The Impossible Trinity of China's Corn Related Policies

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Abstract: China's recent corn-related policy reforms have changed the dynamics of its domestic market and may have profound implications for international trade. On the supply side, China aims to adjust the planting area for corn down to 33 million hectares by 2020 (MOA, 2016); on the demand side, China's recent plan to implement a national E10 mandate (gasoline with 10% ethanol) by 2020 will give a significant boost to corn consumption. Using a partial equilibrium model, this paper demonstrates that these policy changes will lead to a steep increase in corn price to unprecedented levels without increasing import. Therefore, we concluded that the trinity of corn policies including area limit, E10 mandate, and corn self-sufficiency are not self-consistent. We further show that if China removes the trade barrier for corn the import value will reach a level comparable to that of soybeans.

I. Introduction

Based on the rapidly growing demand for animal products and the relative scarcity of arable land, observers have long expected China to become a major corn importer (Hansen et al., 2017). However, by expanding planting area and restricting imports, China has mostly maintained self-sufficiency of corn. From 2000 to 2017, China's corn planting area increased from 23 million hectares to 35 million hectares. The Chinese government achieved the area expansion by setting high procurement price for corn which made corn more profitable to produce than competing crops. However, most of the expansion happened on marginal lands northern China with low and unstable productivity. At the same time, China maintained restrictions on import. China has a tariff-rate quota which permits 7.2 MMT of annually corn import at the 1% within quota tariff rate. This quota, if reached, would constitute a modest 3.3% of total domestic consumption based on 2017 data. However, the quota has never been reach even when domestic corn price in China is much lower than international price, raising concerns that China has been restricting corn import using administrative methods not permitted under WTO rules. From 2009 (the first year China became a net importer of corn) to 2017, China imported an average of 3 MMT per year of corn annually, comparing to 11 MMT for Mexico and 13 MMT for Japan over the same period.

China's recent corn-related policy reforms have changed the dynamics of its domestic market and may have profound implications for international trade. On the supply side, in order to curb overproduction, China aimed to adjust the planting area for corn down to 33 million hectares by 2020 (Ministry of Agriculture (MOA), 2016), a 13% percent decrease from the peak level in 2016 (USDA, PSD online database). To achieve this goal, it replaced the support price for corn with a direct producer subsidy based on area planted (Wu and Zhang, 2016).

Immediately following the policy change, China's domestic corn price dropped to the lowest point since 2009, and corn acreage began to fall.

On the demand side, China's recent plan to implement a national E10 mandate (gasoline with 10% ethanol) by 2020, if successful, will give a boost to corn consumption. Currently corn is the main feedstock for China's ethanol production, accounting for 65% of the total output. If China continues to rely on corn for ethanol production, the E10 mandate can add 18 MMT to annual corn consumption (Li et al., 2017). China's recent policies to limit planting area and to boost demand are on a collision course with its long standing policy of corn self-sufficiency. With the United States ramping up the pressure on China to further open up its market and to increase import, it is time to reexamine whether China's corn self-sufficiency is sustainable and the potential consequences of China opening up corn import.

Using a partial equilibrium model with two regions (China and the rest of the world) and three commodities (corn, wheat, and soybeans), we evaluate the perspective for China to import corn under alternative policy scenarios. We first project future commodity prices under the current trade regime, i.e. free soybean trade and restricted corn and wheat trade. Using reasonable price and income elasticities, we project that if China limit the corn planting area to its current level, domestic corn price will reach a historical high point. Exactly when this will happen depends on the actual amount of corn stockpile: if the USDA estimate of about 101 MMT is correct, the price hike will happen in two years; if the 220 MMT reported by the Chinese media is correct, China can continue to release its stockpile and keep the price under control until 2026. However, with the additional corn demand from the ethanol mandate, the corn price in China will reach a historical high by 2020 even with the high stockpile level. Therefore, we conclude that without opening up corn import, China's initiative to limit corn planting area is in conflict with its growing demand for corn, especially with the ethanol mandate.

After establishing that the current policies are not sustainable, we analyze the consequences of China opening up its corn import. Given China's adamant pursuit for self-sufficiency of food grains (wheat and rice), the liberalization of corn trade is more realistic than the wholesale liberalization of all crops. If China allows free corn trade (i.e. parity between domestic and international prices), we project that China's corn import will reach 88 MMT by 2020 and 173 MMT by 2027.

The following sections of this paper is organized like this: Section 2 presents the model set up; Section 3 presents data sources and model parameterization; Section 4 motivates and presents policy scenarios; Section 3 presents model projections in various policy scenarios; Section 4 concludes.

II. Model

This paper employs the partial equilibrium approach which has been adopted by standard projection models such as the FAPRI model. Partial equilibrium models construct supply and demand functions for a group of related commodities and solve for prices that clear the markets. It assumes that the markets for factors and other commodities are not affected by the commodities in the model, which is the key difference between partial equilibrium and general equilibrium models.

Our model includes three commodities, corn, wheat, and soybeans. These crops are mostly produced in northern China and are relatively isolated from the market for rice. Among these crops, wheat is assumed to be domestically produced with a small fixed amount of import (the average of the three years before projection starts). Wheat is considered a food grain, and according to China's food security policy should be "absolutely secure." (Xinhua, 2016). From 2011-2017, the average import ratio for wheat is only 2.2%, therefore it is realistic to assume that the wheat market is a domestic one. Since China is a major soybean importing country that purchases 64% of the world's total soybean export in 2017, the soybean market is set up to be international. The international soybean price clears the import-export market, and China's domestic soybean price, determined by a price transmission from the international price, clears the domestic market. For corn, we first use the domestic market with small fixed import (average of the past three years) to demonstrate that the current policies are unsustainable, then use an international market to explore the potential consequences of China opening up corn import.

Domestic Production and consumption

Domestic production is specified as the product of area planted and yield (1). Yield growth is assumed to follow linear trends with time where c is the index for the three crops and t is index for years (2). Area is determined by area planted in the last year as well as domestic prices of all three crops (3). We have also tested area models with lagged prices and yield model with price responses and find that those models do not fit the data well.

$$Production_{ct} = Yield_{ct} * Area_{ct} \quad (1)$$

$$Yield_{ct} = Constant + \beta_{0ct} Year \quad (2)$$

$$\ln(Area)_{ct} = Constant + \beta_{1c} ln(Area_{c,t-1}) + \boldsymbol{\beta_2 ln(Price_t)} \quad (3)$$

$$\ln(Consumption_{ct}) = Constant + \beta_{3c} \ln(Price_{ct}) + \beta_{4c} \ln(PcGDP_t) + \beta_{5c} \ln(Population_t) \quad (4)$$

Domestic consumption for all three crops are modeled by aggregate demands that response to own prices and grow with per capita GDP and population. Existing cross demand elasticities estimates are often statistically insignificant and have conflicting signs between different studies. Therefore we opt to only include own price responses in our demand side model.

Rest of World (ROW) Production, Consumption and Price transmission

Since the area planted for ROW is not of interest, we simply model the total production as a function of lagged production and prices (5). The ROW consumption is modeled in a similar way as China's domestic consumption as driven by own price, and per capital GDP and population for ROW (6). For soybeans, domestic price is determined by a price transmission equation from the world price (7). For corn which has not been freely traded before, we assume that the domestic price will equal world price plus 11% Value Added Tax (VAT).

$$\ln(Production_{ctw}) = Constant + \beta_{6c}\ln(Production_{c,t-1,w}) + \boldsymbol{\beta_7 ln(Price_{tw})} \quad (5)$$

$$\ln(Consumption_{ctw}) = Constant + \beta_{8c}\ln(Price_{ctw}) + \beta_{9c}\ln(PcGDP_{tw}) + \beta_{10c}\ln(Population_{tw}) \quad (6)$$

$$\ln(Price_{ct}) = constant + \beta_{11c}\ln(Price_{cw,t-1}) \quad (7)$$

Market Clearing Conditions

For domestically traded commodities (wheat, and corn in the restricted import scenarios), the market clearing conditions is for domestic supply to equal to domestic demand (8), where the change in stockpile $\Delta Stockpile_{ct}$ and net import are exogenously determined policy variables. For internationally traded commodities (soybeans, and corn in the free import scenarios), the market clearing condition is for China's net import to equal to ROW's net export (9), which is equivalent to the equality between excess demand in China and excess supply in the rest of the world (10). The model is solved by finding domestic (international) prices for domestically (internationally) traded commodities to satisfy equation 8 (equation 10.)

$$Consumption_{ct} + \Delta Stockpile_{ct} = Production_{ct} + Net\_import_{ct} \quad (8)$$

$$Net\_import_{ct} = Net\_export_{ctw} \quad (9)$$

$$Consumption_{ct} - Production_{ct} + \Delta Stockpile_{ct}$$
$$= Production_{ctw} - Consumption_{ctw} - \Delta Stockpile_{ct}w \quad (10)$$

III. Parameterization

The key to achieve accurate projections is to use valid price responses. Since the emphasis of the paper is on making projections instead of estimating elasticities, we adopt price elasticities from the literature when possible and estimate them if not. Also, when possible, we cross validate our estimations with those in the FAPRI elasticity database. The elasticities used in the model area summarized in the Table 1.

Table 1. Model parameters.

Parameter	Description	Corn	Wheat	Soybeans
β_{0c}	Annual yield growth (eq. 2)	0.07	0.08	0.01
β_{1c}	Coefficient for lagged area (eq. 3)	0.93	0.94	0.77
β_{2corn}	Area response to corn price (eq. 3)	0.22	-0.05	-0.27
β_{2wheat}	Area response to wheat price (eq. 3)	-	0.16	-0.21
$\beta_{2soybean}$	Area response to soybean price (eq. 3)	-0.07	-	0.27
β_{3c}	Own price demand elasticity (eq. 4)	-0.22	-0.20	-0.38

β_{4c}	Demand elasticity to per capita GDP (eq. 4)	0.91	0.06	1.1
β_{5c}	Demand elasticity to population (eq. 4)	0.98	-	-
β_{6c}	ROW coefficient for lagged production (eq. 5)	1.03	-	0.99
β_{7corn}	ROW production response to corn price (eq. 5)	0.23[a]	-	0.37[a]
β_{7wheat}	ROW production response to wheat price (eq. 5)	-	-	-0.21[a]
$\beta_{7soybean}$	ROW production response to soybean price (eq. 5)	-	-	-0.05[a]
β_{8c}	ROW own price demand elasticity (eq. 6)	-0.24[b]	-	-0.24[b]
β_{9c}	ROW Demand elasticity to per capita GDP (eq. 6)	0.91	-	0.91
β_{10c}	ROW Demand elasticity to population (eq. 6)	0.98	-	1.42
β_{10c}	Price transmission coefficients	1	-	0.50[c]

Notes: a. estimates from Haile et al. (2015); b. estimates from Roberts and Schlenker (2013); c. from Reimer et al. (2012). Other coefficients are authors' calculations and are close to those in the FAPRI elasticity database.

IV. Policy Scenarios and Implementation

In this study we explore potential policy changes in three areas: 1. limiting corn import and ensuring the self-sufficiency in corn; 2. achieving the policy goal of limiting corn planting area at the current level by 2020 and beyond; 3. meeting the E10 mandate. Furthermore, the policy implications are complicated by how much corn stockpile China actually has.

To model the corn import restrictions, we set corn import at the constant level of 3.6 MMT per year, which is the average level from 2015-2017. As previously mentioned, China allocate import quota using an opaque administrative system. Therefore, it is reasonable to model import under restriction as an exogenous policy variable. For scenarios of trade liberalization, we assume that the corn price in China is equal to international prices plus 11% value added tax (VAT), which essentially removes all trade barriers except the VAT. We do not use price transmission as in the case of soybeans because China has never imported corn under free trade which makes it impossible to empirically measure the price transmission coefficient. In between a tight restriction on corn import and an almost complete removal of all trade barriers, it is possible that China may pursue a partial trade liberation, such as letting the TRQ function without administrative interference. We plan to explore those scenarios in the next steps for this paper.

To limit corn planting area, the government is likely to use subsidies as policy tools. However, for modeling convenience, we simply set the maximum planting area to 35 million hectors, which is close to the current planting area for corn. As long as the subsidies to farmers are the only policy tool to achieve the area limit, directly setting maximum planting area will provide the same equilibrium quantities and prices as explicitly modeling the subsidies. However, if the government simultaneously change subsidies to farmers and subsidies to processors, the equilibrium will depend on the exact mix of the subsidies.

The ethanol mandate is modeled as perfectly inelastic demand, derived from the gasoline consumption projected by the USDA, and an ethanol mixed rate that increases linearly from the current level (2.5%) to 10% by 2020, then stay at 10% afterwards. We assume that 75% of the China's ethanol is produced domestically, and that 65% of domestic ethanol production uses corn as the feedstock. Furthermore, we assume that 3.2 tons of corn can produce 1 ton of ethanol. The assumption of perfectly inelastic demand is only an approximation: If corn price becomes too high, domestic ethanol from corn may be replaced by ethanol from other feedstock and imported ethanol. However, without explicitly modeling the ethanol market, our approach is sufficient to demonstrate the reaction of the grain markets to the E10 mandate under current conditions.

Besides different policy options, an important source of uncertainly is the actual corn stockpile. While China's corn stockpile is estimated by USDA to be only 101 MMT, the number reported in Chinese media is as high as 220 MMT. The higher stockpile number reported in Chinese media seems to be more consistent with the Chinese government's urgency to stop price support and sell off stockpile for corn. Otherwise the low corn stockpile by USDA is actually lower than China's wheat stockpile. The stockpile level determines for how long the government can de-stockpile in order to keep the price low.

Table 2. Summary of Policy Scenarios.

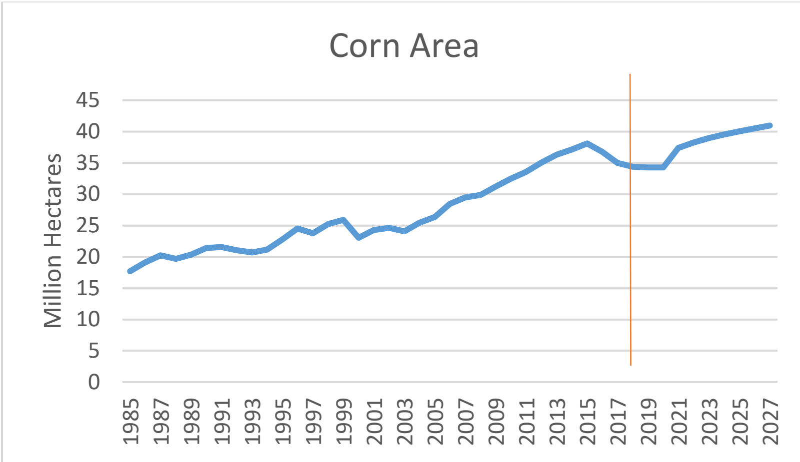
	Area limit	Ending stock in 2007	Ethanol mandate	Import policy
Scenario 1	No	101 MMT	No	Fixed at 3.6 MMT
Scenario 2	35 million hectares	101 MMT	No	Fixed at 3.6 MMT
Scenario 3	35 million hectares	220 MMT	No	Fixed at 3.6 MMT
Scenario 4	35 million hectares	220 MMT	Yes	Fixed at 3.6 MMT
Scenario 5	No	101 MMT	No	Endogenous

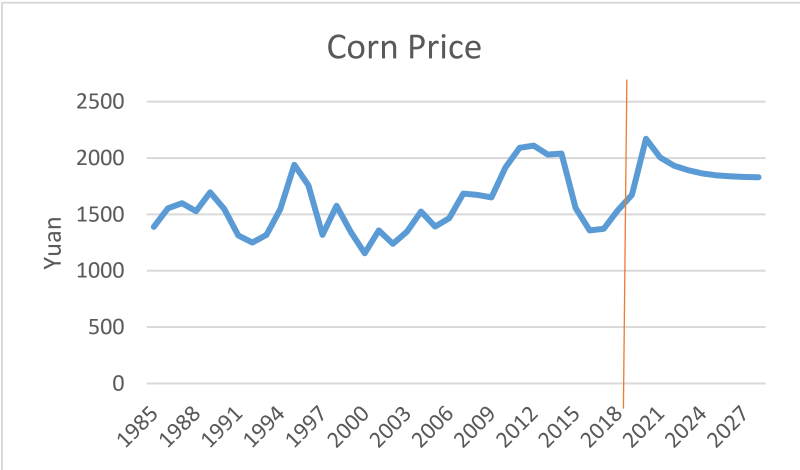
We construct 5 policy scenarios using combinations of the three policies and two possible stockpile levels discussed above. Different policy scenarios are summarized in Table 2.

V. Results

We starts with a baseline scenario in which the government does not impose area limit for corn, continues to restrict import of corn and wheat, and does not implement the E10 mandate. Furthermore, we assume that the low corn stockpile of 101 MMT reported by the USDA is correct and that the Chinese government releases corn stockpile at the same rate as in 2017 (22 MMT/year). This will allow the Chinese government to continue the current stockpile selling-off into 2019 before the corn stockpile reach 35 MMT, near the historical low point in 2005. The simulation shows that domestic corn price will rebound to about 2170 yuan in 2020, but gradually decrease afterwards. The price decline is driven by both the linear growth in yield and the expansion of planting area. While this policy combination produces acceptable prices (similar to the support price from 2009 to 2014), it cannot meet with the government’s goal to limit corn planting area to its current level with planting area increasing to 37 MMT in 2020 and 41 MMT in 2017. Besides violating the policy goal, the continued expansion of planting area will further push production into low productivity lands and hamper yield growth. This cannot be captured by this model with exogenous linear yield growth.

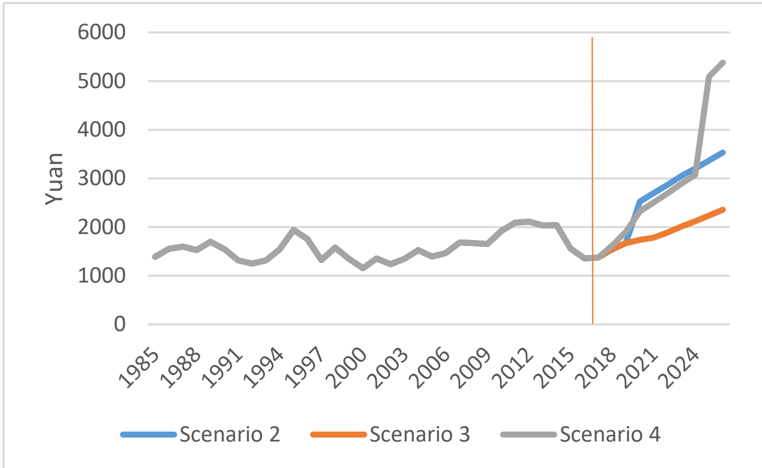
Figure 1. Corn planting area and corn price in the baseline scenario (scenario 1).





Alternatively, if China were to enforce the area limit (which will be reached by 2021), corn price is going to immediately jump above the highest level in the history and continues to go up steeply. While wheat planting area remains stable, the dramatic increase in corn price will crowd out the planting area for soybeans.

Figure 2. Corn price projections in scenario 2~4.

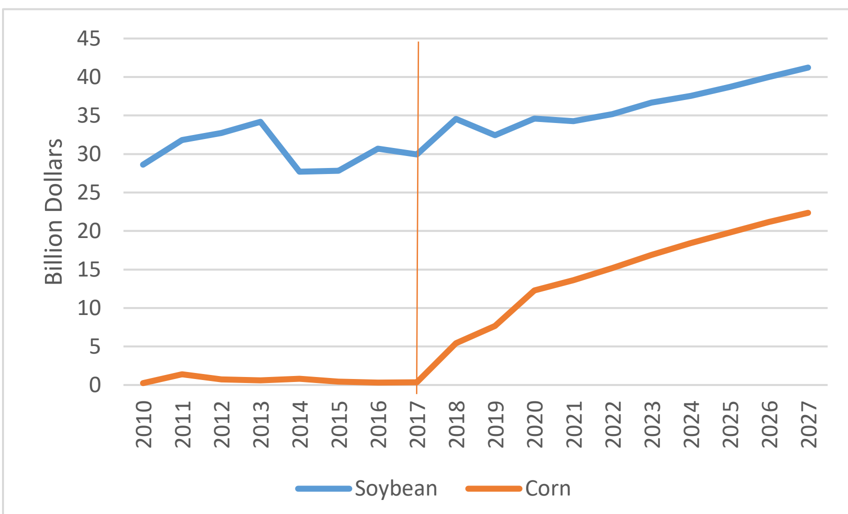


If the higher stockpile number is correct, the government can continue to sell off stockpile at the current rate until 2026. The continuous stockpile selling off can slow down the price increase until the stockpile depletes. This scenario implies that if China decides to import ethanol, there may be no immediate need to open up corn import.

However, if China want to reach the E10 mandate by 2020, a significant amount of corn has to be used for biofuel production. A reasonable estimate is that the national wide ethanol mandate will add about 18 MMT of additional corn demand by 2020 (Li et al. 2017), and this additional demand will grow with gasoline demand afterward. The demand for corn for ethanol production is likely to be inelastic since there is no ideal substitutes for corn for fuel ethanol production in China: the supply of cassava is unstable and the future of cellulosic technology is uncertain. Therefore in our exercise the demand for corn from the E10 mandate is treated as exogenous. The results show that with high stockpile and the E10 mandate, corn price in China will quickly increase beyond the highest point in history. The similarity between scenario 2 and scenario 3 is expected since the addition demand from the E10 mandate is roughly the same as the stockpile release each year.

Finally, we make projections under the scenario that China opens up corn import. Since China's previous corn import is low, the price transmission for corn cannot be reliably estimated. We simply assume that the domestic corn price equal world price plus 11% value added income tax. With free corn trade, there will be no pressure to increase corn planting area, therefore the area limit policy will not be binding. Under the low-stockpile, with ethanol mandate scenario, corn import will reach 88 MMT by 2020 and 173 MMT by 2027. Discouraged by the low prices, domestic production will continue to decline and the import dependent rate will be over 50% by 2025.

Figure 3. Projected trade values for corn and soybean import in scenario 5.



VI. Conclusions

While the expectation for China to import corn on a large scale has never materialized, recent developments in China's corn related policies have rekindled exporters' hope. Using a partial equilibrium model with two regions (China and ROW) and three crops (corn, wheat and soybeans), we demonstrate that China's current set of policies (and policy goals) will lead to unsustainably high prices. With the proposed area limits and the ethanol mandate, corn price in China will reach the highest price in history by 2020 and continue to increase rapidly after that even if the high stockpile numbers are correct.

With the current trade negotiations between China and the United States, it seems likely that China will open up its corn import. In this scenario China's corn import will dramatically increase in the coming years to reach a comparable level to soybeans. At the same time, China's domestic corn production will drastically decline to about 75% of its current level in ten year. Since a complete liberalization of corn trade will course large disturbance to the domestic market, China may pursue a partial liberalization such as removing the administrative restrictions on corn import (i.e. let the current tariff rate quota do its work) or tweaking the tariff rate quota. We are going to explore these possibilities as the next step of our research. Alternatively, China can choose to import fuel ethanol which will reduce the disruption to the crop production system at the cost of domestic fuel ethanol producers.

Reference

Haile, Mekbib G., Matthias Kalkuhl, and Joachim von Braun. (2015) "Worldwide acreage and yield response to international price change and volatility: a dynamic panel data analysis for wheat, rice, corn, and soybeans." American Journal of Agricultural Economics 98(1): 172-190.

Hansen, James, Mary. A. Marchant, Francis Tuan, and Agapi Somwaru (2017) “U.S. Agricultural Exports to China Increased Rapidly Making China the Number One Market.” Choices, 32(2)

Li, Minghao, Wendong Zhang, Dermot Hayes, Riley Arthur, Yantao Yang, and Xiudong Wang (2017) “China’s New Nationwide E10 Ethanol Mandate and Its Global Implications.” Agricultural Policy Review, Fall 2017 issue.

Ministry of Agriculture (2016) “The Plan to Adjust Planting Structure (2016-2020).”

Reimer, Jeffrey J., Xiaojuan Zheng, and Mark J. Gehlhar.(2012) "Export demand elasticity estimation for major US crops." Journal of Agricultural and Applied Economics 44(4): 501-515.

Roberts, Michael J., and Wolfram Schlenker. (2013) "Identifying supply and demand elasticities of agricultural commodities: Implications for the US ethanol mandate." American Economic Review 103(6): 2265-95.

Wu, Qianrong and Wendong Zhang (2016) “Of Maize and Markets: China’s New Corn Policy.” Agricultural Policy Review, Fall 2016 issue.

USDA, Production, Supply, and Distribution Database (2017)