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Modeling the Potential Impacts of African Swine Fever on Chinese Whey Demand

Lesley Ahmed, Justin Choe, Brad Gehrke, and Samantha Schreiber

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LESLEY AHMED, JUSTIN CHOE, BRAD GEHRKE, AND
SAMANTHA SCHREIBER

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The views expressed here are solely those of the presenters.
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Recent Headlines

“Quarter of world’s pig population ‘to die due to African swine fever’ ”

“China reshapes global meat markets as swine fever rages”

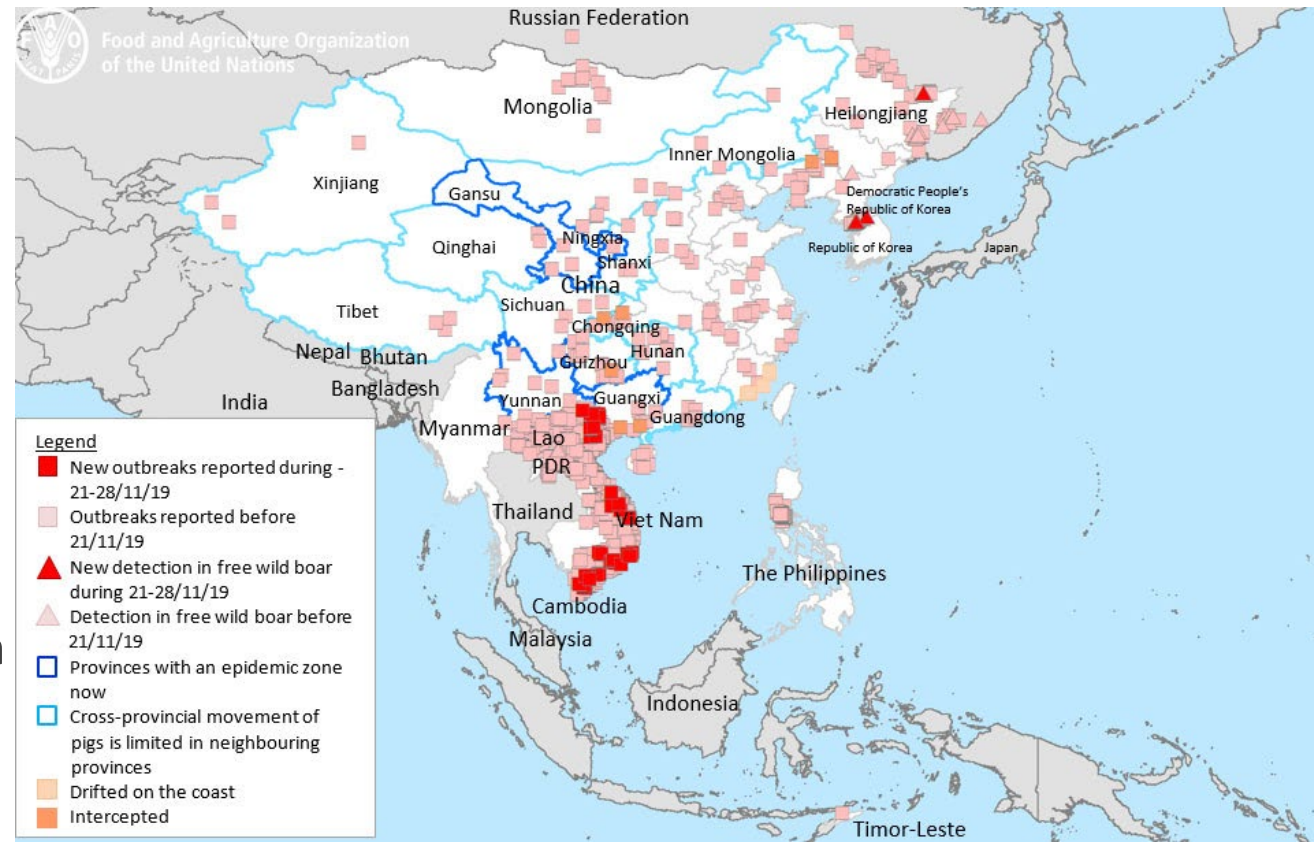
“African Swine Fever has pork on the chopping block”

“China’s pork market won’t recover before 2025”

“Whey suppliers to feel brunt of pig culling in China”

What is ASF?

- Highly infectious viral disease affecting domesticated and wild pigs
 - Spread by ticks, contact, ingested
 - First recent outbreak August 2018
- Chinese swine market hit particularly hard
 - World's largest pig herd (half of world total)
 - Many of Chinese pig herd (40%) raised on small farms with weak hygiene standard



Chinese Swine Loss Estimates

- National Bureau of Statistics: As of March 2019, China had **10%** fewer pigs, **11%** fewer sows than last year
- Reuters: Some report as many as **40-50%** of pigs lost from ASF in China, from infected pigs dying, culled, or sent to market early when disease is discovered nearby
- Rabobank: ASF affecting **150-200m** pigs, expected **30%** loss in pork production in China

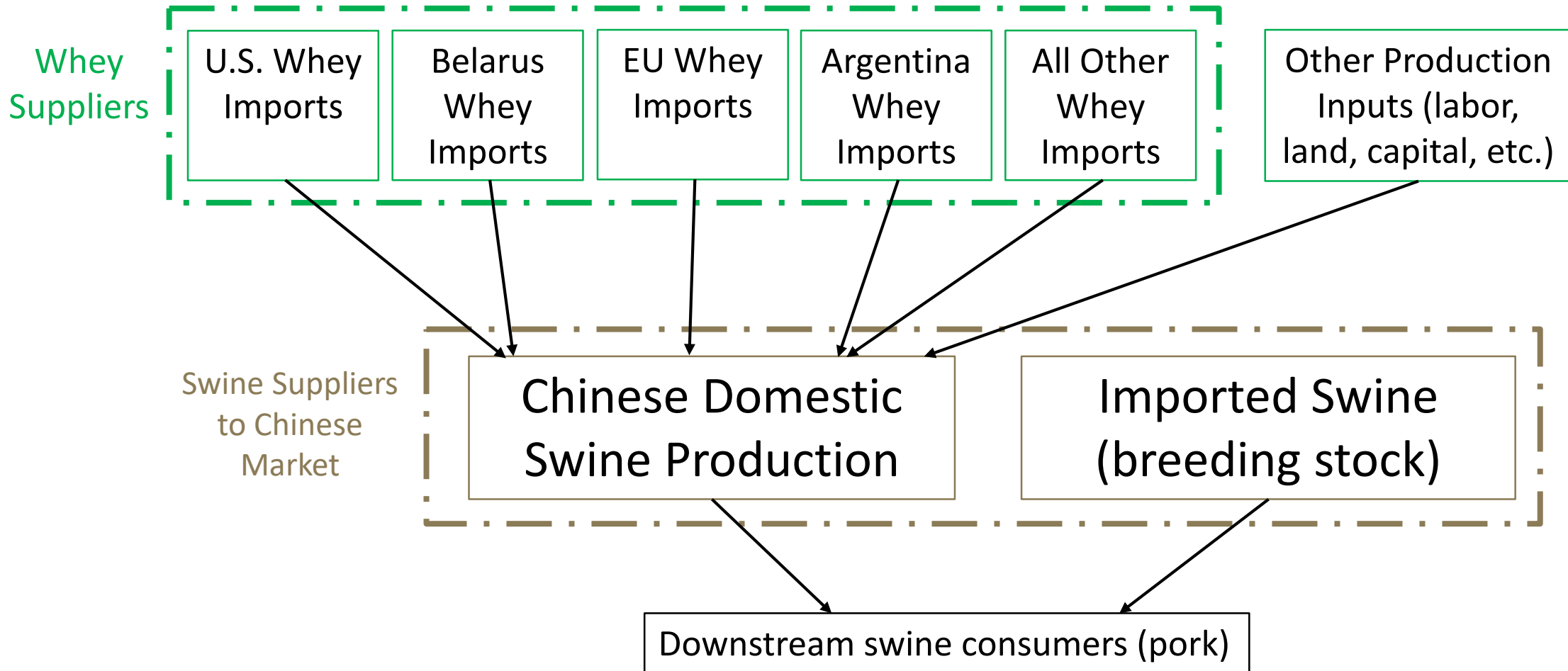
Introduction

- Research goals:
 - Estimate economic impacts of ASF and Chinese tariffs on imports of U.S. whey to Chinese whey and swine markets
 - Run counterfactual analyses of changes to the Chinese swine market

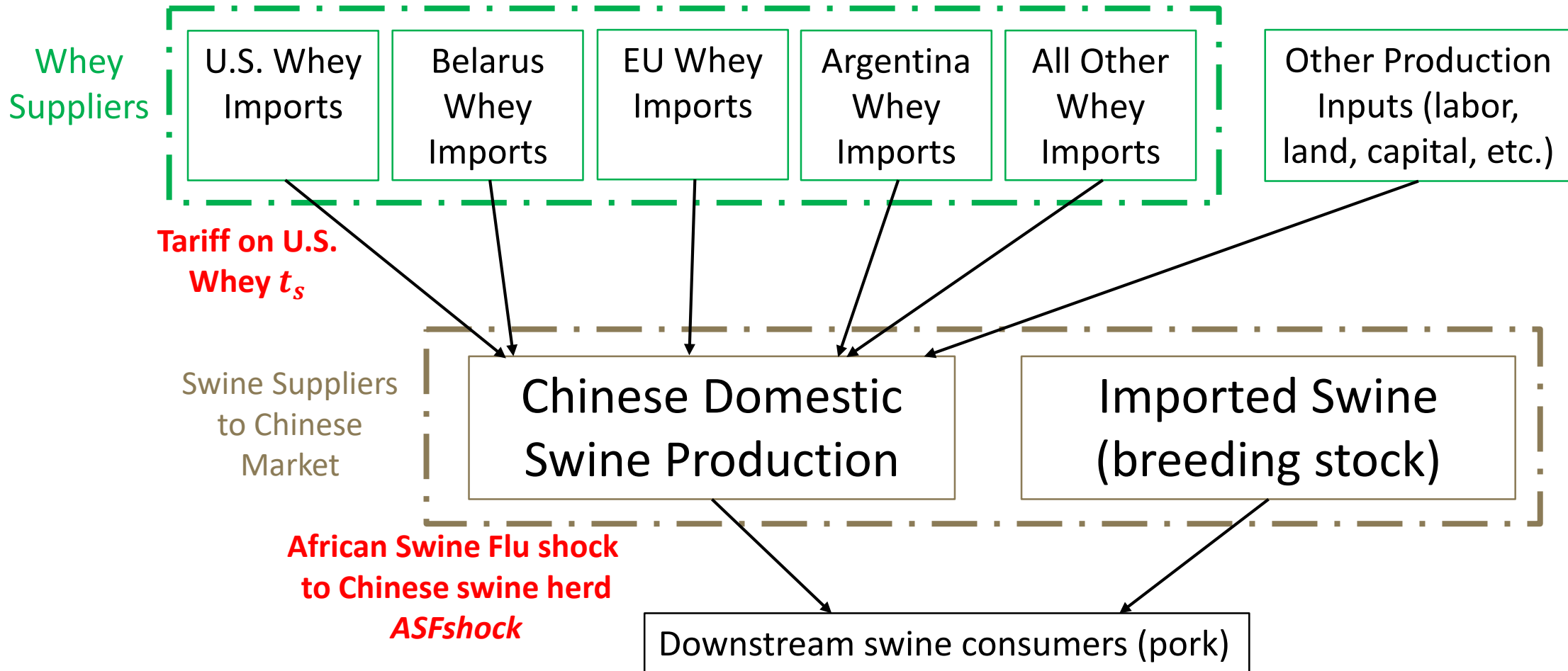
Model Description

- PE model of Chinese swine (final goods) and whey (intermediate goods) market
- Armington CES demands, imperfect substitutes, perfect competition
- Policy Changes:
 - African Swine Fever shock to swine production
 - 25% Chinese tariff increase on imports of whey from the United States

Model Structure



Policy Changes



Model Specification

Final Goods Price Index, for i in $\{China, Swine Imports\}$

$$P = \left(\sum_i b_i (p_i (1 + t_i))^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

Whey Price Index, for k in $\{U.S., Belarus, EU, Argentina, Other\}$

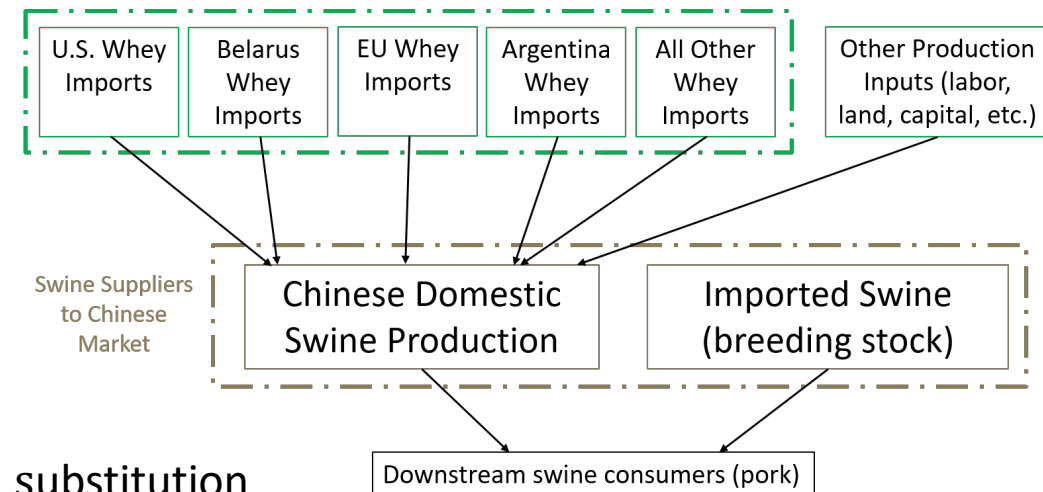
$$z = \left(\sum_k \gamma_k (p_k (1 + t_k))^{1-\theta} \right)^{\frac{1}{1-\theta}}$$

Price of Chinese Domestic Swine

$$p_d = (w^{1-\lambda} + \alpha z^{1-\lambda})^{\frac{1}{1-\lambda}}$$

θ = substitution elasticity between whey imports

λ = substitution elasticity between production inputs



σ = substitution elasticity between swine suppliers

Model Specification

Final Goods Demands:

$$q_d = k P^{\sigma+\varepsilon} (p_d)^{-\sigma}$$

$$q_f = k P^{\sigma+\varepsilon} (p_f(1+t_f))^{-\sigma} b_f$$

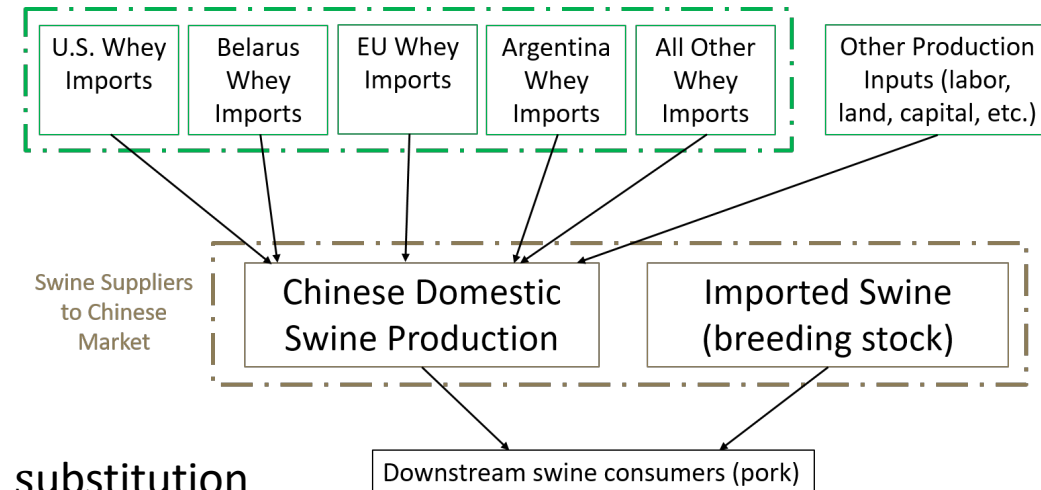
Intermediate Goods Demand:

$$q_s = \left(\frac{k \gamma_s \alpha}{p_s(1+t_s)} \right) \left(\frac{p_D}{P} \right)^{1-\sigma} \left(\frac{z}{p_D} \right)^{1-\lambda} \left(\frac{p_s(1+t_s)}{z} \right)^{1-\theta}$$

$$q_N = \left(\frac{k \gamma_N \alpha}{p_N} \right) \left(\frac{p_D}{P} \right)^{1-\sigma} \left(\frac{z}{p_D} \right)^{1-\lambda} \left(\frac{p_n}{z} \right)^{1-\theta}$$

θ = substitution elasticity between whey imports

λ = substitution elasticity between production inputs



σ = substitution elasticity between swine suppliers

Model Inputs

	Pre-shock 2017 Values (in \$ millions)	Source
Chinese Swine Production	142,352.6	Estimated from raw FAOSTAT data
Imports of Foreign Swine	20.6	IHS Markit
Imports of U.S. Whey	168.3	IHS Markit, adjusted
Imports of EU Whey	158.7	IHS Markit, adjusted
Imports of Belarus Whey	2.6	IHS Markit, adjusted
Imports of Argentina Whey	9.8	IHS Markit, adjusted
All Other Whey Imports	20.6	IHS Markit, adjusted

Policy Changes	Model 1: ASF (low) + Tariff	Model 2: ASF (high) + Tariff
% Change in Swine	-30%	-50%
Tariff on U.S. Whey	2% → 27%	2% → 27%

Model Results

(in % changes)	Model 1: ASF (low) + Tariff	Model 2: ASF (high) + Tariff
Price of Chinese Swine	44.4%	101.4%
Quantity of Chinese Swine	-30.8%	-50.4%
Producer Price of U.S. Whey	-11.9%	-17%
Consumer Price of U.S. Whey	9.7%	3.3%
Quantity of U.S. Whey	-53.1%	-67.3%
Quantity of Foreign Imported Swine	20.2%	41.9%

Model Results

(in % changes)	Model 1: ASF (low) + Tariff	Model 2: ASF (high) + Tariff
Price of Chinese Swine	44.4%	101.4%
Quantity of Chinese Swine	-30.8%	-50.4%
Producer Price of U.S. Whey	-11.9%	-17%
Consumer Price of U.S. Whey	9.7%	3.3%
Quantity of U.S. Whey	-53.1%	-67.3%
Quantity of Foreign Imported Swine	20.2%	41.9%

Tariff incidence greater for producers as ASF shock increases

Chinese consumers see large price increases

Large reduction in US Whey imports as remaining swine producers switch to other sources

Large increase in foreign imported swine to fill market demand, but nowhere near a 1-for-1 replacement

Effects on Other Whey Imports

(in % changes)	Model 1: ASF (low) + Tariff	Model 2: ASF (high) + Tariff
Imports of non-U.S. Whey	-7.7%	-30.9%
Price of non-U.S. Whey	-2.0%	-8.8%

(in millions)	2017 Data (Pre-ASF)	Estimated Post-ASF Values
Imports of U.S. Whey	168.3	78.9
Imports of EU Whey	158.7	146.5
Imports of Belarus Whey	2.6	2.4
Imports of Argentina Whey	9.8	9.0
Imports of Other Whey	20.6	19.0

Counterfactual: Change in Whey Consumption Rate

- ASF causes “industry consolidation”, small swine firms close down
 - Whey consumption rate higher for larger firms
 - Current estimate of whey consumption rate 0.45 kg/piglet weaned
 - U.S. whey consumption rate 2.2 kg/piglet weaned by some estimates
 - After industry consolidation, will imports of U.S. whey surpass pre-ASF levels?

(in % changes)	Model 1: ASF (low) + Tariff	Counterfactual: Industry Consolidation
Price of US Whey	-11.9%	6.1%
Quantity of US Whey	-53.1%	42.4%
Price of Chinese Swine	44.4%	10.5%
Quantity of Chinese Swine	-30.8%	-9.5%

Large rebound in imports of U.S. Whey

Finding: without any re-bounce in Chinese swine herd, imports of U.S. whey increases nearly to pre-ASF levels due to change in whey consumption rate.

Conclusions

- Model estimates:
 - Large reductions in Chinese imports of U.S. whey (53%) after ASF impacts on swine herd
 - Reductions in other whey imports (EU, Belarus, Argentina), though declining less than U.S. whey due to tariff imposition
 - Large increase in imported foreign swine to re-populate market, but no-where near one-for-one replacement
 - Large price increases for Chinese swine industry
- Possible extensions:
 - Add in other intermediate goods markets (soybeans) to capture substitution effects
 - Explicitly model pork industry, other meat varieties

USITC PE Modeling Portal

Link here: https://www.usitc.gov/data/pe_modeling/index.htm

Features:

- Industry-specific PE models, in both spreadsheet and Mathematica formats
 - Perfect and imperfect competition
 - Intermediate goods models
 - Firm heterogeneity, offshoring, and intellectual property models
 - Time to build and stockpiling dynamic models
- Technical documentation and working papers

Thank you!
