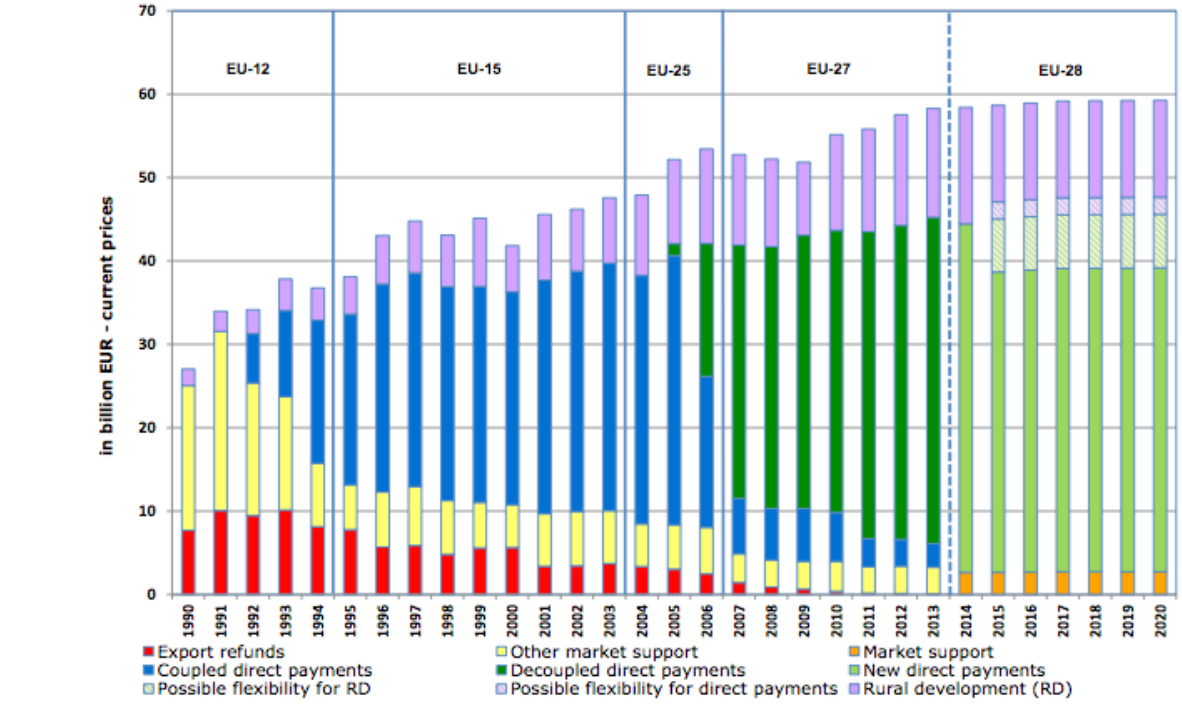
The rapidly fading diversification benefit, which was inherent in traditional mixed farming, is something that was to become central to my research.

5.3 Macro Economic Drivers

Other than simple demand and supply, there are a number of other factors that can cause volatile prices for UK farmers. These can all be aggregated into wider (macro) economic, influences, like exchange rates, oil prices and government policy.

For the last 40 years, the Common Agricultural Policy (CAP) has had a significant influence on the requirement of a farmer to manage volatile prices. Through the 1970's and 1980's the CAP used a wide range of instruments to help farmers. These included intervention buying and export refunds.

The beginning of the end of this period of interventionism can be traced back to the Uruguay round of GATT (General Agreement of Tariff and Trade) that was signed in 1994. Commissioners Fischler and Boel decoupled payments from agricultural production and this began to pull European farming back towards global market forces. This increasingly market orientated approach would appear to be gradual from the outside looking in. However, the last 20 years has seen this process accelerate to the point where market intervention only accounts for 5% of the CAP budget today. As recently as 1992 that figure was 90%.



Source: DG Agriculture and Rural Development

Chart 5: Changing support for EU farmers
Source: European Commission, 'Overview of CAP Reform 2014-2020'

This rapid reduction in price support, (shown in red and yellow bars above) has exposed millions of family farms to price volatility without suitable risk management tools to manage this new reality.

The final macro element is speculation on **financial markets**. Commodities are becoming easier to trade as a short-term financial asset. This may be adding to the increasingly volatile nature of commodity markets as the overall level of trading increases. While tempting to blame 'fat cat' hedge funds for some of the volatility we have seen, caution needs to be applied as the added

liquidity into agricultural markets can offer significant benefits to commodity 'sellers' and should not be ignored.

When climatic risk is added to the more prosaic risks like financial and social risks, it is easy to see why farming is not for the faint hearted!

5.4 Farmers' attitude to risk

Some farmers are clearly willing or able to accept more risk than others. Attitudes to risk are often related to the financial ability of the farmer to accept a small gain or loss.

Farmers' attitudes may be classified as: risk-averse - those who try to avoid taking risks; risk-takers - those who are open to more risky business options; and risk-neutral farmers - who lie between the risk-averse and risk-taking position.

In business terms there is little point exposing yourself to risk, unless there is a reward. Higher profits are usually linked with higher risks. The relationship between risk and profit needs to be managed as carefully as possible. Good price risk management involves assessing the impact of a price fall and then planning to reduce the detrimental effects.

A major study into the risk perception of European farmers was published by Szekely (2008). In the survey farmers were asked to rate some of the factors according to their subjective opinions. Factors could be rated from 1 (no effect on the farm) to 7 (major effect on farm). The results are in Chart 6.

	Hungary (A) *Mean* *Greater than*	Poland (B) *Mean* *Greater than*	Netherlands (C) *Mean* *Greater than*	Spain (D) *Mean* *Greater than*	Germany (E) *Mean* *Greater than*
Weather and natural disasters	6.24 CDE	6.41 CDE	5.06 -	5.74 CE	5.41 -
Animal disease and epidemic	4.91 -	5.19 -	5.98 AB	3.36 -	3.35 E
Price volatility	5.68 CE	5.55 -	5.24 -	5.48 -	5.35 -
Marketing difficul-ties	5.06 BDE	4.05 -	4.69 BE	4.39 E	3.95 -
Input market	3.98 BCE	2.21 -	3.27 B	3.75 B	3.47 B
Debt	2.63 -	3.42 A	4.52 ABDE	2.97 -	3.04 A
Political measures	4.15 B	3.31 -	4.89 ABD	4.07 B	5.23 ABD
Technological processes	4.22 B	3.64 -	4.31 BD	3.62 -	4.02 B

Chart 6: Sources and Perception of Risk in Continental Europe
Source: Szekely 2008

Overall, in continental Europe, farmers consider weather and natural disasters as the factors with the largest effect followed by the volatility of prices.

Szekely also went on to ask the same farmers about their planned future use of risk management instruments, as shown in Chart 7.

Valid cases HU – 202 PL – 206 NL – 214 SP – 197 GER – 200	Hungary (A) *% of cases Greater than*	Poland (B) *% of cases Greater than*	Netherlands (C) *% of cases Greater than*	Spain (D) *% of cases Greater than*	Germany (E) % of cases Greater than
Same as now	69.8% -	61.2% -	65.4% -	75.1% B	80.0% BC
Crop insurance	14.9% -	41.3% ACDE	9.8% -	20.8% C	13.0% -
Livestock insurance	2.5% -	37.4% ACDE	13.6% A	5.6% -	6.5% -
Diversification	8.9% -	37.4% ACDE	7.5% -	7.6% -	6.5% -
Marketing contracts	16.8% -	18.0% -	11.7% -	12.2% -	8.5% -
Production contracts	9.9% -	7.3% -	10.3% -	4.6% -	6.0% -
Off-farm investment	8.9% -	23.8% AC	10.7% -	13.2% -	14.0% -
Off-farm employ-ment	10.4% -	36.9% ACDE	8.9% -	11.7% -	10.5% -
Property ins.	6.9% -	5.3% -	16.8% ABE	8.1% -	7.5% -
Vertical integration	4.0% -	33.5% ACDE	3.3% -	13.2% ACE	4.5% -
Avoiding credit	15.8% B	1.9% -	19.6% BE	18.3% BE	8.5% B
Hedging	0.5% -	58.3% ACDE	6.1% A	4.1% -	4.0% -
Holding financial reserves	26.2% B	3.9% -	19.6% B	17.3% B	16.0% B

Chart 7: Use of Risk Management Instruments
Source: Szekely 2008

He found that the way farmers manage risks is enormously varied. Most of the risks outlined in Chart 7 are each worthy of a Nuffield Study of itself and a generic approach to them would be too broad to make inroads into the subject. To make progress, I decided to focus on just two.

As price and income are generally accepted to be more of a problem for British farmers in our temperate climate, my report focuses exclusively on Price Risk Management solutions**.**

Given the concerns about price and income, the risk management tools which I looked at to help family farms with volatile prices were increasing the use of insurance and hedging.

5.5 How volatile is British farming?

Before I began my research into financial risk management tools suitable for family farms, it was important to understand whether farming income was becoming more volatile over time. Based on the hundreds of articles on volatility in 2015/16, it could have been assumed that volatility was a new threat to British farming.

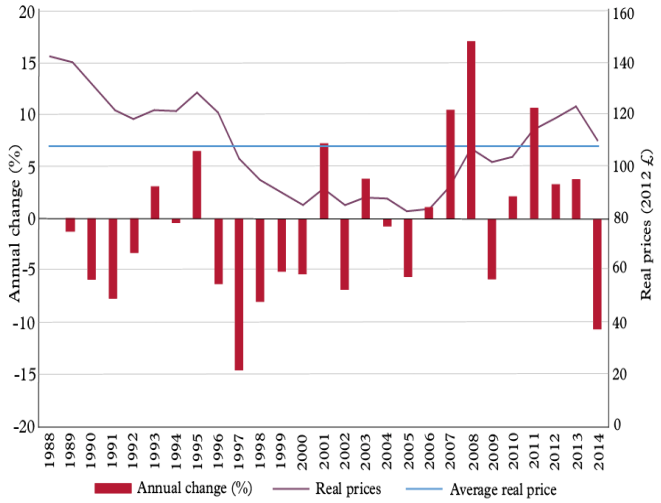


Chart 8. Real Indexed prices for all agricultural commodities (UK)
Source: Defra

Chart 8 highlights two interesting features. The first is that volatile prices have been an established feature of British farming for decades. However, the volatility shown could only be described as extreme in only a few selected years.

These aggregated charts showing all farm commodities do not show the whole picture. Taken as an average, UK farm commodities appear only moderately volatile. However, individual farmers often produce only certain individual commodities such as potatoes and milk. When these are isolated, the effect on a family farmer is much more pronounced.

Chapter 6. Price risk management

6.1 Overview

The initial period of my Scholarship was devoted to investigating macro influences, policy and the scale of the problem of volatility. Most of my research was spent in Europe, with a highlight coming in Brussels at an event called Fi Compass 'Financial Instruments for Agriculture'. This was a fascinating opportunity to hear the plans and challenges first hand, at the heart of the European Commission. Fi Compass brought together regional organisations to learn about the wider problem of variable farming incomes and what role Pillar 2 (rural support) could play in the future.

In common with findings on most of my travels, it was noticeable how few public or private sector stakeholders truly understood the opportunities and challenges associated with developing financial instruments for farmers and then getting them to use it. Nearly everyone I spoke to was positive about the potential to help farmers manage volatility; it was just that the practical details of its implementation seemed ill-thought through. In particular, many people mentioned the potential of Futures exchanges. While undoubtedly useful, they can take decades to build enough liquidity and require significant demand from both sides of the market, both farmers and processors.

In 2015/16 the farming press was full of statements about volatility and all agreed something needed to be done. There was much talk of Futures for dairy farmers in particular and even the recommendation to farmers to use 'financial tools and trading methods to help ride out volatility'. http://www.fwi.co.uk/news/prepare-for-decade-of-volatility.htm

Commissioner Hogan addresses the 2nd Fi Compass 'Financial Instrument' event in Brussels that I attended.

© Fi Compass EU

After spending many weeks studying CAP and the labyrinthine complexities of Pillar 2, the British electorate rather pulled the rug from under my attempts to understand how CAP could help manage volatility for British farmers.

While this was a surprise and did require a refocus on how risk management tools might sit within a post-Brexit farm policy, it prompted wider access to DEFRA and organisations like the Agriculture and Horticulture Development Board (AHDB), both of which were very interested in new ideas and research that could be useful to UK farmers.

The AHDB invited me to join the Volatility Forum, which opened many doors to meet and discuss ideas with fellow stakeholders such as banks, consultants and farmers.

6.2 Price risk management tools

I then began the next stage of research into tools that could have the potential to help family farmers cope with an increasingly uncertain financial future outside the EU. The tools I focused on were **Futures, Options** and finally **Insurance**.

Clearly these tools have been in existence for some time, but I wanted, with a modern and software focused mind-set, to take a fresh look at their potential to see if a new combination or delivery method could be found to appeal to farmers.

If price intervention by the public sector continues to be reduced, then the question was could the market step in to fill those shoes and offer family farms another type of market support?

Some of the key advantages of market-based instruments over publicly run price stabilisation schemes are *(summarised from Varangis and Larson, 1996):*

- Instead of trying to influence the price, market-based instruments create more predictable cash flows by generating more certainty on future revenue.
- Market-based instruments can be used by individual farmers to target their exact financial position. For example, someone with larger borrowings can protect more of his or her revenue to reduce risk.
- If future revenues are secured, lenders know that revenues will cover repayment of a loan. Risk management can therefore increase the creditworthiness of the borrower.
- Futures are very efficient at finding fair market prices, providing reliable benchmarks for physical trade.
- Exchanges can provide liquidity, low transaction costs and standardisation.

The major negatives of market-based instruments revolve around a lack of knowledge and the complexity, real or perceived, around derivatives. **These barriers to adoption were becoming central to my research.**

*Definition of a Derivative***:** *A product (such as a future or option), whose value derives from and is dependent on the value of an underlying asset, such as a commodity, currency, or security*

Without a thorough understanding of what might prevent a farmer from using risk management tools, any other research into a potential solution would be built on poor foundations.

During this time, I was fortunate to meet Dr Jeremy Cole, (seen below) and to question him about his recently completed PhD on *'Behavioural determinants of the adoption of Financial Price Risk Management Tools by Wheat farmers in England.'* Dr Cole spent considerable time looking at predictors that could help us understand which farmers might use risk management tools and those who would remain unlikely users. The key predictors studied were age, education, size of farm and whether the respondent had children.

Dr Cole's key finding for me was encapsulated in this snippet from his PhD:

'Financial Price Risk Management (FPRM) like any other product or service innovation, has to be presented in an appropriate format (show a relative advantage, compatibility, lack of complexity, ease of use and low risk of use) to the appropriately targeted customer, if the innovation is to achieve widespread adoption.'

http://centaur.reading.ac.uk/66398/1/17027200_Cole_thesis.pdf Page 280

© Jeremy Cole

This overarching need for simplicity was a recurrent theme for 18 months of my Scholarship. Most discussions with City financiers or academics started with a complete lack of understanding about why a farmer *wouldn't* be comfortable using a Bloomberg style screen to manage their price risk.

6.3 Exchange-based risk management: US Futures

From its farmer-focused Chicago birth in 1848, it seemed the agricultural risk management industry had forgotten its roots and was more focused on offering a product designed for financiers, rather than for farmers who were simply looking to reduce risk.

The Financial Times covered this issue very succinctly in an article published on 6th July 2017:

> *"Until recently, commodity markets have been driven by supply and demand factors of the physical raw material, with players commanding extra information on physical flows gaining an edge over other market participants…short-term trading in food commodities by speculators such as hedge funds has risen, accounting for almost half the volume in the futures contracts traded."*

Source: https://www.ft.com/content/c386de76-61a2-11e7-8814-0ac7eb84e5f1?myftTopics=46165eb7-8ed9-380a-9483-b2db0a4e56c4#myft:my-news:grid

The Chicago Board of Trade in 1855 and a typical Bloomberg screen today showing volatile markets.

While increasing speculation is a positive for liquidity, it can move the price away from what might be expected in a simpler risk transfer process. This can make it harder for a farmer to rely on exchange prices for risk management purposes.

6.4 Translating farming for financiers

During my scholarship, I was privileged to be able to spend time with some of Europe's most influential financiers, including Crispin Odey (*seen left)* (Hedge funds), Peter Hambro (Banking/Mining) and Graham Birch, a Fund Manager who previously managed $40bn of commodities for Blackrock.

© Shutterstock

Their collective financial expertise and advice was outstanding, but it confirmed again my observation about how hard it is for city financiers to truly appreciate the practical reality of life on a family farm and what financial tool might be useable.

The need for well-designed solutions to gain adoption in the farming industry is well documented. In *Pannell et al., 2006/8,* the paper concludes that 'the financial benefit of the tool needs to be greater than the costs of learning about and affecting the practise.'

This simple statement rang true with the feedback that I had been getting on my travels. It effectively rules out modern derivative-based risk management for the vast majority of family farms in the UK, because of the time it would take to learn about the commodity markets.

Before we take a detailed look at risk management for farmers, it is worth outlining the main methods most farmers use to sell their goods.

Chapter 7. Sales Methods

7.1 Methods

Farmers market their produce using 5 key methods: spot selling, forward selling, pools, Futures and Options. The common denominator of each of the five methods is that the farmer, as a fragmented market participant, is a price-taker, because individually farmers do not produce enough volume to affect the market place. The seller either accepts the price being offered, or it goes unsold.

1. Spot selling is the simplest of all the methods. After harvest, the spot sale price represents the price a commodity can be bought for on a given day. Because it is post-harvest, all parties to the transaction know the quality and quantity.

It is estimated that spot selling accounts for 25% of all UK ex farm sales. *(Source DEFRA 2009)*

2. Forward selling is a contract between a buyer and seller (the farmer), for a future date at an agreed price, quality and quantity. A farmer usually sells a percentage of the crop before harvest for a future collection. This provides some price certainty for the farmer while the crop is still in the ground. Forward selling also provides valuable market information to both parties about future demand and prices. With the price set in advance, the farmer has transferred some of the price risk to a merchant or buyer. The obvious downside to a farmer is that their revenue does not increase if the commodity price rises higher than the price contracted in advance. In addition, if the yield is unexpectedly low then 'buying in' charges can have a big impact on the bottom line.

Despite these potential pitfalls, ***forward selling accounts for 37-54% of sales*** according to the same DEFRA (2009) report.

3. Pools are where a farmer lets a 3rd party organisation handle the grain marketing on their behalf, in return for a fee. The usual UK structure is for the 3rd party to be a co-operative. Most sales from the pool are made in three segments: Harvest, pre-Christmas and post-Christmas to June.

20% of grain sales are estimated to be sold via Pools *(source DEFRA 2009)*

4. Futures, from a farmer's perspective, are very similar to forward contracts: the main difference being the standardisation of the contracts so they can be actively traded on an exchange. The most famous exchange is the Chicago Board of Trade (CBOT/CME). A predetermined price and delivery date is agreed, but without counterparty risk.

The exchange requires margin accounts and regulated access via brokers to remove the risk of either party not completing the transaction. The other major difference is that unlike forward contracts, Futures are a derivative and are cash settled rather than any party taking physical delivery. Farmers and speculators can transfer risk to each other during the lifetime of the contract. For a farmer, any cash profit made on the exchange can offset losses incurred on their physical sales.

The main downside to a Futures contract is that there is the potential for an unexpected price change. The farmer has to make up the losses via a margin call. These losses can incur very rapidly on an exchange. Margin calls are payments required (often in just 24 hours) to cover these 'paper' losses. For this reason alone, I have always felt that Futures are better suited to 'sophisticated' investors in a regulatory sense, rather than a 'retail' investor like a farmer.

Futures use accounts for about 5% of farmers in the UK *(Defra and HGCA 2009)*

5. Options The most common description of an Option in a farmer context is that the farmer has the right but *not the obligation* to buy and sell a commodity at a future time and at a price that is agreed in advance. The lack of obligation is a crucial differential to a Futures contract and removes a great deal of uncertainty and risk for the farmer. The farmer pays a fee for this tool and it can be thought of as an insurance contract.

Options are used by about 4% of UK farmers *(Defra and HGCA 2009)*

There are two types of Option, *a Put and a Call*:

a Put enables a farmer to sell at a higher price if the price falls, and

a Call enables them to buy at a lower price if the price rises.

In both cases, the price is linked to the underlying volatility of the commodity, the length of protection and the price selected.

The academics, Black, Scholes & Merton, who proved instrumental to the growth of Options, won the Nobel Prize for Economics in 1997 for their work on a formula that resolved the theoretical price of an Option over time.

$$\text{value of call option} = N(d_1)\ S - N(d_2)\ Ke^{-rt}$$

where:

$$d_1 = \frac{\ln(\frac{S}{K}) + rt + \frac{\sigma^2 t}{2}}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

Chart 9: the BSM formula for a Call Option *Source Black Scholes Merton*

The model is essentially divided into two parts: the first part, ***(d1)****, multiplies the price by the change in the option premium in relation to a change in the underlying price. This part of the formula shows the expected benefit of purchasing the underlying asset outright. The second part,* ***(d2)*** *provides the current value of paying the exercise price upon expiration.*

Unknown to me at the time, this equation was going to play a slightly larger role in my Scholarship than I had anticipated. A respectable B in GCSE maths hadn't prepared me for this turn of events.

7.2 Reasons for low uptake of Options and Futures in the UK

In the UK, only 5% of arable farmers use futures and 4% use options *(DEFRA and HGCA, 2009).* The HGCA/AHDB completed some research into this low uptake of Futures and Options in 2009, with the following results:

Reason	Percentage %
Lack of Understanding	13%
Cost	10%
Perceived High Risk	9%
Not Necessary	34%
Not Applicable	27%

Chart 10: Reasons stated for farmers not using Futures and Options
source: DEFRA/HGCA 2009

7.3 Conclusion

Farmers will always manage price risk with a combination of physical and derivative instruments. However, in the UK and Europe the benefits of Financial Risk Management tools are largely being overlooked due to issues that are eminently solvable with good design and innovation.

7.4 Is there a solution?

The last 10 years alone have seen many examples of industries being disrupted by technology. One of the key themes has been disintermediation, or 'cutting out the middleman'. From flights and holidays, to accommodation and loans, technology has empowered millions of people to save money and take more control of their work and leisure. Increasing focus on 'User Experience' and simple design has been driven by the meteoric rise of smartphone adoption. Smaller screens have led to some outstanding advances in user experience. As a result, it has become commonplace to manage previously complex tasks with just a mobile telephone.

While Spot Sales and Forward Contracts are of course not complex transactions, it became clear to me that the current user experience surrounding the wider risk management industry left a lot to be desired, particularly when approached from a farmer perspective.

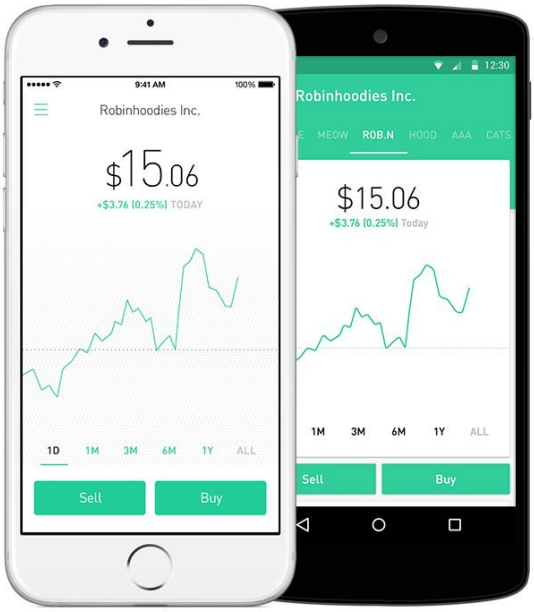
With 15 years of experience running US/UK technology companies, I knew that modern design and new financial 'fintech' models had the potential to overcome some of the inertia shown in Chart 10 *(see above).* In the study, a combined 32% of farmers identified complexity, cost and risk as the reasons why they didn't use price risk management tools. The potential impact of a new approach using 'fintech' is substantial.

When you start with a customer-first approach and strip out complexity, risk and costs, the results can be outstanding.

A US company called Robin Hood *(seen right)*, was launched during my Scholarship and aimed to disrupt the stock trading industry.

The founders focused on a highly targeted audience (Millennials), lowered the risk and costs involved (fractional trading/no Margin) and appealed to inexperienced traders with a very simple design.

18 months later, as I write, the company has 2 million customers and is worth $1.3bn.



©Robin Hood Inc.

Chapter 8. International Perspective

8.1 Overview

Other than Europe, most of my travel was in North America. I travelled thousands of miles to gain a better appreciation of US financial risk management tools and to meet fellow technology entrepreneurs to explore new ideas to simplify the experience and models.

From my base in Chicago, I travelled to Wisconsin, Dallas/Fort Worth, Washington, New York, Kentucky, Florida, Carolinas, Georgia and Virginia.

The US trips were focused on financial, commodity and software meetings to explore and exchange ideas for innovation.

Chicago, as might be expected, was naturally the place where most progress was made in terms of commodity expertise, but the rest of my travels all played a part in a wider understanding of the opportunities for innovation and the challenges for European farming.

Slightly less productive moments included being invited to go ice fishing in Wisconsin, where I got to drive my hire car onto a frozen lake and being fined for speeding in Dare County, North Carolina on Independence Day which ended up being quite expensive.

The friendships, fun (and fines) will be remembered long after my scholarship comes to an end.

8.2 US Crop Insurance

The U.S. crop insurance program was initially launched in 1938 in response to a campaign promise of President Franklin Roosevelt. It now has a total liability in excess of $114 billion and insures 262 million acres*. Crop Insurance in the US is the largest subsidised agricultural insurance programme in the world. For major grains, in excess of 85%* of planted acres are insured by a policy sold through the federal programme.

The USDA's Risk Management Agency (RMA) administers crop Insurance and the program provides producers with two main options. They can opt for an insurance policy for a loss in crop yields, or a decline in revenue. The RMA pays private insurance companies to sell and operate the program, and dictates the types of policies that the private insurance companies can offer.

US farmers can actually protect 128 crops, but just four of the crops (cotton, soybeans, corn and wheat) account for more than 65%* of all the acres in crop insurance programs.
**Source: U.S. Department of Agriculture, Risk Management Agency. Costs and Outlays of Crop Insurance Program http://www.rma.usda.gov/aboutrma/budget/costsoutlays.html*

As an international observer, the first thing that strikes you about the US Crop Insurance model is the sheer scale, complexity and costs involved. In most policies, the taxpayer usually pays up to 60% of the premium and the farmer pays the remaining 40%.

The federal government then pays the private insurance companies 22-24% of the premiums to cover their operating costs. In addition, the taxpayer is liable for the indemnities if yields or

revenue falls. The taxpayer pays a higher percentage of the losses as the scale of the losses increase.

Seen through the lens of a post-Brexit Britain, it is hard to comprehend how DEFRA, or the wider public, would feel about a level of support, shown in Chart 11, that in some years makes CAP payments look like a bargain.

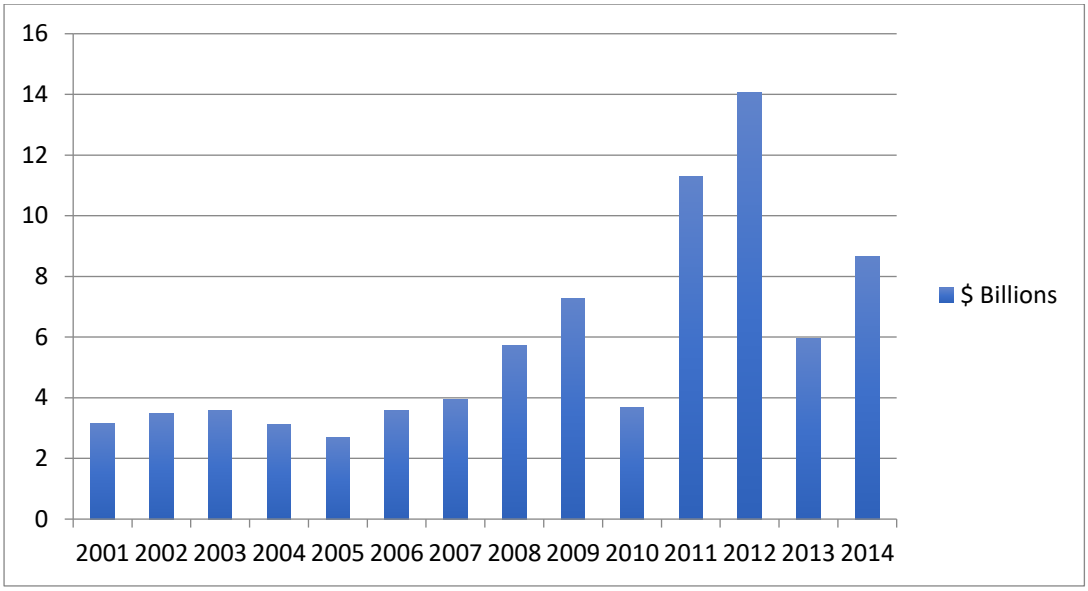


Chart 11: Cost of Crop Insurance Program 2001-14
Source: USDA Risk Management Agency

8.2.1 Revenue Insurance

When taking up Revenue Insurance, the farmer starts by choosing a level of revenue they want to protect. The cost of the premium increases if the farmer selects a higher price. The yield element of the policy is calculated based on historical farm figures for each farm.

The producer receives a payment if the yield drops, or prices decline, or a combination of both.

8.2.2 Yield Insurance

90% of yield-based policies are sold as Actual Production History or 'APH' policies. These cover flood, frost, drought and disease. The farmer can choose an entry-level policy that only covers catastrophic events which is calculated at less than 50% of his or her normal yield and 55% of the estimated market price. For this level of catastrophic protection, the taxpayer pays 100% of the premium. As the level of protection for the farmer goes up, the US taxpayer covers a lower percentage of the premium.

8.3 Revenue vs. Yield

When I considered the opportunities and challenges for a European version of crop insurance, two elements stood out for me. Firstly, that farmers clearly understand the concept and mechanics of insurance and secondly, that revenue insurance is more popular than yield insurance.

Revenue policies were only introduced in 1997, while yield insurance has existed in various forms since 1938. By 2003, Revenue policies had overtaken Yield insurance in acreage terms.

The frustrations and challenges in being part of such a huge risk management operation felt very similar to some criticisms of the CAP. There is a perception that larger farms get too much support while smaller family farms are not supported to the same level. The 2014 Farm Bill tried to address these issues by limiting the amount of subsidy a farmer can receive to $125,000 (a spouse can also receive $125,000). Anecdotally, it was often commented to me that big farmers and agribusinesses had no problems circumventing this new restriction.

8.4 US Index based Crop Insurance

Other new elements of the 2014 Farm Bill saw the launch of two new schemes called Price Loss Coverage (PLC) and Agriculture Risk Coverage (ARC).

> **Agriculture Risk Coverage-County (ARC-CO):** The ARC-CO program provides revenue loss protection at the county level. A determination regarding revenue loss for each commodity is made after the USDA publishes the market year average price (MYA)
>
> **Price Loss Coverage (PLC):** The PLC program provides payments when the market year average price for a covered commodity falls below the crop's reference price specified in the 2014 Farm Bill.
>
> *Source: USDA: https://www.fsa.usda.gov/programs-and-services/arcplc_program/index*

The emergence of ARC and PLC in the 2014 Farm Bill was relevant to my research for two reasons. Firstly, it further consolidated the popularity of price rather than yield. Secondly, both introduced an index-based element to settlements.

This increased use of indexes had the potential to save a significant proportion of the 'admin and operational' overheads that US tax payers pay insurance companies 22-24% of the premium to operate. Index- based settlements are far cheaper to administer, as they reduce or remove the need for an expensive and time-consuming claims process.

The question I began to ask is - **how efficient could a form of ARC/PLC be, and could this offer any potential in a European context**?

Chapter 9. The Potential for a European Crop Insurance Programme

9.1 Overview

There has been much talk in the last few years of the potential for and challenges to setting up a British or European crop insurance scheme. The potential scale, cost and complexity of this new form of risk transfer from farmers to the public sector is a significant area of study in itself.

It is clear that a US style programme would face some major obstacles on this side of the Atlantic. The first being that Europe's farming economy is very heterogeneous. Indeed, this highly variable commercial and climatic landscape is often cited as a fundamental problem of the CAP in general. Creating a centralised agricultural policy for 28/27 countries is highly complex and because of this, there is a natural tendency to default to a 'one size fits all' position.

> *'The heterogeneity of risks and agricultural structures throughout the EU favours a more decentralised approach, using instruments best suited to the specificities of particular regions and sectors'* *(Bielza Diaz-Caneja et al., 2009; EC, 2011)*

Governments funding a new Crop Insurance initiative would also require a dramatic shift away from the redistributive Pillar 1 (direct payments). When combined with potential World Trade Organisation (WTO) restrictions, which try to stop market distortion, the political obstacles involved would be almost insurmountable for the foreseeable future, even if the economic benefits were substantively clearer.

The time I spent in Brussels was really useful to understand the mechanics of how a crop insurance initiative might work at an EU level. My conclusions chimed with Bielza Diaz-Caneja et al., in that a far more effective volatility solution could be designed, built and promoted to farmers by starting from the grass roots of each member country, rather than pursuing a top down approach.

9.2 Portugal

While exploring the wider challenges of crop insurance in Europe, I travelled twice to Portugal and spent time with Professor Francisco Gomes da Silva, (seen left) who was previously the Portuguese Secretary of State for Agriculture, until 2014.

© Francisco Gomes da Silva

I spent a significant amount of time with the University of Lisbon to share ideas and to better understand the potential of agricultural crop insurance in a Portuguese context. This included meeting farming organisations and banks such as Credito Agricola and BPI in Lisbon. Portugal was a great place to study, as the university is well known for its agricultural expertise and strong connections to European Institutions like EIP Agri and has excellent cakes.

Portugal is also, economically speaking, one of the countries most exposed to volatile agricultural prices, as can be seen in the darker shades of Chart 12 below.

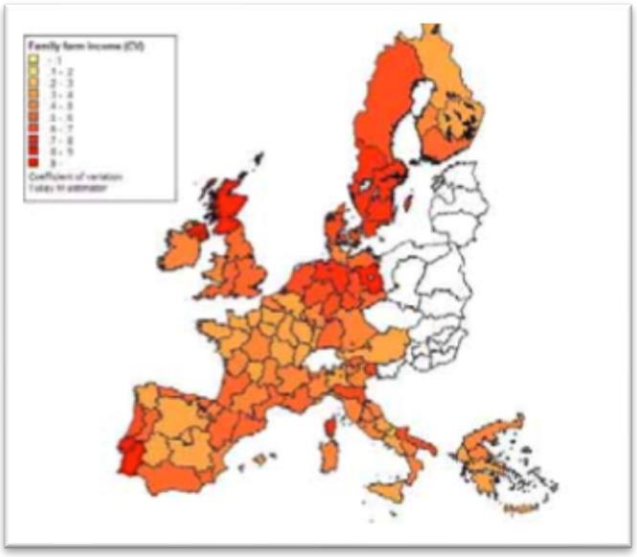


Chart 12: Volatility of farm incomes:
Source: DG Agri

The limitations of a US style insurance programme were now clear. Europe, (and the UK) clearly needs a sharper tailor to cut the cloth required to fit our unique national requirements.

Three months after returning from the US, I was still ruminating on the popularity of price protection over yield and the potential of index-based solutions to lower operating costs and simplify the user experience for farmers.

The last area of background research on my list, was to dig a little deeper into **why no meaningful private sector crop insurance solution had emerged in the US or in Europe**?

9.3 Public vs. the private sector

At this stage in my study, it felt important to take a fresh look at the accepted wisdom that the public funded US crop insurance programme had to exist, because the private sector could not provide the same products.

Market failure is the most commonly cited reason for justifying the enormous expense to the US public. The theory goes that if selling insurance to farmers is uneconomic, (correlated risk makes the premiums too high) then the government has to step in and protect the food and farming industry from volatile prices. However, the lack of a private sector involvement is not conclusive evidence of the existence of a market failure. What if the model just needs to be improved?

In 2013 Goodwin and Smith found that:

> *'A classic "chicken and the egg" conundrum applies here—is the government involved because private markets have failed or has the provision of such significant subsidies displaced any incentives for private insurance? The most prominent example is revenue coverage, which is now the dominant form of federal crop insurance.*
>
> *Commodity Options markets that provide private insurance contracts on agricultural commodity prices have been in existence for over twenty years. An argument of convenience is that such contracts do not precisely match the insurance needs of individual farmers.*

However, such an argument presupposes the lack of any private intermediary that could tailor price protection to individual producers' needs by using private market Options.

Although proponents of the programs often claim that they are necessary because of a failure of the private market to provide efficient risk management mechanisms, no convincing evidence that such market failures exist is apparent.'

(Source: *Goodwin and Smith 2013. Volume 95. Issue 2. American Journal of Agricultural Economics)*

Reading this article in the American Journal of Economics represented a mini 'light bulb' moment for my research and reaffirmed my belief that this was not an area 'roped off' for the public sector alone.

After much thought and several weeks of fascinating meetings in Paris, Lisbon and London I found that I readily agreed with Goodwin and Smith's paper and that despite appearances, the private sector has the potential to play a significant role in helping family farms manage volatile prices.

9.4 Building a market based solution

In terms of building a new market-led solution, the UK has a huge advantage in being home to the City of London, seen right.

London is undeniably home to some of the most talented financial and insurance professionals in the world and with more collaboration, this proximity could create a competitive advantage for British agriculture.

© Shutterstock.

By now, the research, contacts and international travel had given me an in depth understanding of the operations, maths and economics of risk management and where some opportunities for genuine innovation could lie.

The next step (and a slightly daunting one) **was to change my focus towards developing a new product that might be better suited to farmers simply looking to reduce risk, rather than speculators.**

Chapter 10. Hedging

10.1 Overview and History

All price risk management solutions orbit around the basic concept of hedging. Despite how common the use of the word is; it is often surprising how many gaps in understanding still exist. Hedging is talked about often, but rarely explained.

This definition from Investopedia was the most succinct I could find:

'A hedge is an investment to reduce the risk of adverse price movements in an asset.'

The concept of a hedge as asset protection is simple enough, but where it gets slightly more confusing is when you dig a little deeper and consider *how* you can 'hedge' and the regulations that surround it.

If you want to create a better way for farmers to manage volatile prices, then you are creating a mechanism to enable them to reduce the risk of the price of an asset like milk, from falling. This risk of course does not disappear; it is simply transferred from the farmer to a 3rd party.

Some of the confusion is caused by the myriad of different ways the risk transfer process can take place and in pure economic terms, the grey areas between them.

Chart 13: The relationship between derivatives, gambling and insurance: *Source: Own*

Historically, the relationship between insurance, derivatives and gambling has always been close, as per Chart 13.

Edward Lloyd's coffee shop customers started by gambling on whether a ship would return safely. This metamorphosed into the slightly more respectable activity of a ship owner effectively betting that his ship would not return, to hedge the risk.

If someone wished to insure a ship, a contract would be drawn up and the insurer would sign his name underneath - hence the term "underwriter".

3000 years before Edward Lloyd had brewed his first pot of coffee, the code of Hammurabi in modern day Iraq, set out a form of maritime insurance that included a form of loan that did not have to be repaid if the ship sank. The blurring of the lines in risk management is clearly nothing new.

Aside from the caffeine fuelled origins of Lloyds, farmers in the German and Swiss Alps, were taking a different path that shared risk rather than traded it. These humble agricultural beginnings, would eventually lead to the creation of the global insurance behemoths of Munich, Zurich and Hannover Re.

It may seem like I've lost my train of thought with all this trivia, but these historic and financial grey areas illustrated earlier innovative solutions and highlighted very real hurdles that needed to be overcome to develop a risk management solution for family farms.

If the risk of a price fall remains, do you share it (pool) or transfer it (trade)? Whichever path you choose has big implications for your ability to design a tailor-made product for farmers, because of the varying regulation involved.

10.2 Hedging with Derivatives

Writing nine years after the financial crash of 2008, the bad taste that surrounds the word derivatives still lingers. They would be a hard sell to family farms not used to price risk management.

The world's largest insurance market is in the derivatives markets. Put simply, investors and traders can use derivatives markets to insure themselves against a price fall of a stock or commodity, for example. The key difference with a derivative (Put Option) compared to insurance, is that there does not have to be an actual 'insurable risk', (to you or your farm) to trade on a derivative marketplace. To make a trade you simply need to find a counterparty with a different opinion to you and who is willing to put 'their money where their mouth is.'

While often dismissed as just gambling, derivative markets undeniably play an important role in greasing the axle of global commerce. Whether the participant wants protection from exchange rates or commodity price falls, having a hedge in place allows you to specialise to gain economies of scale and invest in the future with more confidence.

The major barriers are the increasing regulations involved. Farmers are classified as retail investors in a regulatory sense, which makes selling financial products to farmers complex and expensive. With various MIFID (Markets in Financial Instruments Directive) regulations from Europe, this process is getting even harder.

> For example, signing up a farmer to a broker account can now take 2-3 months because of Know Your Customer (KYC) rules.
>
> You then pay a £150 Legal Entity Identifier fee and, after all that, a deposit of £20,000 + can be required and only then you can start buying Options.

So, for derivatives to be viable, because of cost and regulation, arable farms need to be more than 400 hectares. But, less than 5% of European farms are over 50 hectares and less than 1% globally.

While derivatives are economically a very efficient form of risk transfer, the rules and regulations involved has clearly taken them out of the reaches of most family farms.

10.3 Hedging with insurance

I knew from the US crop insurance example and my own research that farmers respond well to concepts of insurance rather than derivatives, despite the economic similarity in some cases.

During this stage of my Scholarship, (late 2016) I did a number of talks all over the UK on volatility to hundreds of dairy and arable farmers. The difference in perception when describing an insurance product over a derivative product was very noticeable across all sectors.

11. From Research to Development

11.1 Overview

Insurance doesn't need explaining to farmers, whereas the opportunity cost of learning about derivatives and regulation, usually outweighs the financial benefit of the tool.

In hindsight, the simplicity and common sense of the sentence above is so obvious. However, by this stage I was simultaneously exploring the intersect between insurance and derivatives and testing different risk transfer ideas that might work for farmers.

To help me understand and visualise how this might work, I built an entire derivatives platform to test some of my early risk transfer theories with a team of developers and some of the world's finest mathematicians.

11.2 Prediction market development

I was extremely fortunate to have had the advice of Professor Yiling Chen of Harvard University and some researchers at the University of Victoria in Wellington as we tested and explored these various concepts.

Our most promising work was done around the concept of Prediction Markets (a form of Options Exchange), and while the maths was fascinating and the platform worked well, none of these ideas passed the simplicity test for farmers, or the ability to regulate in the UK.

11.3 A low point

In hindsight, these were by far the toughest months of my Scholarship. I made very little progress despite hundreds of man-hours and the help of some very talented academics and software developers.

Achieving a balance between a model that could deliver an efficient transfer of risk and a simple user experience for farmers was some of the most complex technical work I've ever been involved with professionally.

To make any progress I had to start again and scrap thousands of lines of code that had been written. While that process was about as fun as a wet weekend in Cornwall, it was clear after speaking to farmers all over Europe and in the UK, that the best path forward was to base any new product design around insurance.

This new focus made everything simpler from a farmer's perspective. With a little imagination and many more lines of code, I knew we could make the process of getting a quote to protect your farm from volatile prices, as simple as insuring your car.

In design terms, things had just got a lot easier by developing an insurance product. However, as was fast becoming the norm with this project, it had a pretty complex knock on effect that I tried to ignore for a few weeks. It became the 'elephant in the room' and I had absolutely no idea how to solve it -***you can't insure commodity prices…***

11.4 Insurance and the systemic risk barrier

As elephants go, this one was particularly inconvenient. I wanted to create an insurance-led initiative for farmers to protect them from volatile prices and everything I read about the basic laws of insurance said this wasn't going to be possible.

This is because risk pooling is essential to the concept of insurance, just as those forward thinking Alpine farmers realised in the 15th Century. Risk pooling simply means the spreading of financial risks among a large number of participants, for example:

> 100 farmers insure their barns against fire and pay a small amount into the pot (as a premium) to cover the risk. The probable risk is that only 1 or 2 of the barns will catch fire and they can easily be rebuilt using all the premiums.
> However, if those barns were all on the same farm and the fire could spread between them, the insurer could be liable to rebuild all 100 barns, which might ruin them.

This risk of 'contagion' is called **Systemic Risk** and it makes most insurers come out in a rash.

Farm commodities are of course very similar in nature and if the price of milk falls in Somerset, it also falls in Suffolk. If an insurer accepted premiums from 100 dairy farmers and the price of milk dropped, then they would have to make a payment to all 100 dairy farmers.

© Shutterstock

Researching ways to overcome the systemic risk barrier became my single biggest priority. For over three months I read every type of insurance research paper I could find online and met experts in London, Germany, the Channel Islands and France to hunt down any leads that could throw the initiative a lifeline.

I had a nagging feeling that without substantive progress in this area, my Nuffield scholarship would end up being a wonderful experience, rather than a catalyst for something that could potentially make a real difference to family farms.

11.5 Insurance Linked Securities and Catastrophe Bonds

The area that I thought offered the most potential was the growing prominence of Insurance Linked Securities (ILS) and Catastrophe (Cat) Bonds. These two areas are at the very cutting edge of Insurance research and both offer an innovative method of risk transfer between the traditional insurance world (underwriters), and the financial markets.

The majority of this research was looking at how to transfer the risk of huge natural disasters like hurricanes rather than agriculture, but with a little imagination you could see how this could also be applied to farming.

I was, at this stage, clearly completely out of my depth but over time I began to identify three academics that were clearly interested in similar areas:

- Professor Callum Turvey of Cornell University
- Professor Hirbod Assa of Liverpool University
- Professor Dmitry Vedenov of Texas A&M University

In September 2016, Turvey & Assa co-authored a paper called, 'Modelling and Pricing of Catastrophe Risk Bonds with a temperature based agricultural application'. While I realise that the sound of this paper might sound like purgatory to some, this was actually quite an exciting moment. It was the first time Cat Bond research had included a mention of farming and so I wrote to Professor Assa in Liverpool.

11.6 Liverpool University

To his immense credit Hirbod *(seen right)* was willing to meet up and discuss some ideas I'd had and his work in this space.

Hirbod Assa

He was the perfect host and is a distinguished academic with PhDs in both Mathematical Finance and Economics and has a particular interest in agriculture. It was the break I desperately needed.

I travelled to Liverpool shortly after and met the whole team at the Institute of Financial and Actuarial Mathematics (IFAM), including Dr. Corina Constantinescu.

They were extraordinarily generous with their time and were excited by what I'd been working on and the scale of the impact it could potentially deliver. Shortly after, I agreed with the University of Liverpool **to collaborate formally on the initiative, that by now was called Stable.**

After months of solitary work, coding and research, the hand of support offered by the IFAM was a big moment for the research project and a considerable personal boost.

© Simon Wang

Not only did the Stable initiative now have the guidance of a world-class academic, but we could also involve some talented PhD students that would give us the manpower needed to finish the research.

I was then introduced to the brilliant Simon Wang *(seen left),* who is a PhD student and maths protégée from China and together we got to work on trying to solve the problem of systemic risk. He was to become instrumental to the project and a good friend.

Chapter 12. Up Horn, Down Corn

12.1 A.G. Street

My father John has always loved the books of A.G. Street and I was reminded again of the phrase 'Up Horn, Down Corn' while reading Paul Baker's Nuffield report on Mixed Farming. It is one of those phrases that you hear from time to time, but through familiarity has lost some of its impact.

Reading A.G. Street's bucolic prose is like being sent a fading postcard from the past. It is at once uplifting and for me, slightly melancholic. Life on the farm jumps off the page, full of people and characters each with a defined role in a prosperous farming system and a way of life that must have seemed like it would go on forever.

The Writer, A. G. Street

12.2 The breakthrough

Much has clearly changed, but reading that well-known phrase again sparked a vague idea and I made a mental note to run it by the team at Liverpool University first thing in the morning.

Was 'Up Horn, Down Corn' true in a statistical sense? If it was true, how true was it?

If A.G. Street was a statistician, he might have said 'individual farm prices and input costs can show low correlation within a 1 year period.' It would be fair to say it doesn't quite have the same ring to it.

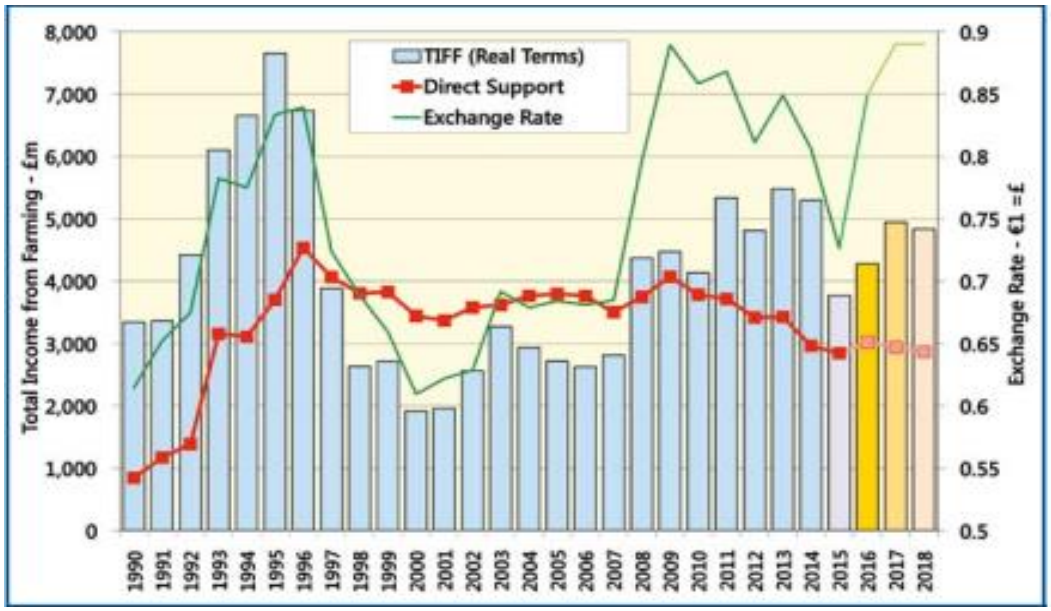


Chart 14: Total Income from Farming 1990 to 2018
Source: DEFRA/Andersons

We know that total farming income (TIFF) is closely associated with external factors like exchange rates, as can be seen in Chart 14, but that's only half the story as the chart displays an average of all commodities and farm income streams.

I wanted to build a model that took A.G. Street's adage of traditional mixed farming and put it under the microscope of the most modern data science tools.

The question was, could we build an insurance product that acted like a very large mixed farm and diversify enough systemic risk to lower the risk for an insurer and offer an attractive premium to a farmer?

12.3 Big data and machine learning

The first requirement for big data analysis is a big amount of data. Because our emergent theory required prices for all UK farm commodities (Dairy, Livestock and Arable) rather than just Arable (with its exchange-based prices), we needed to look further afield than just LIFFE or MATIF.

The logical place to start was the Agriculture and Horticulture Development Board (AHDB) and we received an enormous amount of help from the Market Intelligence team and others such as Jack Watts and Patty Clayton. The team at the AHDB deserve a great deal of thanks for their patient handling of my endless questions about the indices and methodology behind them. I can't thank them enough for all their help.

The data we needed required a considerable amount of work to prepare for our analysis, as it all had to be standardised across the various commodities, with any missing values completed using complex interpolation.

12.4 Algorithms

While I worked on the AHDB data, the Liverpool team went into overdrive and built 5 sophisticated algorithms that could automatically read and analyse the price data. We also built a ground-breaking machine-learning engine that could autonomously analyse trillions of combinations of prices and dates to complete an in-depth look at what by now, had become known as our 'Up Horn, Down Corn' theory.

This work is similar to what Quantitative analysts, or 'Quants' do for merchant banks and hedge funds in the City; we were just applying it to British farming.

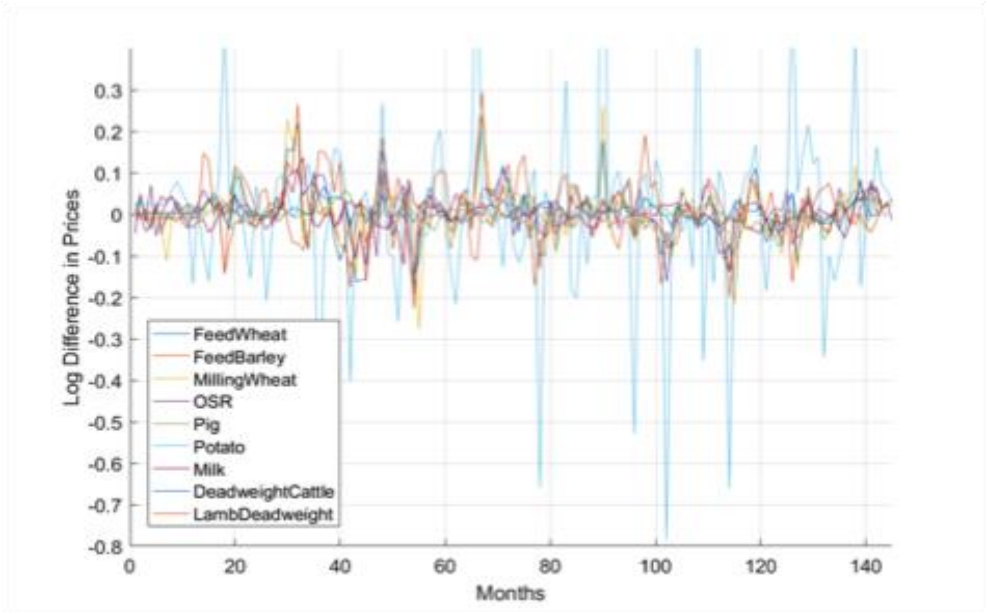


Chart 15: A standardised Log Difference view of our key UK farm commodities
Source: Own Work

By this stage, our theory was building momentum in academic circles and we were delighted to be invited to work with the Virtual Engineering Centre (VEC) in Liverpool.

This is one of Europe's most advanced centres for computer-based engineering and is home to one of the UK's most powerful computers, called Blue Joule *(seen right).*

© Science Technology Facilities Council

12.5 Progress at last

Amongst the team at Liverpool, there was a growing sense of excitement as by now we were able to use our algorithms to both forecast farm commodity price trends *and* search for diversification opportunities, just like a traditional mixed farmer.

Our machine-learning engine generated 1,058,400 contracts continuously to test our theory and analysed 62 trillion data points. After months of big data work, **we finally proved that applying our 'Up Horn, Down Corn' theory to insurance models could have a significant impact on agriculture, by reducing the risk of protecting farmers from volatile prices.**

The risk management platform and suite of algorithms we developed can now enable an insurer to understand and price the risk more accurately. **This work enables an insurer to offer to protect family farms around the world from volatility at commercially attractive prices without needing public subsidy.**

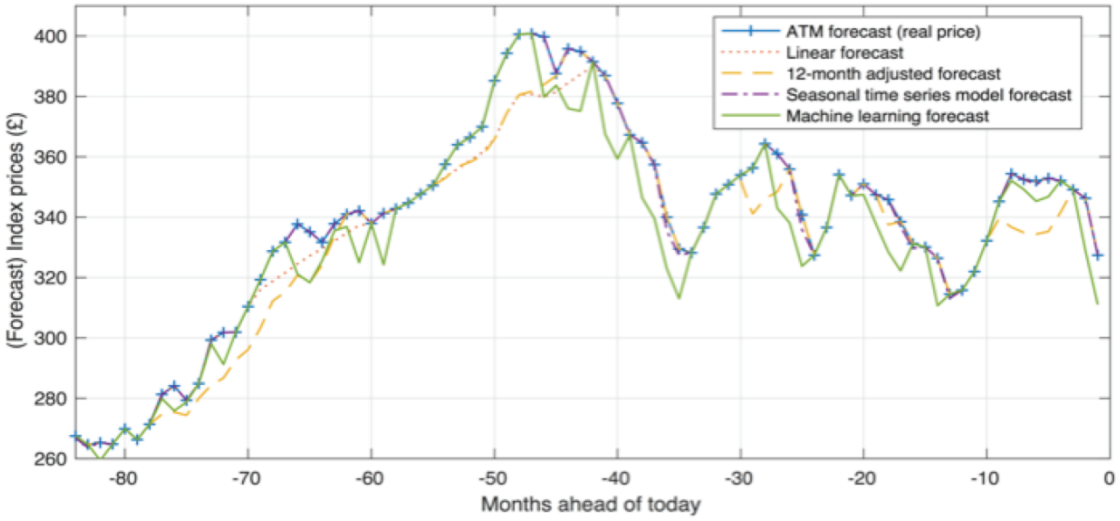


Chart 16: Our 4 algorithms forecasting the future price of a UK farm commodity. In this case the UK Deadweight Beef Price: *Source: Own Work*

Chapter 13. Index Insurance

13.1 Overview

Index insurance is simply a form of insurance that is linked to an index, such as rainfall, yields and price rather than an actual loss. It is most commonly used to overcome the challenges of traditional crop insurance in developing countries and is widespread in Africa.

One of the major advantages of index linked insurance is that the transaction costs and overheads are lower because there is no claims process. This can make it a more viable method for private-sector insurers and affordable to family farms. Another crucial advantage is that index insurance creates less adverse selection (insurers just get high-risk customers) and moral hazard (makes farmers take more risks), than traditional insurance.

With the data work progressing well, I could spend much more time investigating the intricacies of Index Insurance with those already involved in the industry. This included productive meetings with SCOR (Paris), Munich Re and Hannover Re (Germany), Markel and Aegis (UK) and Credito Agricola (Lisbon). The advantages and disadvantages of Index Insurance can be summarised as in Chart 16 below.

Advantages	Disadvantages
Lower operational costs	Basis Risk (Real or Perceived) The index has to move in line with the farmer's actual loss.
The data used is public and transparent for both parties which builds trust	The index has to be reliable to maintain trust
Fast payouts for farmers with no paperwork involved	Insurance Premium Tax
No moral hazard- the farmer doesn't take more risks	
UK Index (GBP) rather than €/$	

Chart 17: The Pros and Cons of Index Insurance

There are also considerable regulatory advantages in taking an insurance first approach, as it removes the product from the most demanding aspects of MIFID regulations that control the sale of derivatives. Index linked insurance does however need good price indices data. Here, despite the EU running most areas of agricultural policy, national governments have all maintained quality ex-farm price indices that are public, transparent and offer low basis risk.

13.2 AHDB

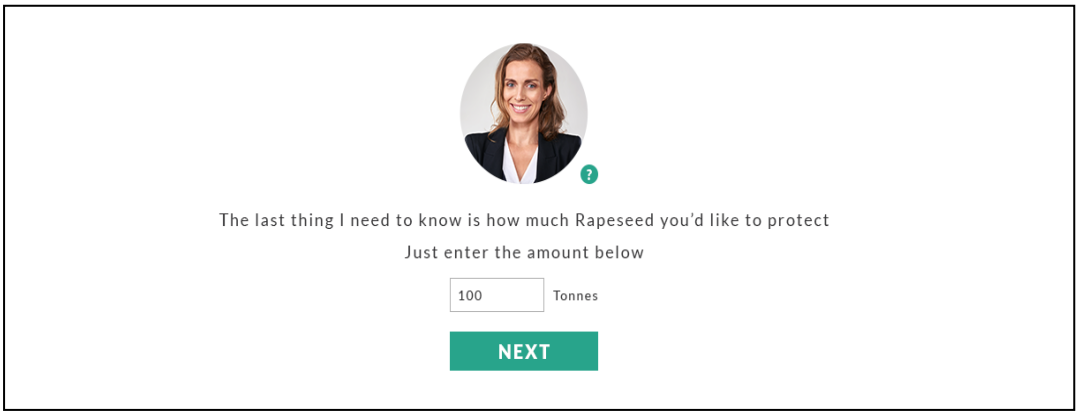
One of the most satisfying aspects of using the AHDB indexes to help British family farms has been that we've used public data that already exists and is already funded by farmers, via the levy.

We are fortunate as an industry to have this quality data as a resource and I believe its prominence and value will only increase as other Agtech and Big Data applications come to the fore.

Chapter 14. Industry Support

As the initial phase of the research and development came to an end, we had finally completed both the design of the farmer-facing index insurance product (seen below) and the big data models that sat behind it.

This enabled us to begin demonstrating our research **as a product** to potential commercial partners that could help make it a reality. I was keen to ensure we received advice and feedback from insurers and banks, (the two most likely commercial partners) at the earliest opportunity to ensure we were being practical and realistic.



A screen shot (seen above) from the interactive 'chatbot' system which I designed that lets farmers get a free online quote in less than 2 minutes by answering just 3 questions. If the index price falls, then the farmers lost income is replaced automatically.

14.1 Barclays Bank

My first commercial contact was with Mark Suthern at Barclays Bank, to whom we showed the product to in early 2017. The response was reassuringly positive and the advice and support we received was incredibly useful.

While we had made an encouraging start, it was still necessary to build a relationship with an insurance company that could potentially use our research and risk management platform for underwriting.

14.2 Cornish Mutual

Shortly afterwards and thanks to Mark Suthern at Barclays, we were introduced to Peter Beaumont and the team at Cornish Mutual. After a trip to Truro we began to work together to test our models and Nuffield research and see if it could be applied in a commercial insurance operation. We were also fortunate to have been helped by Patrick and Sibylle from Baloise (a £7bn Swiss Insurer) and Tom, Ruth and Matt from Anthemis, (a London and New York Venture Capital Fund), who helped us check our findings and methodology.

All our commercial partners have made a huge difference to the Stable initiative and we are continuing to work with them closely, along with other international Insurers and Banks.

14.3 An invitation to Paris

During this time I travelled again to Paris, as we were invited to present Stable at the headquarters of SCOR and Goldman Sachs, at an Agri Risk conference (called IARFIC).

This was attended by some of the world's leading Agricultural Economists, including Professor Callum Turvey from Cornell University and Professor Lysa Porth from the University of Manitoba.

This was a real privilege for everyone who had worked so hard to bring the project to life and I made some valuable new contacts in the Agri Insurance world.

Professor Assa presenting our research in Paris.

© Authors Own

Following the conference in Paris I was invited to discuss my Nuffield research with underwriters from Hannover and Munich Re; some of the largest insurance companies in the world.

At this stage, it would be fair to say my Nuffield experience was beginning to exceed my wildest expectations.

Chapter 15. Discussion- A Role for Government

In my introduction I referred to the opportunities for British farming around Financial Technology or 'Fintech'. This area covers a wide range of software-led innovation to create new ways to improve the efficiency of supply chains using technologies like Block Chain/Smart Contracts and Peer-to-Peer Marketplaces.

As the UK begins heading to the exit door of the EU, the future of a British farming policy looms large. The purpose of this section is not to discuss the pros and cons of Brexit, but instead to highlight a practical idea that may be of use to policy makers.

There would appear to be general consensus that the ability and willingness of a UK government to provide the same degree of public support to UK farmers over the medium to longer term is questionable. Greater accountability and competing claims on the public purse make this a very real challenge for our industry going forward. While 'public support for public good' will and should be offered, it is surely incumbent on the government to make use of the latest technology to ensure the financial help that *is* available to farmers goes as far as possible.

DEFRA appears to be very keen on a form of US price insurance to help farmers manage volatile prices. If the US model is directly transposed to the UK, this could involve the public subsidising the cost of the Crop Insurance premiums by up to 60%.

This strikes me as a very wasteful method to deliver targeted help to farmers when better/efficient models already exist in other areas. The rise of peer-to-peer marketplaces such as Market Invoice and Zopa, provide a possible alternative. They are incredibly efficient online platforms that have sped up cash flow for SMEs and democratised lending respectively.

Over 100 financial organisations have already received support via the British Business Bank, which is wholly funded by UK Plc, to enable them to grow and help SMEs with cash flow and investment requirements. Market Invoice alone has received £100m, which is lent on purely commercial terms. This £100m (and other private sector investment) has been recycled in the marketplace many times over and to date Market Invoice has advanced over £1.3bn to SMEs looking to speed up their cash flow.

Now let's transpose this approach to helping UK farmers manage volatility, using the precedent that has already been set by the British Business Bank. Farmers could purchase Crop Insurance without public subsidy, with the government providing the risk capital on a discounted, but still on an entirely commercial basis. This would reduce the cost of risk capital and lower the costs to the farmer. **Crucially**, **the net cost of this protection on the public purse would be close to zero.** DEFRA would be able to offer additional targeted support to British farmers of every size and sector, without the government being seen to favour farmers over nurses for example. My Nuffield research has proved it is entirely possible. I believe it is a really interesting opportunity to apply some genuine innovation to one small part of a future British Farming Policy. Further afield, this approach could also influence the economics and impact potential of international aid given to farmers in developing countries, via DFID.

Chapter 16. Conclusions

1. Whether the Stable initiative remains solely a private sector enterprise, or at some stage includes the public sector remains to be seen. Either way, I sincerely hope the advice, support and hard work from everyone involved in the Stable initiative can go on to become genuinely useful for British farmers and that they in turn take advantage of it.
2. There is still a long way to go, with many hurdles still to be faced but I am quietly confident that an idea nurtured by a Nuffield Scholarship will successfully cross the divide from academic research into the wider commercial world.
3. British farming will clearly face substantial Brexit-derived challenges in the next few years and volatile prices are here to stay. The obstacles are significant, but I finish my report full of optimism for the future of our industry.
4. The UK has extraordinary depths of talent and there is a deep pool of goodwill from experts from outside the industry who are willing and able to help family farms succeed. Our Universities are some of the best in the world and I'd love to see even more done to involve more of them in the future of food and farming.
5. This is not just about botany and big data: I'm convinced that there is so much more that could be done with more collaboration and open minds.

Chapter 17. Recommendations

Price volatility is a big problem and is not going away, but there is much we can do to as an industry to tackle it:

- We must do everything we can as farmers to increase productivity. It's the first line of defence with regard to volatile prices.
- The City of London is a huge resource for financial innovation- we should involve them more if possible.
- Agriculture has lots more challenges to solve than just volatility. Genuine innovation can come from unexpected sources and industries- let's find a way to break out of the 'echo chamber' of farming and create a wider conversation.
- UK Universities are some of the best in the world and represent an untapped resource for farming. There is enormous goodwill for our industry and they are willing and able to help.
- Finally for all developers and designers interested in creating innovative products for agriculture: turn off your computer and go spend time on a farm. Time spent understanding the practicality and reality of farming will save you endless time and money and enable better products to come to market.

Chapter 18. After my Study Tour

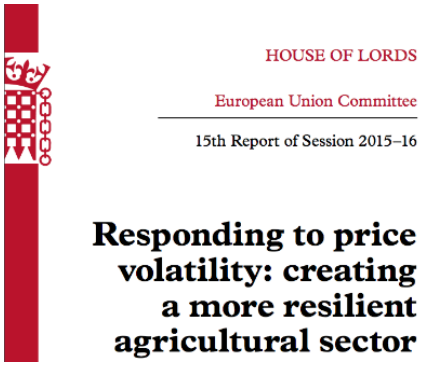
The Stable initiative is now my full time focus and the next 6 months will be taken up with the UK launch in 2018.

We've already been approached to launch in Australia, New Zealand and South America so the future looks promising.

I'm determined not to run before we can walk, but the potential to make a real impact in Agricultural Risk is becoming a real possibility.

Outside of this work, I was fortunate during my scholarship to be able to get involved in both the House of Lords and the House of Commons inquiries into volatility and potential solutions in 2016.

It sparked my interest in getting more involved in our industry in the areas of technology, investment, entrepreneurship and innovation and try and repay all the help and support I've received along the way.



©House of Lords European Union Committee

Chapter 19. Acknowledgements

Finding the words to thank people who have made this whole experience happen is no easy task. I will start with my amazing wife Pippa, who is incredibly supportive of my sometimes-unorthodox approach to a career and enthusiasm for new projects. I would be lost without her.

My parents John and Roe, also deserve an enormous debt of gratitude. The confidence they inspired to make the most of these amazing opportunities, is something I will always be grateful for

From the very first step in a pub with the wonderful Dr Derrick Wilkinson, who helped me to apply for a 'Nuffield', the level of help and support I've received along the way has been remarkable.

The sense of quiet belief that Wallace Hendrie, Julian Darling and Mike Vacher so effortlessly instilled was a huge influence on me and I was genuinely inspired to do something significant to repay their faith in me.

From the insanely gifted academics at Liverpool, Harvard, Wellington and Lisbon, to the City grandees of Mayfair, Paris and Chicago, none of this would have been possible without them.

Special thanks must also go to Edward Wakefield, Peter Beaumont, Mark Suthern, Andrew Petherick, Charles Norton Smith, Robbie and Jess Green, Martin Liu, Percy Lawson, James Stephens, Rory Stewart MP, George Eustice MP, Sergey Bashkov, Ian Piggott, Domenico Cirrotti, Dr Jeremy Cole, Crispin Odey, Peter Hambro, James ter Haar, Rufus Pilgrim, Iain Tremain, Maggie Charnley at DEFRA, Mike Houghton, Phil Morris, Jack Watts, Amanda Cornwell, Ruth Foxe Blader, Tom Ryan and Matt Jones from Anthemis, Patrick Wirth and Sibylle Fischer at Baloise, Roger and Robert Mercer, Dr Sean Butler from Cambridge University, Dr Rob Wylie, Liliya Serazetdinova, Laurence Agnes, Mark Hawkins, Leira Zelaya, Sharon Alvarez, Evy Hambro, Graham Birch, Henry Gurney, Karl Bagga, Francisco Gomez da Silva, Christina Capitao and all the team at Inovisa in Lisbon, Tom Green, Lord de Ramsay, Charles Evans Lombe, Archie Struthers, Duncan Worth, Richard Pemberton, Lindsay Hargreaves, Roger Keeling, David Thompson, Hady Wakefield, Tom Barclay, James Bolesworth, Benjamin Bodart, Rohit Kaushish, Louise Manning and Ian Mason.

Their collective belief, advice and support along the way was transformational in so many ways and I will be forever grateful.

Finally, it just remains to thanks my fellow Nuffield 2016 cohort for making the experience so memorable. You'd be hard pressed to find a more talented bunch of people and I wish them all every success in the future.

Richard Counsell, Nsch

Chapter 20. Glossary and Abbreviations

With a report focused on Insurance, Software and Financial Mathematics, it is inevitable that some industry jargon will creep in. While I attempted to keep it to a minimum, I hope the Glossary below may prove useful.

Algorithm	A computer based formula for solving a problem, based on conducting a sequence of specified actions.
At the Money	In Options, when the strike price equals the price of the underlying asset
Black Scholes Merton Model	A formula for calculating the price over time of a Financial Option
Call Option	An option that gives the buyer the right but not the obligation to buy an asset at a predetermined price. You profit from a call when the asset price rises.
Derivative	A product whose value derives from and is dependent on the value of an underlying asset, such as a commodity, currency, or security.
Futures Exchange	A marketplace where futures contracts and options on futures contracts are traded.
Hedging	A hedge is an investment made to reduce the risk of adverse price movements in an asset.
Machine Learning	A type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed.
Margin Account	A margin account is offered by brokers to allow investors to borrow money to buy securities. The investor can part pay for the share or commodity and the broker lends the investor the remaining amount in return for interest.
Margin Call	When a broker requests further cash to cover losses in your Futures trading position
MIFID	The Markets in Financial Instruments Directive is the EU legislation that regulates firms who provide services to clients linked to 'financial instruments' (shares, bonds, units in collective investment schemes and derivatives), and the venues where those instruments are traded.
Put Option	An option that gives the buyer the right but not the obligation to buy an asset at a predetermined price. You profit from a put when the asset price falls.
Put Spread	A Put spread is an option strategy seeking maximum profit when the price of the underlying asset declines. The strategy involves the simultaneous purchase and sale of options.

Chapter 21. Further Reading

For anyone interested in further reading on the subject, I can recommend the following papers.

UK Focus

House of Lords Inquiry

https://publications.parliament.uk/pa/ld201516/ldselect/ldeucom/146/146.pdf

House of Commons Inquiry

https://publications.parliament.uk/pa/cm201516/cmselect/cmenvfru/474/47404.htm#_idTextAnchor009

Papers

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