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Impacts of Chinese African Swine Fever Losses and Rebuilding on the U.S. Agricultural Sector

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Abstract

Outbreaks of African Swine Fever (ASF) in China reduced the Chinese hog herd by nearly 40 percent between 2018 and 2019 according to official Chinese estimates. Such precipitous declines in domestic stocks have increased China's import demand for pork, which may in turn put upward demand pressure on the U.S. hog sector. At the same time, the lower hog inventories weaken Chinese demand for soymeal, a primary feed input produced from imported soybeans.

This paper will explore the effects of ASF losses on Chinese, U.S. and global pork production and trade, as well as effects on meat substitutes, such as poultry and beef, and pig feed ingredients, mainly soybeans. We do this while incorporating the MFP payments and trade actions. Looking beyond 2020, the implications of Chinese herd rebuilding under different scenarios will be simulated, considering possible effects from industry consolidation and modernization.

We use the GTAP-AGR general equilibrium model with data from the GTAP version 10.0 database to analyze the simulated effects on output, prices, trade, and farm income of the affected commodities, as well as substitution between livestock feed inputs. The GTAP-AGR model introduces agricultural specificity by introducing new behavioral relationships into the standard GTAP framework. GTAP-AGR focuses attention on the factor markets, modifying both the factor supply and derived demand equations. GTAP-AGR also modifies the specification of consumer demand, assuming separability of food from non-food commodities. Finally, GTAP-AGR introduce the important substitution possibilities amongst feedstuffs used in the livestock sector.

{Incorporate final results}.

1. Introduction

This paper expands upon earlier work on the effects of U.S. Market Facilitation Program payments by evaluating the effects of concurrent shifts in Chinese agricultural import demand from Chinese African Swine Fever losses and simulating potential changes to Chinese productivity following herd rebuilding.[1] Soybeans, the U.S. agricultural product receiving the largest share of MFP payments, are an important swine feed component. China, which accounts for approximately half of global swine stocks, also accounts for around half of global soybean imports. Widespread outbreaks of African Swine Fever (ASF) in China beginning in late 2018 are responsible for a dramatic drop to China's swine stock, estimated at between 40 and 60 percent. These losses have significantly affected China's pork production, demand for substitute meats, and demand for swine feed inputs such as soybeans, with the implications reaching beyond China's borders to the global marketplace. Although ASF outbreaks continue, the Chinese government has issued a plan to rebuild the pig herd and pork production by the year 2023 that includes components that would favor a more consolidated, modernized industry structure with increased productivity.

This paper analyzes the effects of Chinese AFS losses and potential effects of industry changes following herd rebuilding in a general equilibrium framework that incorporates effects from U.S. MFP payments and trade actions. Although there is extensive literature on epidemiological aspects of ASF, there is relatively limited literature on the economic effects of the most recent ASF outbreak, centered in China. Lusk (2019) and Hayes (2020) evaluate the effects of a hypothetical ASF outbreak in the United States. Most related to our research, Carriquiry, et. al. (2019) use the ICARD FAPRI model to look at multiple rounds of impacts from ASF losses, in scenarios both with and without Chinese tariffs on U.S. pork and soybeans in place. They consider a future with endemic ASF in China and the rest of Asia, assuming a permanent 30% reduction to sow herds. The analysis focuses on the effects on U.S. pork and soybean exports and prices and finds **{similar/different conclusions from our work}.** There are also a number of papers and articles that evaluate the effects of ASF using trade statistics, prices, and back-of-the envelope calculations. **{These results are similar/different from ours…}** Although some of these papers consider similar questions, none does it in a general equilibrium framework that incorporates inter-sectoral linkages. The GTAP-AGR model is especially suited for this analysis because of the way it models relationships between fodders and gives the ability to look at the effects on farm income, which is important in the United States where farm operations often have productive activities in multiple agriculture sectors.

This paper does not address effects from COVID19 demand shifts or policies, including USDA farm supports tied to the CARES Act.

2. Background

African Swine Fever

Concurrent with the disbursement of MFP payments to U.S. hog producers, the outbreak of African swine fever in China reduced the Chinese hog herd by nearly 40 percent between 2018 and 2019 according to official estimates. Such precipitous declines in domestic stock have dampened Chinese

[1] Ahmed, Peters, and Tsigas, "GE Analysis of the Effects of Market Facilitation Payments on the U.S. Farm Sector," December 10, 2019 (https://drive.google.com/open?id=12g7YXLblckgEKReO077Q5rHNzHgmN-ht).

demand for soybeans and feed grains, and at the same time increased China's import demand for pork, which may in turn put upward demand pressure on the U.S. hog sector.

ASF is a severe viral disease among both wild and domestic pigs that is easily spread by live pigs, pork products, and contaminated feed and equipment and objects.[2] There is no approved vaccine and ASF results in significant production costs, often with complete herd losses.[3]

{paragraph and figure on number of ASF cases, herd culling, and Chinese statistics on sow stocks, pig stocks, and pork production and prices from mid-2018 through latest available data in 2020.}

Chinese Herd Rebuilding

Although China is reporting recurring ASF cases and the outbreak is not yet under control, when the industry does rebuild, it is expected to be more consolidated, with larger more efficient producers accounting for a larger share of hog production. Several components of China's 2018 "Three-Year Plan to Speed up Recovery of Hog Production" are expected to favor rebuilding with larger, more efficient hog operations, including allowing hog operations with 5,000 head or more to begin construction without final environmental approvals and subsidized purchases of modern feeding and environmental control equipment, and the creation of 120 replicable demonstration farms.[4]

Productivity of hog operations is generally positively related to the size of the operation because of economies of scale and the ability to spread the cost of more modern equipment and practices across a larger number of hogs. In China, prior to ASF, large hog operations accounted for x percent of hog production. **{Statistics on productivity of large farms in China vs. small farms. Comparison to the United States}.**

Market Facilitation Payments

USDA instituted the Market Facilitation Program (MFP) in 2018. The program included 1) commodity payments, 2) commodity purchases, and 3) export promotion funds to mitigate trade actions of foreign governments in the loss of exports for U.S. farmers. USDA authorized $12 billion for this program in 2018 and $16 billion in 2019. This paper incorporates the commodity payments only.

In 2018, USDA announced the second round of MFP on May 23, 2019, with further details and payment rates released on July 25, 2019. Payment rates for this round of MFP payments are based on a single-county payment rate multiplied by the total 2019 acreage planted to MFP-eligible crops and range from $15 to $150 per acre.[5] Eligible crop include alfalfa hay, barley, canola, corn, cranberries, dried beans, dry peas, extra-long staple cotton, flaxseed, lentils, long grain and medium grain rice, millet, mustard seed, oats, peanuts, rapeseed, rye, safflower, sesame seed, small and large chickpeas, sorghum, soybeans, sunflower seed, temperate japonica rice, triticale, upland cotton, and wheat.

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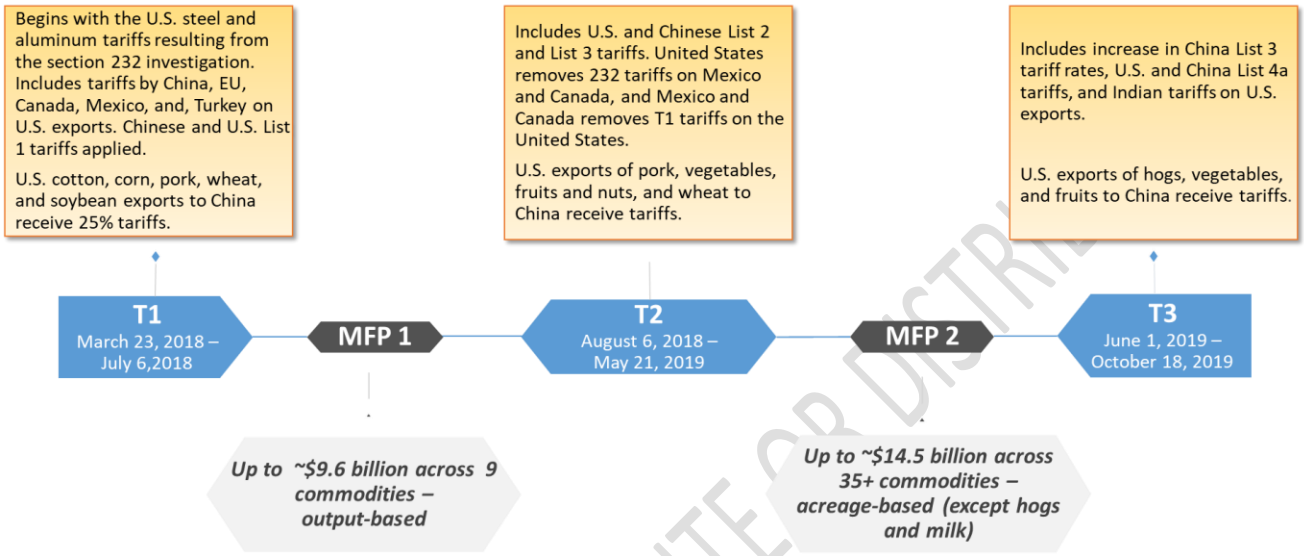
[2] OIE, "African Swine Fever," accessed April 13, 2020. (https://www.oie.int/en/animal-health-in-the-world/animal-diseases/african-swine-fever/).

[3] OIE, "African Swine Fever," accessed April 13, 2020. (https://www.oie.int/en/animal-health-in-the-world/animal-diseases/african-swine-fever/).

[4] Dim Sums Blog, 2019.

[5] A producer's acreage eligible for payment cannot exceed total 2018 planted acreage. USDA, FSA, "Market Facilitation Program," https://www.fsa.usda.gov/programs-and-services/market-facilitation-program/index (accessed September 24, 2019).

Figure 1: Timeline of ASF Losses, Trade Actions and MFP **{Update figure below from IATRC presentation to show ASF losses and how the timing and shocks align WITH AN EMPHASIS ON ASF}**



3. Data

We started with the GTAP version 10 database with a 2014 base year, then modified it to split apart relevant sectors, soybeans from oilseeds, pork from other meats, and swine from other animal products.

We included 2018 and 2019 trade actions in the baseline, using the Iowa State University CARD Trade War Tariffs Database.[6]

We estimated MFP 1 and MFP2 payments based on USDA reports of actual payments. Actual payment amounts were lower than initial USDA estimates of potential payments.

Official Chinese swine inventory statistics were used to estimate the African Swine Fever shocks.

For the simulations of Chinese industry re-building, we assume a **{90% - may try different levels – possible the ongoing 30% lower than 2018 beginning inventories that is used in the Carriquiry, et. al. (2019) paper}** recovery to swine stocks. To estimate the productivity increase, we considered USDA and Chinese statistics on productivity by hog operation size.

4. Methodology

We use the GTAP-AGR general equilibrium model with data from the GTAP version 10.0 database to analyze the simulated effects on output, prices, trade, and farm income of the affected commodities, as well as substitution between livestock feed inputs. The GTAP-AGR model introduces agricultural specificity by introducing new behavioral relationships into the standard GTAP framework. GTAP-AGR focuses attention on the factor markets, modifying both the factor supply and derived demand

[6] Li, M. (2018) CARD Trade War Tariffs Database. https://www.card.iastate.edu/china/trade-war-data/ (Accessed April 14, 2020).

equations. GTAP-AGR also modifies the specification of consumer demand, assuming separability of food from non-food commodities. Finally, GTAP-AGR introduce the important substitution possibilities amongst feedstuffs used in the livestock sector.

GTAP – AGR Model

The GTAP-AGR Model (Keeney and Hertel, 2005) was used because of its unique characteristics and ability to evaluate effects on the agricultural sector. The GTAP-AGR model limits factor mobility between agriculture and non-agriculture sectors compared to the standard GTAP model. Demand for livestock fodder is modeled by allowing for feedstuff substitution. Land is used only by the farm sectors (mostly crops and a little by livestock and forestry). The GTAP-model also provides a framework for estimating changes in farm income. The GTAP-AGR closure has limited agriculture factor (land) movements between agriculture sectors, and land, labor and capital are fully utilized.

Parameters

In order to account for the idiosyncrasies in timing of the MFP payments, certain parameters were adjusted for the different stages of the simulations. The 2018 MFP payment announcement in July 24, 2018, took place after U.S. planting decisions had been made. The payments were coupled in theory, but because of limited producer ability to adjust production decisions, they were decoupled in practice. The 2019 payments, announced on May 23, 2019, took place during planting season, but the administration of the payments was different from the 2018 payments, and in a decoupled format, except for dairy and pork.

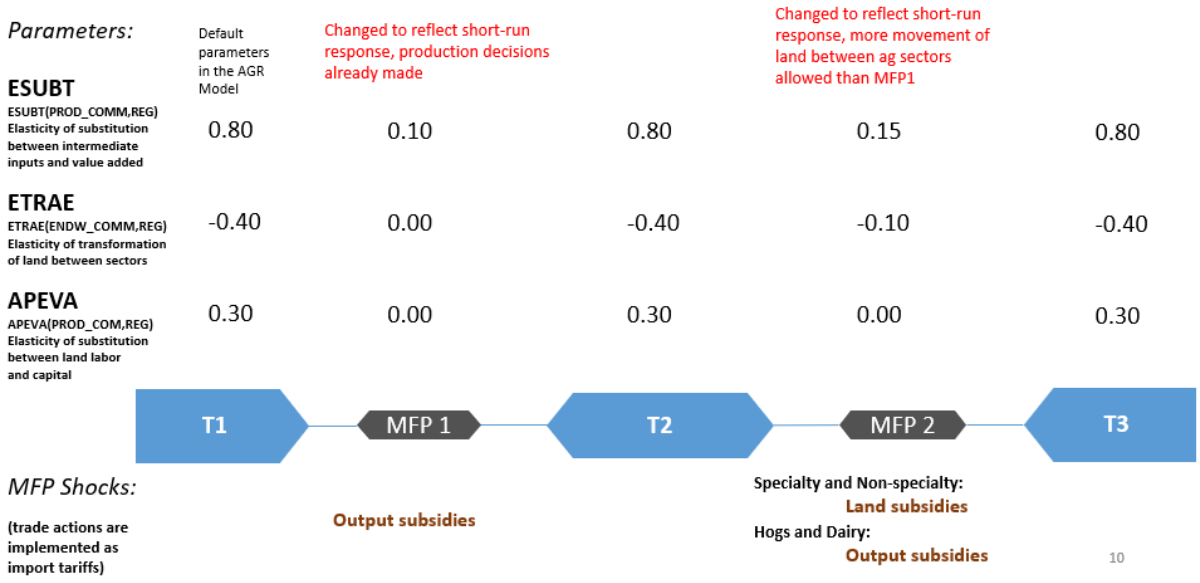
By changing model parameters during the different phases of trade actions and MFP payments, we were able to elicit the short run response. **{Add discussion on final parameters for ASF shocks}.**

ESUBT (Elasticity of substitution between intermediate inputs and value added)

ETRAE (Elasticity of transformation of land between sectors)

APEVA (Elasticity of substitution between land labor and capital)

Figure 2: Policy Experiments and Parameters **{Update with ASF shocks and parameters}**



Simulations

This paper simulates trade actions from IS CARD and MFP payments. Then the effects of ASF losses in China are simulated to evaluate changes to the U.S. agricultural sector. Then scenarios for Chinese swine herd rebuilding are simulated with higher productivity from restructuring.

The trade actions (T1, T2, and T3 in figure 2 above) are all modeled as increases in import tariffs (*tms*) above the baseline levels in the GTAP database. We assume that the MFP1 shock is in effect from the date of its implementation to the date of the implementation of MFP2 (see Figure 1). MFP1 payments and MFP2 payments to the U.S. swine and dairy sector are modeled as output subsidies (*to*), while MFP2 payments to crops are modeled as land subsidies (*tf*).

ASF Losses

The ASF shock is implemented concurrently with T2 trade action and remains in effect through the last tranche of trade actions. ASF is modeled as a shock to the amount of capital available (*qfe*) in the Chinese swine industry. This reflects the lower sow stocks – which are a type of capital for pig and pork production. In keeping with the reported statistics on Chinese hog inventories, we set the initial reduction in the swine herd to 40 percent. In subsequent periods, the Chinese hog inventory rebounds, though only to XX percent of its pre-ASF levels.

Chinese Swine Herd Rebuilding with Higher Productivity

The hog herd rebuild is modeled as a productivity shock to Chinese swine farms (*af*), with the shock implemented at the same time as the third set of trade war tariffs (T3). Based on estimates from demonstration farms and productivity differentials between small and large swine farms, we set this productivity increase at XX percent above farm levels after the implementation of the second round of trade actions.

5. Results

{Results will focus on the effects of the African Swine Fever losses and Chinese herd rebuilding. The tables below are placeholders to demonstrate the model outputs we will analyze. Some may be dropped, if there aren't interesting results. Figures will be used in place of tables where possible. Results will not single out the effects of trade actions or MFP payments, but rather focus on ASF and ASF herd rebuilding with greater productivity.}

Table 3: Effects of Chinese ASF Losses (percent change)

	United States	China	World
Pork production			
Pork imports			
Pork exports			
Pork consumption			
Soybean production			
Soybean consumption			
Soybean imports			
Soybean exports			
Poultry and beef production			

Poultry and beef imports			
Poultry and beef consumption			
Feed grains production			
Feed grains imports			
Feed grains exports			
Feed grains consumption			

Table 3: Effects of Chinese ASF herd rebuilding with greater productivity – pre ASF breakout to post ASF recovery (percent change)

	United States	China	World
Pork production			
Pork imports			
Pork exports			
Pork consumption			
Soybean production			
Soybean consumption			
Soybean imports			
Soybean exports			
Poultry and beef production			
Poultry and beef imports			
Poultry and beef consumption			
Feed grains production			
Feed grains imports			
Feed grains exports			
Feed grains consumption			

Table 4: U.S. Farm Income: Effects of Chinese ASF losses and herd rebuilding with greater (percent change)

	ASF Effects	Chinese Herd Rebuilding Effects
U.S. Farm Income		
Pork imports		

6. Conclusions

{Conclusions specifically related to our results}

Analysis of economic losses to ASF (a viral outbreak) and recovery with a new industry structure and changes to productivity, might be relevant for analysis on the effects of other viral outbreaks and recoveries. The GTAP-AGR model would be particularly useful for evaluating such effects, as well as policy interventions such as farm payments, on the agricultural sector.

DRAFT ONLY – DO NOT SITE

Lit review links to be turned into bibliography.

Jayson Lusk, August 5, 2019– simple simulation of possible U.S. losses if it comes to U.S., http://jaysonlusk.com/blog/2019/8/5/potential-economic-impacts-of-african-swine-fever-asf

ABARES forecast, Dec 10, 2019 https://www.agriculture.gov.au/abares/research-topics/agricultural-commodities/sep-2019/african-swine-fever

Typical Chinese feed has 20% soymeal and 70-75% corn (higher soymeal than U.S. where farmers use DDGs and synthetic amino acids), Germany has 20-26% soymeal (use rapeseed and sunflower meal too). industry standards that pigs typically eat about 300-360 kilograms of feed to grow to 110-120 kg, which is the weight acceptable for market and an annual slaughter rate in China of 660 million pigs. Mason, Josephine and Hallie Gu, "Factbox: China's low-soy Pig Diet and the Impact on Soybean Use," September 19, 2018. https://www.reuters.com/article/us-usa-trade-china-soybeans-factbox/factbox-chinas-low-soy-pig-diet-and-the-impact-on-soybean-use-idUSKCN1LZ0KN

Cost-benefit analysis of endemic ASF in Northern Uganda – primary data from producers that suses model to assess impact of ASF outbreaks on gross margin and pig value. Chenais, et. al. 2017, "Quantitative Assessment of Social and Economic Impact of African Swine Fever Oubreaks in Northern Uganda." Preventitive Veterinary Medicine 144 (2017) 134-148. https://reader.elsevier.com/reader/sd/pii/S0167587716304342?token=003EF219A780A7BE45943B7424899332B62EFD8E73518758518E874961FCEEC7A890F3C9046DE6A9643893CB19E0067E.

Focuses on simulating effects if there is a U.S. outbreak – involves production losses and trade barriers. Carriquiry, et al. "Impacts of African Swine Fever in Iowa and the United States," 2020 https://www.card.iastate.edu/products/publications/pdf/20wp600.pdf.

Cost of implementing biosecurity measures to prevent ASF for smallholder farrow-to-finish operations. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1865-1682.2011.01261.x.

Impact of African Swine Fever on US and World Commodity Markets - uses ICARD FAPRI model to look at multiple rounds of impacts – assume 30% permanent sow herd reduction in China, Vietnam, South Korea, and ROAsia. Scenarios with and without retaliatory duties in place – focus on effects of U.S. pork and soybean exports and prices. https://www.card.iastate.edu/ag_policy_review/article/?a=101

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Farm Bureau: https://www.fb.org/market-intel/african-swine-fever-in-china-keeps-getting-worse

Good, Keith, "China "Scouring the World for Meat" as African Swine Fever Impacts Protein Markets," November 11, 2019 https://farmpolicynews.illinois.edu/2019/11/china-scouring-the-world-for-meat-as-african-swine-fever-impacts-protein-markets/.

O'Conner, Sean. "China's African Swine Flu Outbreak: Implications for U.S. Food Safety and Trade," May 15, 2019.