Agriculture's 'Off-Farm' Data Revolution: A Behavioural Approach to Assessing Policy Implications

A Presentation by Graeme Jobe

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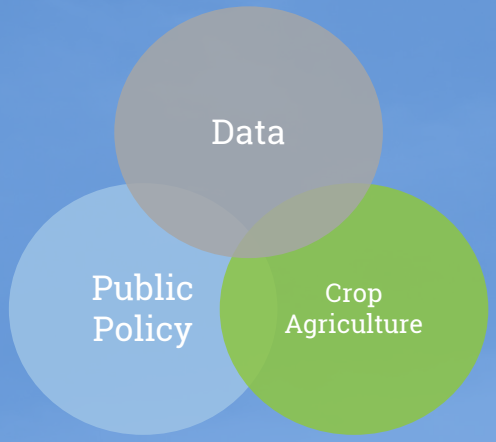
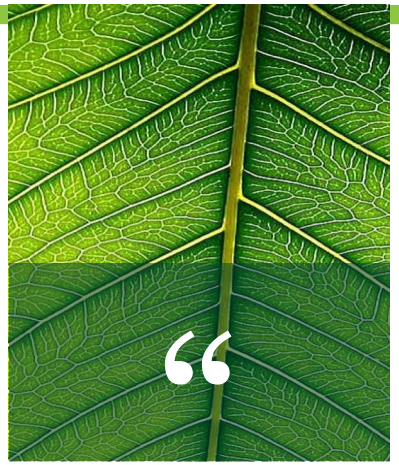
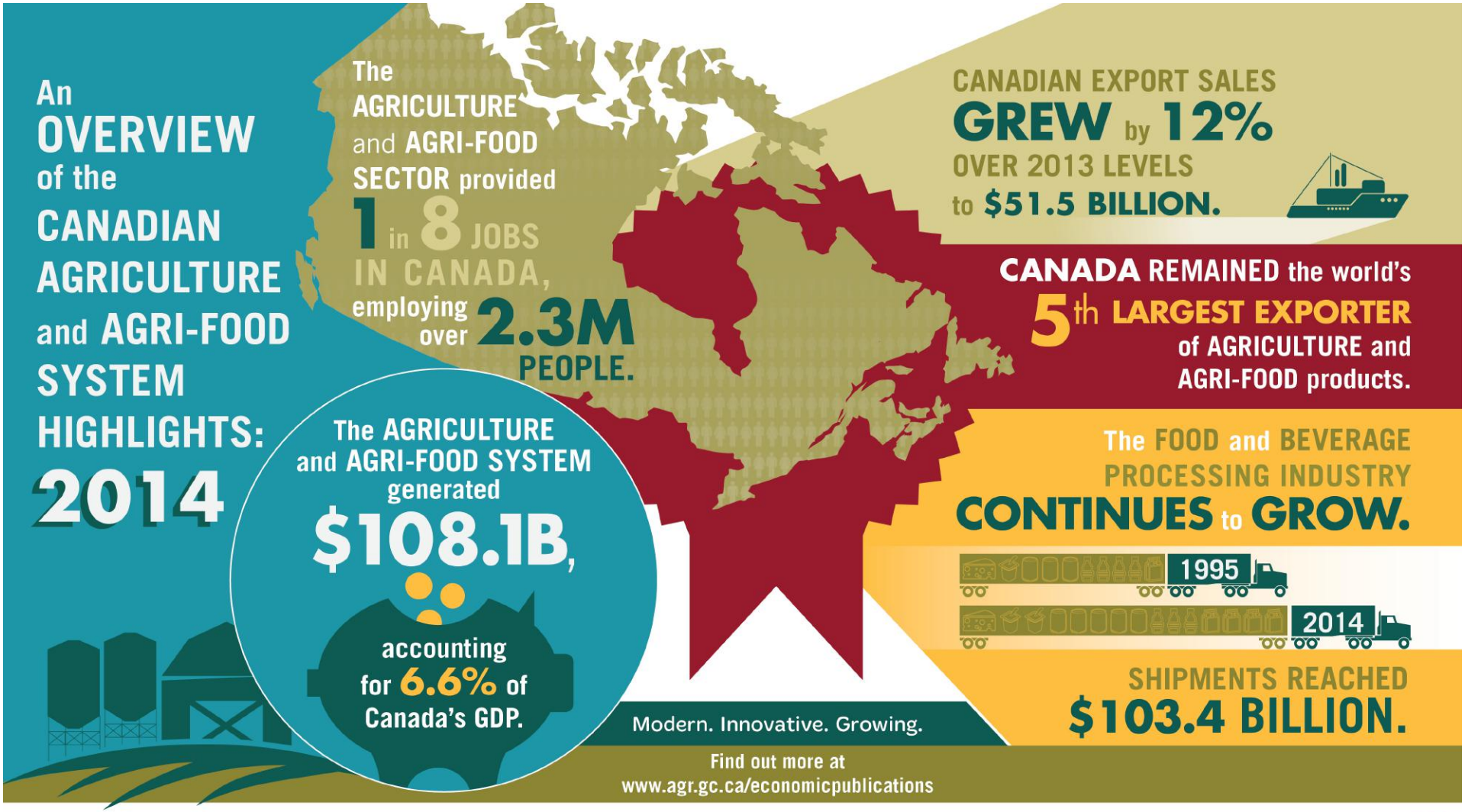




Research Area 3:

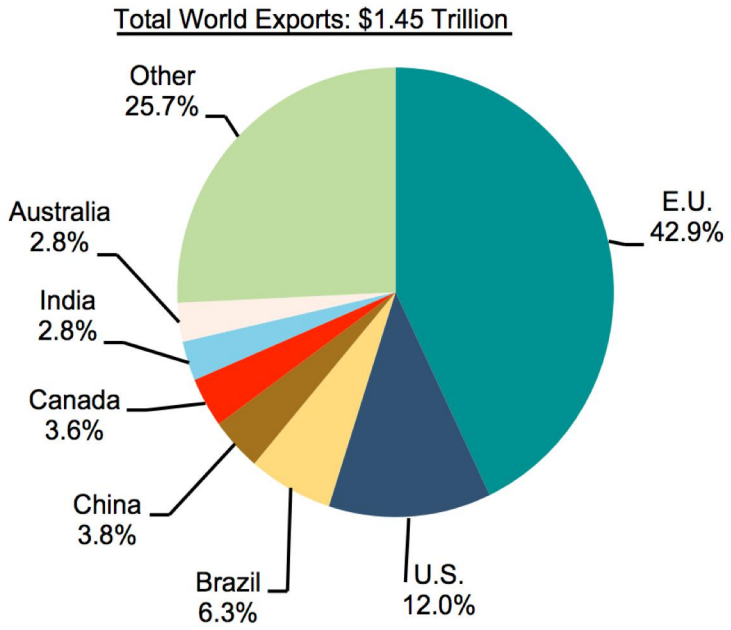
How does the diffusion of digital technology across all sectors of the economy contribute to the overall dynamism and competitiveness of the Canadian economy?



Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

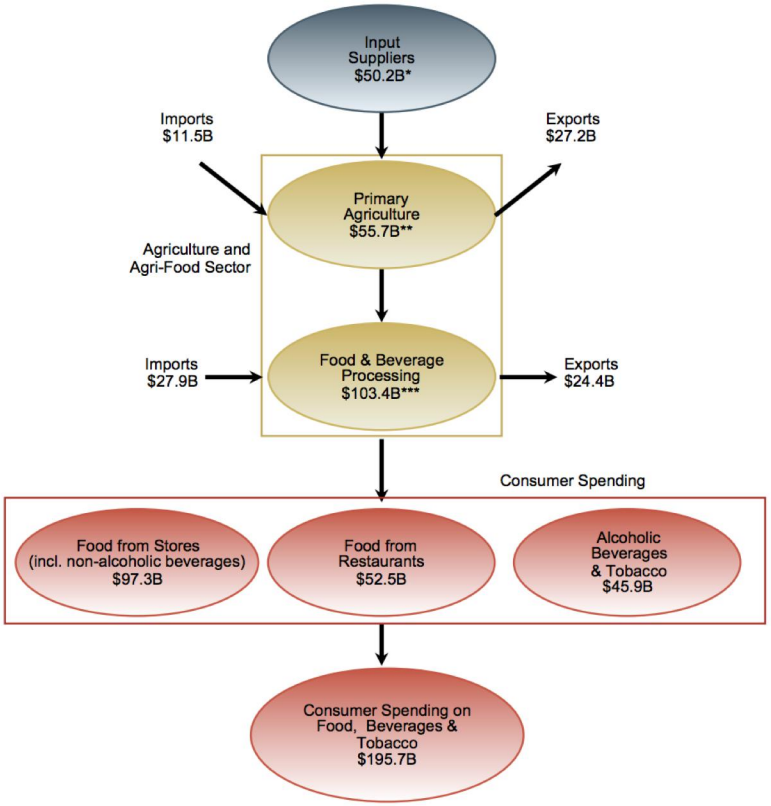
Canada

Chart C.1
World Agriculture and Agri-Food Export Share by Country of Origin, 2014

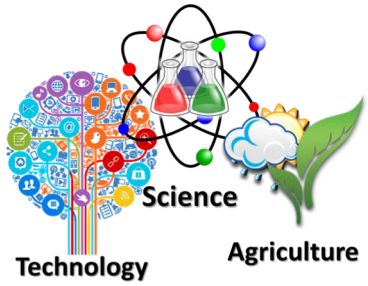


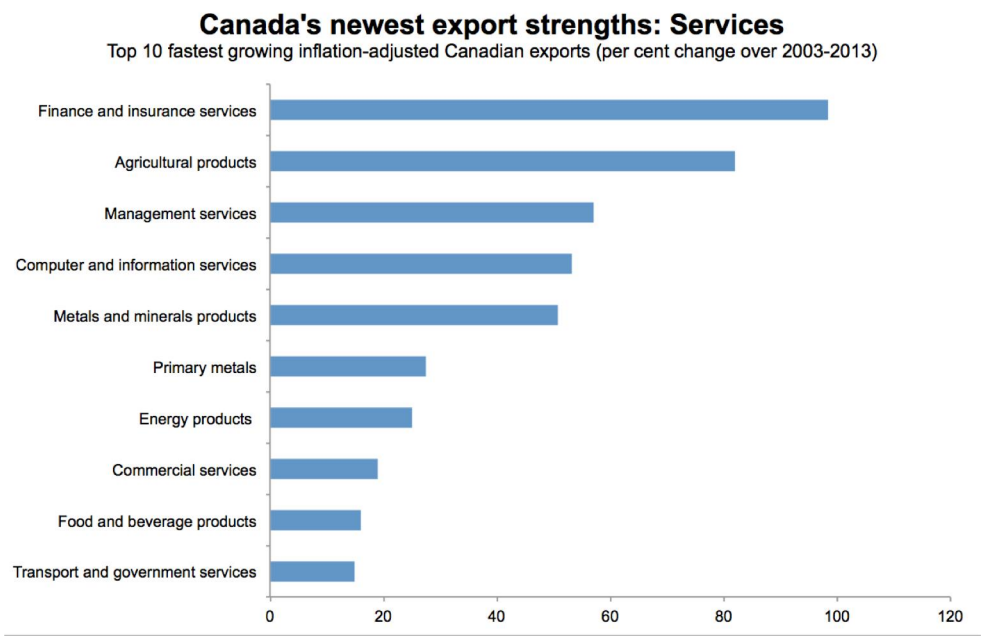
Source: Global Trade Atlas and AAFC calculations.
Notes:1) Excludes all seafood - fresh and processed. 2) Includes intra-E.U. trade.

Chart B.1 The Agriculture and Agri-Food System, 2014



Source: Statistics Canada and AAFC calculations.
Note: *Measures the value of inputs purchased by the primary agriculture sector.
** Measures the value of farm production (farm market receipts).
*** Measures the value of shipments for both food and beverage processing.


Science
Technology
Agriculture


Canada's newest export strengths: Services
Top 10 fastest growing inflation-adjusted Canadian exports (per cent change over 2003-2013)
Finance and insurance services
Agricultural products
Management services
Computer and information services
Metals and minerals products
Primary metals
Energy products
Commercial services
Food and beverage products
Transport and government services
0
20
40
60
80
100
120


FOCUS on food and agriculture
HOW TO FEED 9 BILLION

AgriFood Tech Category Definitions

Ag Biotechnology
On-farm inputs for crop & animal ag including genetics, microbiome, breeding, animal health

Farm Management Software, Sensing & IoT
Ag data capturing devices, decision support software, big data analytics

Farm Robotics, Mechanization & Equipment
On-farm machinery, automation, drone manufacturers, grow equipment

Bioenergy & Biomaterials
Non-food extraction & processing, feedstock technology, cannabis pharmaceuticals

Novel Farming Systems
Indoor farms, aquaculture, insect, & algae production

Supply Chain Technologies
Food safety & traceability tech, logistics & transport, processing tech

Agribusiness Marketplaces
Commodities trading platforms, online input procurement, equipment leasing

Innovative Food
Cultured meat, novel ingredients, plant-based proteins,

In-Store Retail & Restaurant Tech
Shelf-stacking robots, 3D food printers, POS systems, food waste monitoring IoT

Restaurant Marketplaces
Online tech platforms delivering food from a wide range of vendors

eGrocery
Online stores and marketplaces for sale & delivery of processed & un-processed ag products to consumer.

Home & Cooking Tech
Smart kitchen appliances, nutrition technologies, food testing devices

Online Restaurants and Meal Kits
Startups offering culinary meals and sending pre-portioned ingredients to cook at home

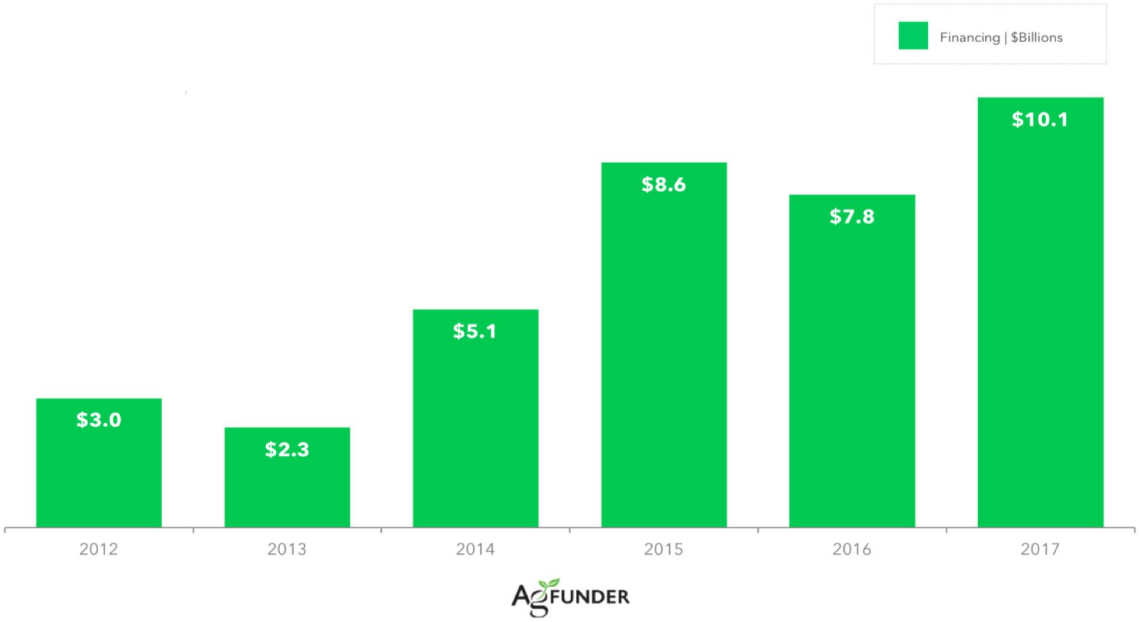
Miscellaneous

Upstream
Downstream
Upstream+Downstream

AgFUNDER

AgriFood Tech Funding Breakdown 2017

$10.1bn	994	+29%	-17%	1487	$1bn
INVESTMENT	DEALS	INVESTMENT GROWTH	DEAL GROWTH	UNIQUE INVESTORS	LARGEST DEAL



Farm Tech Category Definitions

Ag Biotechnology

On-farm inputs for crop & animal ag including genetics, microbiome, breeding, animal health

Farm Management Software, Sensing & IoT

Ag data capturing devices, decision support software, big data analytics

Robotics, Mechanization & Equipment

On-farm machinery, automation, drone manufacturers, grow equipment

Novel Farming Systems

Indoor farms, aquaculture, insect, algae & microbe production (excludes consumer home grow kits)

Agribusiness Marketplaces

Commodities trading platforms, online input procurement, equipment leasing used by farmers

Bioenergy & Biomaterials

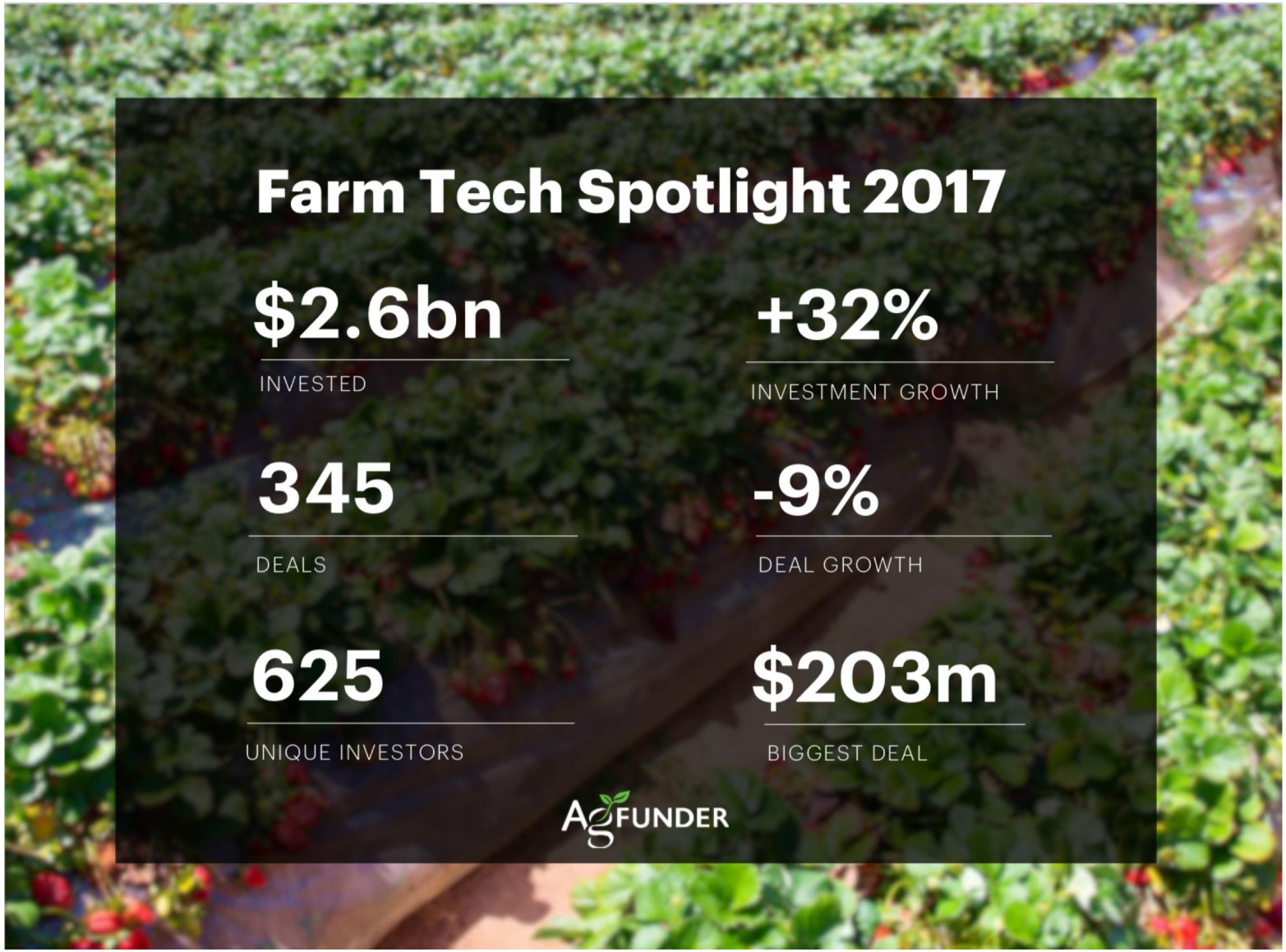
On-farm ag waste processing, biomaterials production, anaerobic digesters (excludes supply chain companies)

Farm-to-Consumer eGrocery

Online platforms for farmers to sell and deliver their produce direct to consumers

Miscellaneous

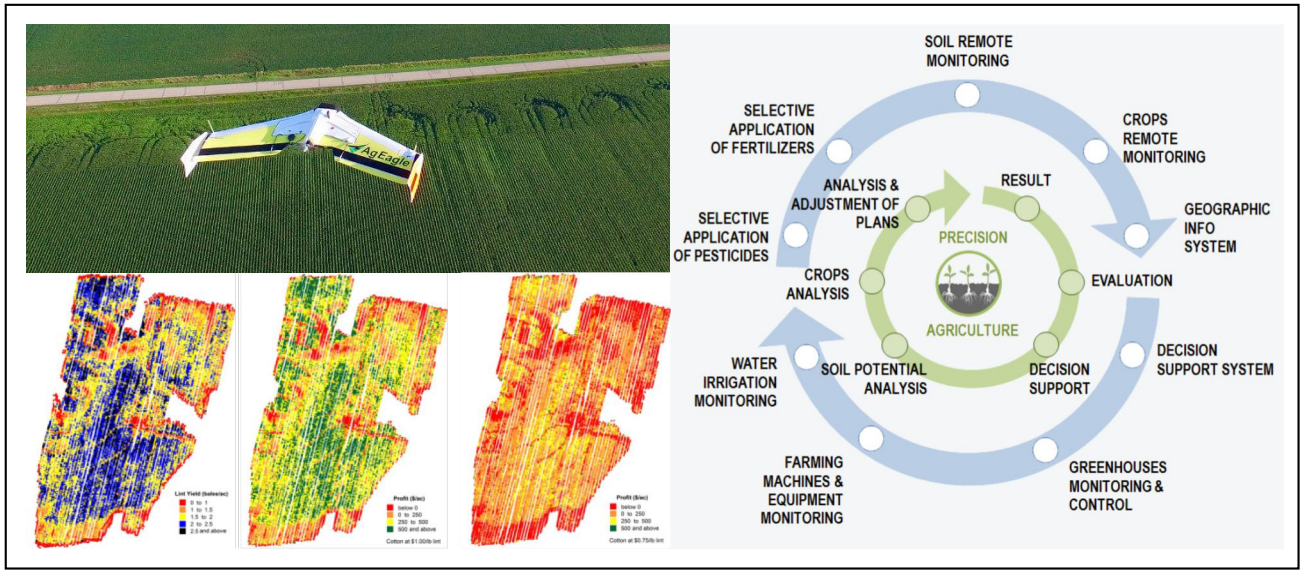
Land management tech, financial services for farmers, etc.


Farm Tech Spotlight 2017
$2.6bn
INVESTED
+32%
INVESTMENT GROWTH
345
DEALS
-9%
DEAL GROWTH
625
UNIQUE INVESTORS
$203m
BIGGEST DEAL
AgFUNDER

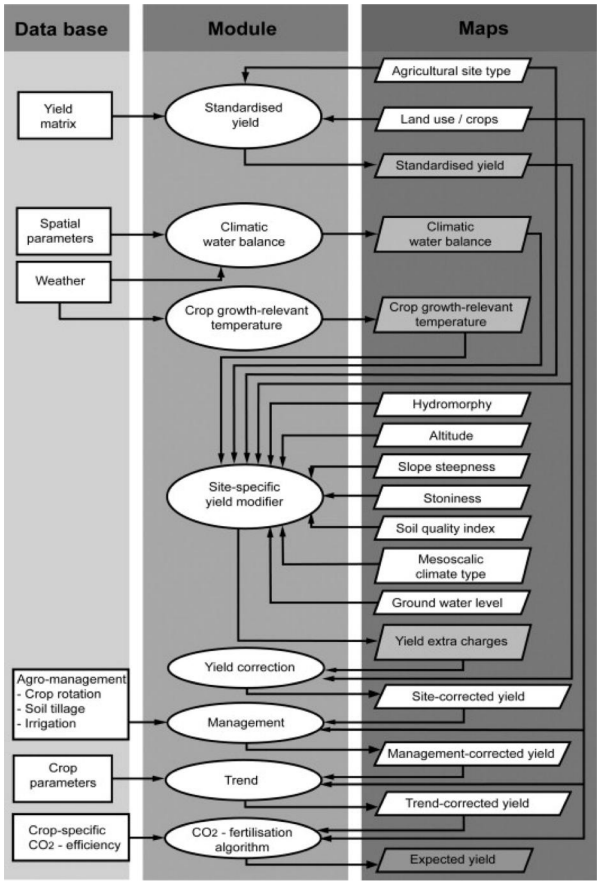
Precision Agriculture (PA)

Technology	Adoption Stage
GPS/GIS-guided Steering	Late (90%)
Semi-automated smart application • Sectional control	Mid
Sensing • machinery • drones • satellites	Early-Mid
Site-Specific Management • Variable Rate (VR) • Multi-cropping	Early
Fully-autonomous	N/A

"Precision agriculture is a catch-all term for techniques, technologies, and management strategies aimed at addressing the variability of parameters that affect crop growth. These parameters may include soil type, pH, soil organic matter, plant nutrient levels, topography, water availability, weed pressure, insect pressure, etc." (Vellidis Research Group, 2018)



Agricultural Data (Ag-data)



Types of Ag-data (Geo-temporal)	
Climate & Weather • Temperature • Moisture	Equipment • Speed • Tillage • Performance/Maintenance • GHG emissions

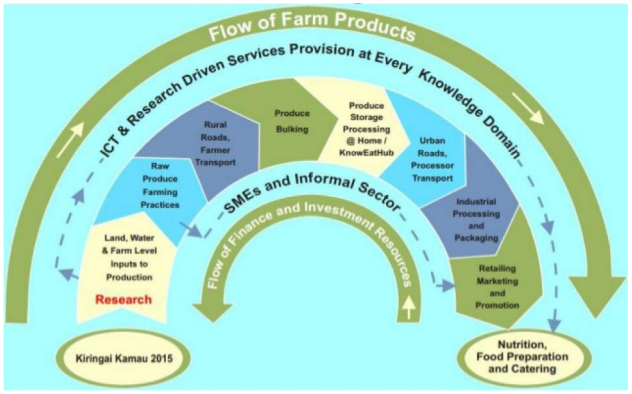
Aerial Imaging
• Elevation/Topography
  • Water/irrigation
• Crop Health
  • Vegetation (NDVI)
  • Pests and Disease
	Input Application (Volume & Rate)
	• Seed rate/spacing
	• Fertilizer
	• Pesticide/insecticide
	• Herbicide
	• Fungicide

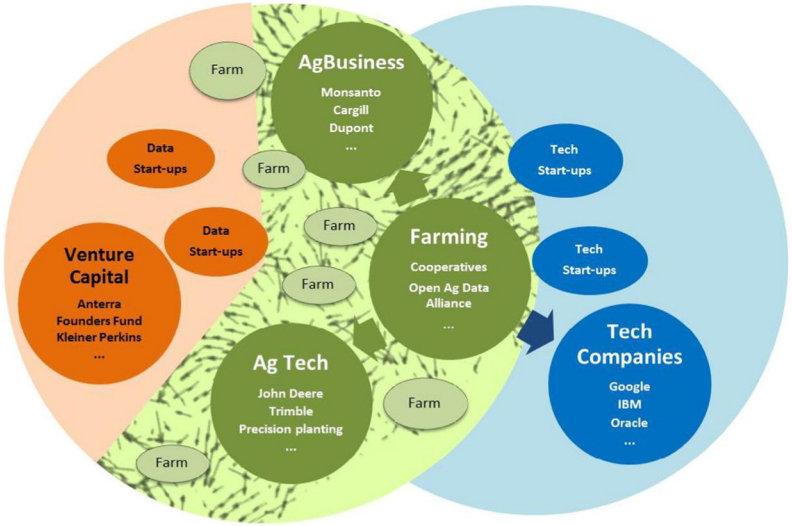
Seed • Genetics • Biodiversity	Yield • Rate • Mass
Soil • Soil type • Nutrients • Biodiversity	Economics/Business Management • Area • Bushels/acre • Cost/acre • Commodity prices • Overhead, revenue, profit

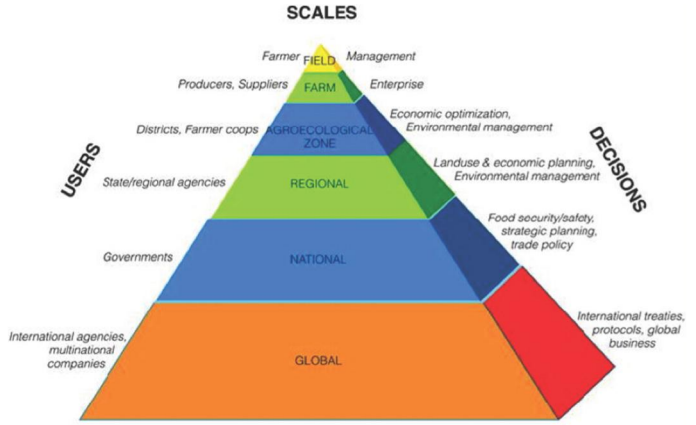

On-Farm

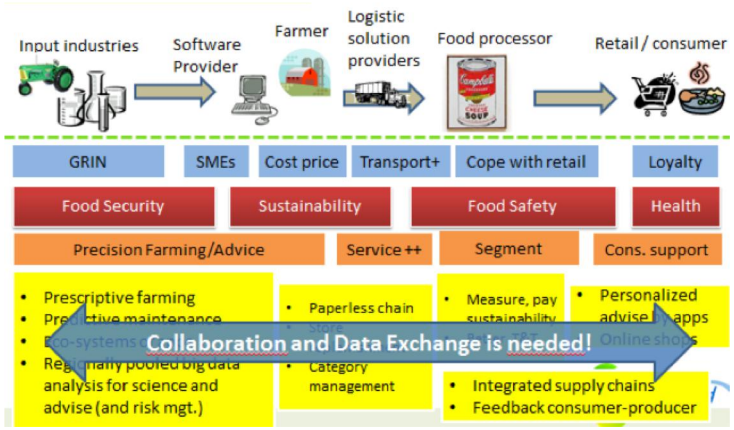

Off-Farm

Ag-data: Stakeholders & Governance









Value of Ag-data?

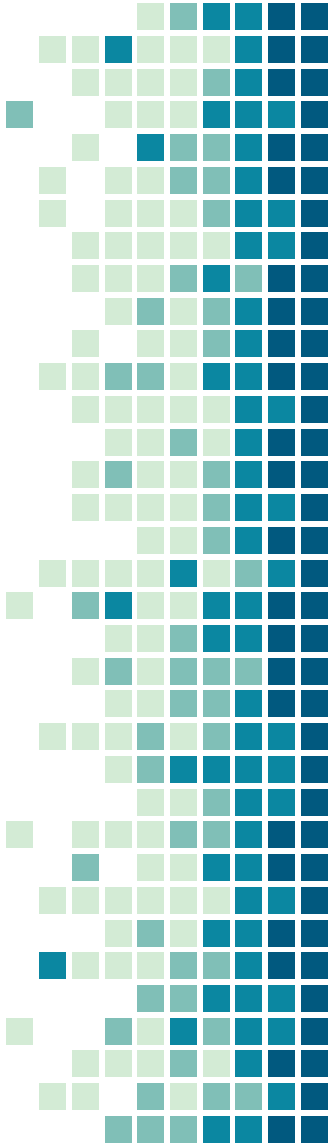
Utility ⇨ Value

Uncertainty

Rivilrousness / Excludability

Ag-data: Structures of Control

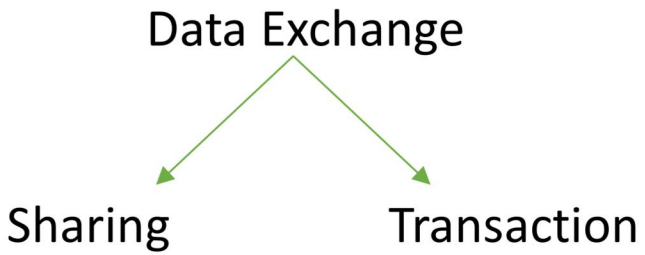
	Legal	Non-Legal
Public	Legislation Regulation	Public Funding Tax Policy Trade Policy
Public/Private		Technical Standards
Private	Contract Intellectual Property (IP)	Technological Knowledge Networks Financial



Policy Objectives

"For stakeholders in the Canadian agri-food space to benefit mutually and realize the full potential of innovations, ag-data must be freely shared and transacted in a stable, predictable, and trustworthy environment."

Is greater legal definition enough? If legal structures were better-defined, would market sort itself out? (Coase, 1960)



Central policy objectives:

- Increased productivity + efficiency ⇨ economic growth & global food security
- Cooperative, positive-sum exchanges
- Economic competition ⇨ innovation & lower cost of food
- Protection for vulnerable stakeholders (i.e. farmers, consumers)
- Innovation (managing creative tension between incentives and openness)
  - maximize commercialization and knowledge diffusion
- Enrichment of public research (advancing knowledge frontier)

Primary Research Question

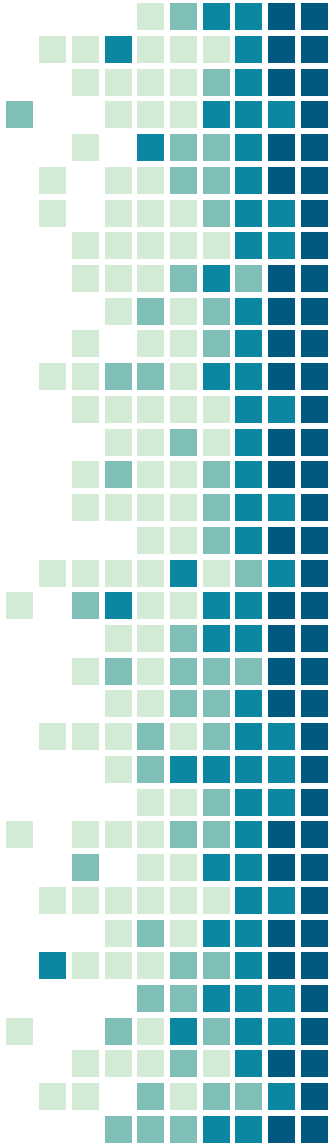
What are the dynamics that underlie ag-data exchange between the key stakeholders in agri-foods?

"This paper applies a behavioral approach to one piece of a larger policy puzzle, considering the question of whether initial assignment of ownership affects outcomes in an environment wherein ag-data is transacted—or, as characterized in the seminal work of Kahneman and Tversky, 'Does starting point matter?'"

"Thaler (1980) called this pattern—the fact that people often demand much more to give up an object than they would be willing to pay to acquire it—the endowment effect." (Kahneman, Knetsch & Thaler 1991)

Loss-aversion

"In more formal terms, this paper conveys an analysis that tests for the presence of the ***endowment effect***, which occurs when the condition of ownership, itself, leads the owner to irrationally overvalue an asset or possession. Inversely, the *endowment effect* could be construed in terms of the condition of non-ownership causing one to undervalue an asset or item when faced with purchasing choices."

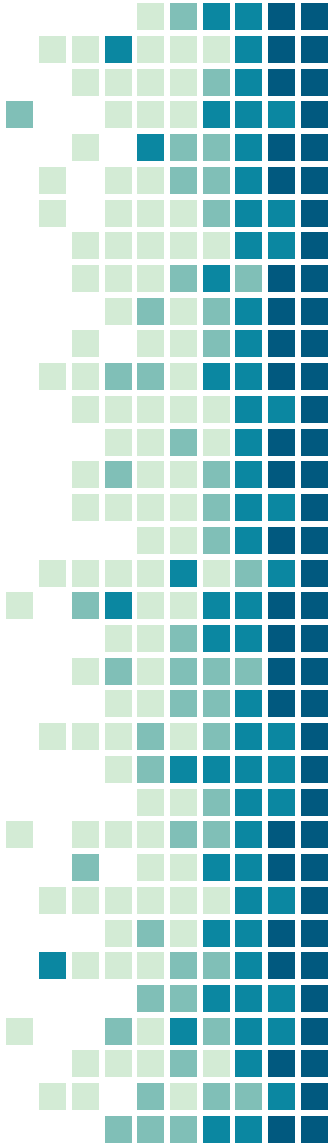


Secondary Analysis: Three Worldviews (Gilpin)

	Realism Nationalism / Keynesianism / 'Mercantilism'	**Liberalism** Neoliberalism / Liberal internationalism / 'State-at-Bay'	**Critical Theory** Marxism / Constructionism / Post-structuralism / Intersectional Feminism / Postmodernism / 'Dependencia'
Primary Unit of Analysis	• state is principal actor	• individual is principal actor	• groups are principal actors (i.e. class, gender, race, sexuality, indigeneity, etc.)
Source and use of power	• global affairs determined by dynamics of states vying to increase power and security (Morgenthau)	• economic global interconnection has undermined predominance of state power competitive enterprise efficiently distributes economic power	• focusses on relational power between groups • power derived through controlling means of production (Marx) power drawn from hegemonic • narratives (Gramsci)
Nature of relations between principal actors	• zero-sum • focuses on relative gains in state power	• positive-sum • focusses on absolute gains of individuals	• zero- or negative-sum • inherently conflictual due to formal and informal institutional structures (Marx)
Role of state	• allow individual to escape state of nature (Hobbes) • smooth out peaks and troughs of economy through fiscal policy and regulation (Keynes) secure regional trade arrangements that • benefit national interest develop military to increase state power advance foreign policy interests abroad and • extend international influence	• provide minimal conditions necessary for market (Hayek) • ensure stability; enforce contracts and protect property rights prevent market failure (e.g. monopoly, • missing and incomplete markets, negative externalities) facilitate liberalization of and participation in global markets	• much of existing political and social institutions must be reformed or dismantled state acts as primary vehicle of wealth • redistribution social democrats: provide social programs (e.g. welfare, pensions, • universal healthcare) Marxists: enforce equity, centrally plan economy

Method

- Surveyed 137 undergrad students from College of Agriculture (U of S)
  - Surveyed digitally, simultaneously in classroom
- All exposed to neutral briefing on ag-data, potential opportunities and risks
- Divided into 2 treatment groups (T1 & T2)
- Between-group treatment applied across 2 groups
  - 65 respondents in T1
  - 72 respondents in T2
- Next came questions about respondents' attitudes toward technology
- Finally, participants were surveyed on their worldviews (WV)
  - 8 questions with one answer for each WV
  - 'Don't know' option
  - 1 question — choose three of many options, some corresponding to WV, others neutral
  - Respondents received '**final score**' for each WV



Method

Treatment #1

Imagine that *you* currently own all data produced by your farm. This means that you have the right to disallow *AgManufacturing Co.* from using your data for any purposes unrelated to delivering AgPrecision™.

This morning, you received an email from *AgManufacturing Co.* indicating that they wish to pay you for ownership of your farm's data. If you wish to transfer ownership, you would be paid *x* dollars per acre for each year data have been collected in the past. Additionally, you would receive *x* dollars per acre for every upcoming season data is produced by your farm.

The transfer of ownership is completely optional. What is the lowest price at which you would still be willing to sell *AgManufacturing Co.* rights to your farm's data?

Various experts have estimated that a price ranging between $3-18 / acre reflects fair market value for these data.

Imagine that each price is the only deal offered; please choose the lowest price you would still be willing to accept.

- $0 / acre
- $3 / acre
- $6 / acre
- $9 / acre
- $12 / acre
- $15 / acre
- $18 / acre
- More than $18 / acre

Treatment #2

Imagine that *AgManufacturing Co.* currently owns all data produced by your farm. This means that *AgManufacturing Co.* has the right to use your data for any purposes.

This morning, you received an email from *AgManufacturing Co.* indicating that they wish to give you the option to buy ownership of your farm's data. If you wish to acquire ownership, you would pay *x* dollars per acre for each year data have been collected in the past. Additionally, you would pay *x* dollars per acre for every upcoming season data is produced by your farm.

The transfer of ownership is completely optional. What is the highest price you would be willing to pay *AgManufacturing Co.*to acquire rights to your farm's data?

Various experts have estimated that a price ranging between $3-18 / acre reflects fair market value for these data.

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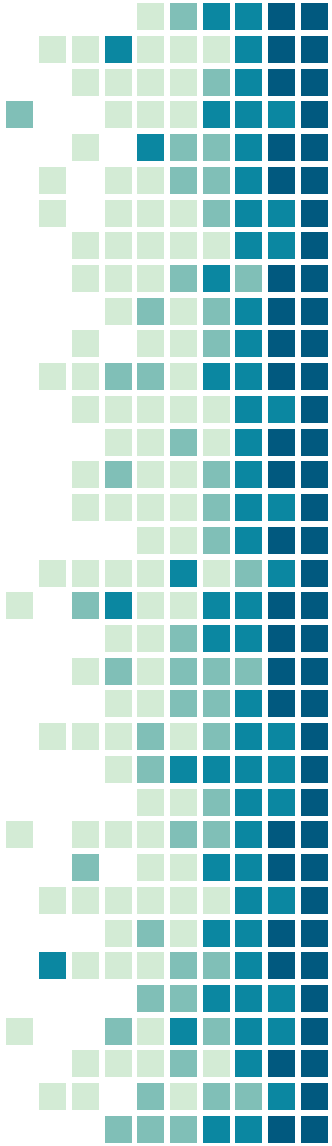


Results (primary)

Treatment #1: p = 65, μ = 11.2

Treatment #2: p = 72, μ = 7.2

Distributions = non-parametric

- *Unpaired Two-Samples Wilcoxon Test* in R

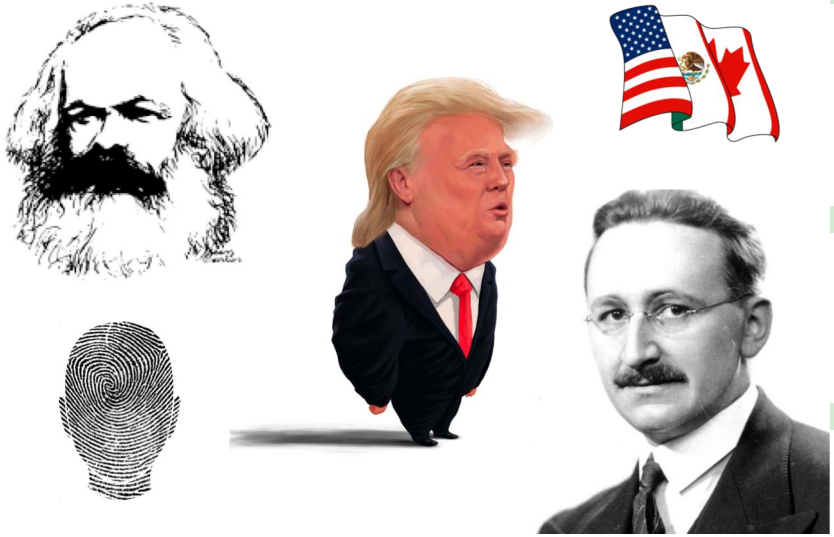
p-value = 1.549e-06

56% endowment effect

Results (secondary)

Worldview Variables	μ	Max
Declinism	1.21	3
Regulation	2.74	5
Historical Pessimism	1.91	5
Future Pessimism	2.23	5
ViewChange	-0.32	n/a
Economic Pessimism	2.09	5
Societal Pessimism	2.63	5
Existential Pessimism	2.20	5
Overall Pessimism	2.23	5

Worldview Variables	μ	Max
Realist	3.34	11
Liberal	3.14	11
Critical	1.88	11



Results (secondary)

Likert scale, points systems = ordinal variables

- non-parametric tests must be used (despite mostly normal distributions)
- Spearman's Rank Correlation Coefficient Test

Variable 1	Variable 2	rho	P-value	sig
Realist	Liberal	-0.22	0.011	***
Liberal	Critical	-0.46	2.03E-08	***
Critical	Realist	-0.37	1.07E-05	***
Realist	T2($)	-0.23	0.059	**
Critical	T2($)	0.20	0.09	**
Liberal	OvrPess	-0.23	0.0068	***
Liberal	LowRegulation	0.24	0.0045	***
Critical	ExistentialPess	0.16	0.058	**
Critical	LowRegulation	-0.17	0.053	**
Critical	Coherence	-0.39	1.07E-05	***
T1	ViewChange	-0.27	0.0245	***
Pessimism	LowRegulation	-0.15	0.071	**

Policy Implications

Current Value = Current Utility + Future Utility + Endowment Effect

Starting Point Matters ⇨ Role for Policymakers


THANK YOU