Spatial price transmission under different policy regimes: the case of Chinese soy and maize market

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Introduction

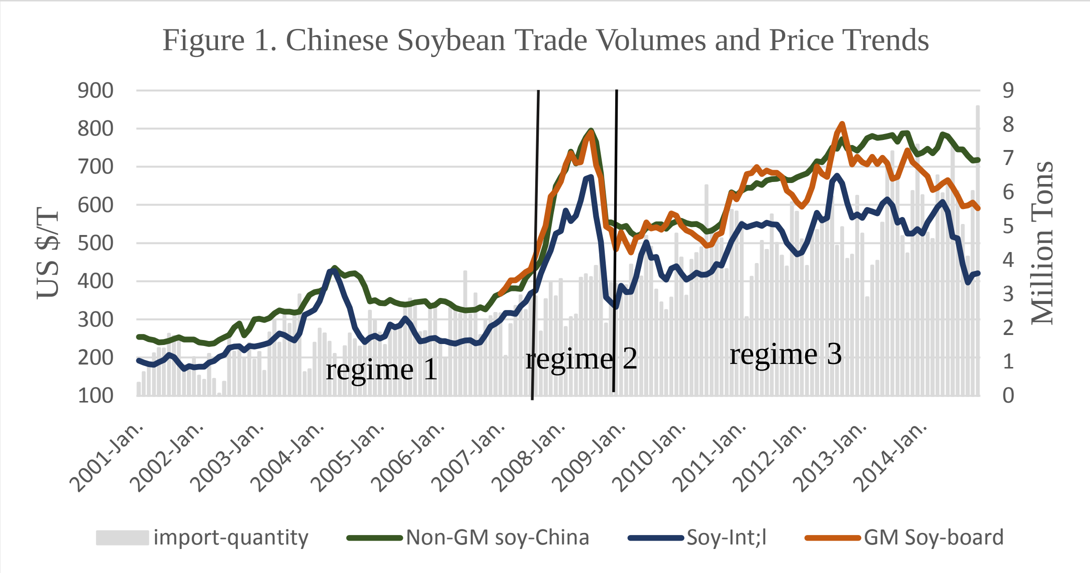
The global market entered an era of instability in 2007, when the world market prices of maize, rice and wheat started to raise rapidly. This increase lasted for 8-12 month, after which they experienced an abrupt fall, and since then two more price spikes have occurred (2010-11 and 2012) (Per Pinstrup-Andersen 2014). Most countries pursued a wide range of policy instruments to insulate domestic prices from global prices which stabilized their food prices at the expense of international price stability (Bouet and Laborde 2010, Martin and Anderson 2012). The international price formation mechanism is increasingly affected by energy and financial market linkages (Tadesse et al. 2014) which may exacerbate price spikes. The food price crisis provides therefore a natural experiment to see policies' effect on spatial price transmission. China is one of several countries that have successfully dealt with this crisis. The overall goals of this paper are to understand how Chinese government responded to the food price crisis, whether these counter measures were successful or not and how they influenced the spatial price transmission of maize and soybean prices.

Price transmission and world market dependency has become an important food policy issue in China after signing of WTO and China's accession in 2001. Previous studies on China's agriculture market suggest there is a strong evidences of vertical price integration between domestic and international market with market liberalization (Jun Yang et al 2008, Huang and Rozelle 2006). However, Chinese government still have certain control over the agricultural market by applying varies policy instruments, such as import tariffs, tariff rate quotas, export subsidies and grain storage and release program. Owing to China's unique economic and political context and nature of agricultural market, Chinese government's response to the global food crisis was rapid and decisive (Jun Yang et al 2008). Chinese government's counter measures started at the very beginning of the crisis and covered a wide ranges of domestic and border policies. The counter measures include releasing government stocks, suspending subsidies for the transport of grain for export, cancelling the rebate of value added tax for exports and so on. We know that the degree of government intervention is different for specific agriculture products. As maize is one of the main staple grain in China, the government implement many policy measures to stabilize its price, such as tariff rate quotas, export subsidies and so on. For the soybean market, however, policy intervention was less pronounced; only a very low import tariff of 3% had been applied from 2001 to 2008. So we choose maize market as a market under regulation and the soybean market as the free market type to see how spatial price transmission was affected under specific policy regimes.

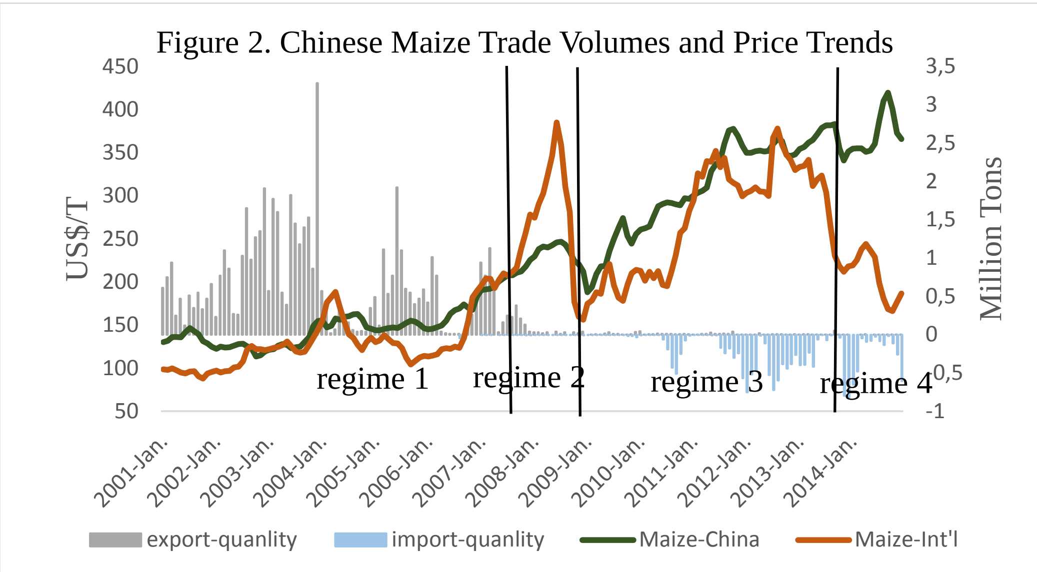
The remainder of this paper is structured as follows. First, policy regimes and data are described. Second, the literature is reviewed and the model framework presented. Third, full sample and subsample estimation results are provided. The paper ends with concluding remarks.

Policy regimes and data description

In order to understand how Chinese government's policy influenced the spatial price transmission mechanisms, a short description of its main instruments, as well as the major changes it underwent in the past 14 years, is necessary. We divide our regimes based on major policy and the time of the food price crisis. This approach permits also to hint at the endogeneity of food policy regime change, i.e. potentially driven by international food price crises.



Source: The soybean international price refers to the U.S. Illinois No.1 Yellow soybean price, FOB, plus freight cost (Bloomberg). The domestic markets price refers to Zhengzhou wholesale market No.3 no-GM Yellow Soybean. The board price refers to harbors distribution GM soybean price. The import quantity data and board price is from the Wind database.



Source: The maize international price refers to the U.S. Illinois No.2 yellow maize, FOB, plus freight cost (Bloomberg); the domestic markets price refers to Zhengzhou wholesale market No.2 Yellow Maize; the trade volumes and domestic wholesale prices are collected from WIND database.

Regime 1: Liberalization and maize export support policies (January 2001 to June 2007)

This period is characterized by market liberalization and low political intervention. In 2001, with the China Accession Protocol, Chinese government made a formal commitment to cancel the soybean quota management system and to carry out a single 3% import tariff. For maize, Chinese government cancelled the protective price purchase policy in most provinces and started tariff rate quota in 2002, applying a with-in quota tariff of 1% and an out-of quota tariff of 65%. The tariff quota is 7.2 million tons since 2004. Owing to large maize harvests and maize stocks, the Chinese government carried out an export value added tax rebate to promote maize exports in 2004. We can see from figure 2 that in this regime China export large amounts of maize mainly to Korea, Malaysia and other neighboring countries.

Regime 2: Countercyclical trade policies (July 2007 to December 2008)

The rising global food prices raised concerns of the Chines central government. The first policy response was the grain reserve scheme in late 2007, which release maize, rice and wheat from government reserves. To a certain extent this policy stabilized the market price, as the domestic market did not experience such a sharp increase as the international market. Due to the large price difference between the domestic and international market, domestic traders found it profitable to ship the relatively cheap Chinese grains to global market. So the office of the price State Council decided to cancel the payment of value added tax (VAT) rebates and put a 5% export levy on all export shipments. In later winter 2008, the export of food was not allowed at all (Jun Yang et, al 2008). Under a series of strong policy intervention the maize price just showed a moderate increase during the food crisis compared to the global market. The sharp rise of global soybean prices increased the burden of domestic soybean crushers. Therefore, on October 2007, the Chinese government carried out a temporary tariff cut on soybean, reducing the tariff form 3% to 1%. However, the international traders interpreted this policy such that china would need more soybeans, leading the international soybean price to increase by more than 2%.

We can see from figure 1 that imported genetically modified (GM) soybeans dominate the domestic soybean market, as domestic non-GM soybean price closely follows the international price. In order to protect the interest of domestic non-GM soybean farmers and shorten the time period and the amplitude of the price shocks from international market, china introduced a Temporary Storage Program (TSP) on October 2008. This policy is designed as follows: when the prices of any commodity covered by TSP are subject to a large pressure to decrease, the government will set up a purchase target and a “temporary procurement price” (TPP) for this commodity. It will buy the commodity through the national reserve system to support the market prices in a certain period. This program is also applied to maize and rapeseed. We can see from figures 1 and 2 that China’s imports increased substantially after implementing the TSP.

Regime 3: From price stabilization policies to marked-based support policies (January 2009 to December 2014 (soybean) and November 2013 (maize))

After 2008 the import of soybeans rose year by year, and the TSP increased fiscal costs further. So on May 2014 the national development and reform commission canceled the TSP and carried out a target price policy instead. This policy is designed as follows: if the soybean market price is lower than the target price, the government will give farmers subsidies according to the price spread and acreage instead of purchasing the commodity. Compared to TSP the target price policy saves costs related government purchasing and storage. For maize, there is no significant market intervention until 2013.

Regime 4 (maize only): Ban on GM-maize (November 2013 to December 2014)

In 2013 October, China detected genetically modified MIR162 maize which were imported from the USA returned. From October 2013 to June 2014, in total 1.25 million[1] ton import corn was returned by Chinese government, which created a market fraction between Chinese and global maize prices impeding price transmission further.

There are other policy changes that occurred within the last decade: China’s bioethanol production had rapidly expanded from 30 thousand tons in 2002 to approximately 1.9 million tons in 2012, making China one of the largest producer of bioethanol in the world. The total amount of maize consumed for bioethanol production by the first four biofuel plants established after 2004 was approximately 4.25 million tons, accounting about 2.1 percent of China’s total maize production in 2012 (Huanguang Qiu et al 2012). As the expanding biofuel development is a rather smooth and continuous process affecting domestic prices but not price transmission from international markets, we do not aim to control for this in our analysis.

Table 1. Policy Regimes

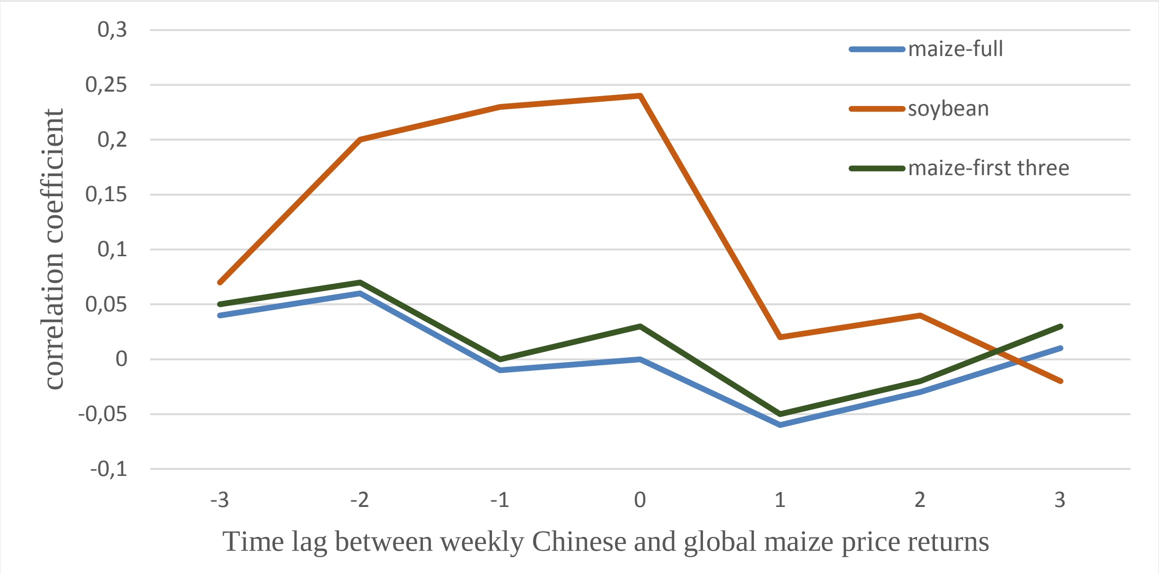
Data	Crop	Regime 1	Regime 2	Regime 3	Regime 4
Monthly	Soybean	Before Jul. 2007	Before Jan. 2009	Jan. 2009 to Dec. 2014	
	Maize	Before Jul. 2007	Before Jan. 2009	Jan. 2009 to Dec. 2014	Jan. 2009 to Nov. 2013
Weekly	Soybean	Before Jul. 2007	Jul. 2007 to Dec. 2008	Jan. 2009 to Dec. 2014	
	Maize	Before Jul. 2007	Jul. 2007 to Dec. 2008	Jan. 2009 to Nov. 2013	Nov. 2013 to Dec. 2014

Table 1 summarizes the different policy regimes. We use both monthly and weekly data for our analysis of spatial price transmission. Due to only 18 observations in the second regime for monthly data, we just combined the first two periods together for the monthly analysis. The monthly frequency data has been chosen because it takes 15-20 days for shipping soybean or maize from the USA to China and to limit the potential problem of aggregation biases associated with daily data.

[1] From the wall street journal，http://www.wsj.com/articles/SB10001424052702304483804579283790519804928

When inspecting the correlation of price changes for different lags as visualized in Figure 3, Chinese soybean prices respond quickly to US prices: The highest correlation is within the same week while correlation for US price changes up to two weeks lagged remains also above 20%. The speed of price transmission at the soybean market is much higher than the physical shipment time (around 3 weeks) which indicates that arbitrage and pricing is based on information and expectations rather than physical delivery (see also Fackler & Goodwin 2001). Contrary, maize markets seem to operate differently: Price correlation is stronger linked to shipment time but in general substantially lower (below 5%). In order to consider both channels of price transmission – the (rather instantaneous) expectation based as well as the (time-consuming) physical delivery based price transmission, we include simultaneous prices as well as price lags that are determined by statistical information criteria.

Figure 3. Correlation between international price changes and Chinese price changes for Soybean and Maize at different time lags



Note. Logarithmic price changes are considered. A time lag of '-2' indicates the correlation coefficient between Chinese price change and two-period lagged price change at the US market; '+2' indicates the correlation between Chinese price change and two-period led price change at the US market.

Data description

Domestic prices refer to non-GM soybean and maize weekly and monthly prices for the period January 2001 to December 2014 from the Zhengzhou wholesale market. The port distribution price refers to the price of imported and unloaded soybean that is further traded on the domestic market. The port distribution price together with the import and export quantity data are collected from the WIND data base. Following the literature, we use nominal price series to conduct spatial cointegration analysis. The global prices data refers to lllinois No.2 yellow maize and No.1 yellow soybean FOB price, which are collected from Bloomberg. Given there is no transport cost data before 2009, we use the transport cost from US Gulf from Bloomberg to Japan instead, after 2009 we get the transport data from WIND data base. The transport costs are added to the global prices in order to obtain CIF prices. In order to keep the data matching, we remove the non-paired data, caused by the inconsistent trading days. We have 681 matching weekly data and 168 monthly data. At the same time, all the prices data are expressed in the same currency and quantity unit (USD/metric ton) using representative exchange rates from the IMF.

From figure 1 we see that domestic non-GM soybean price closely follows the international price ups and downs, which can be explained by the large share of imported soybean that accounts for 80% of domestic total supply. The figure tells, however, another two important things: one is that during the food crisis regime, domestic prices tracked closer to international prices than within the other two regimes. The second finding is that after 2008 the co-movement of the two price pairs does not perform as well as before, despite increasing import quantities. One possible explanation is that the increased import quantities are driven by the implementation of the TSP as the TPP price is increased year by year.

Compared to the soybean market, there may be only weak price co-movement between the international maize and domestic wholesale prices if any. Maize prices have experienced just a modest rise during the food price crisis period and the government policies achieved its goal of dampening world-to-domestic price transmission. Moreover, the maize market experienced a trade regime shift from an export country to an import country when China abandoned its self-sufficiency doctrine. One major reason for this phenomenon is that the maize processing sector had substantial growth in recent years. Nevertheless, the import of maize still accounts a small share of total consumption: the import quantity in 2012 was 5.2 million ton compared to the time domestic production of 201 million tons. After 2013 the price difference of maize prices increased a lot and it almost touched the celling of the out-of quota tariff. Due to the maize quota, import quantities did not react to such a big profit opportunities. The quota maintained at 7.2 million tons since 2004 and 60% of the quota was allocated to state-owned company. Thus, quota owners were able to receive large windfall quota rents due to the high price differential.

Literature review and Model framework

To test the price co-movement in spatial separated market, a variety of empirical models have been used such as correlation analysis, dynamic regression models, and error correction models (ECM). Amongst all these models, cointegration techniques gain an important consideration, as they allow distinguishing between short and long run market dynamics. Cointegration models have developed towards several directions, such as threshold models and asymmetric adjustment models. The basic assumption of the threshold model is that only if the deviations from the long-run equilibrium exceed the threshold, the arbitrage can be triggered and then bring the price back to the equilibrium status (Balke and Fomby 1997). The main concern for asymmetric adjustment models is that the adjustment parameter can be different depending on the sign of the deviation from the long-run equilibrium (Ghoshray 2002). A shortcoming of these models is that the threshold is typically based on transport cost. However, for many agricultural commodities, policy interventions have a significant influence on price transmission as well. For the under regulation market (maize in our case), government intervention may be the decisive factor to influence price transmission between spatially separated markets. The implication of intervention mechanisms may result in the international and domestic price being unrelated to each other at all or being related in a nonlinear manner (Martin et al, 2012). Additionally, as we have explicit information on trade volumes, we do not need to estimate thresholds that lead to a switch in a regime shift but rather can specify regimes based on trade flows and policies.

After the reviewing the numerous counter measures implemented by the Chinese government, it is clear that policy interventions should have an important impact on the agricultural market. It is therefore sensible to give policy regimes and policy instruments an adequate consideration while investigating the spatial price transmission mechanism. In the existing literatures, there are two methods to see the policy regimes effect in cointegration models. One way is using dummy variables to account for the policy changes by putting them outside the cointegration vector (Hui-Shuang and Griffith 1998), another way is to split the sample into sub-sample according to the policy regimes (Barassi and Ghoshray 2007). In our paper we first do full-sample and sub-sample cointegration analysis to see the counter measures' influence on spatial price transmission and then provide a threshold model allowing for regimes shift to see if only the board price above the intervention price can it affect the non-GM soybean and the intervention price act as a down threshold for the board price.

Model framework

In the analysis of time-series data, prices are often non-stationary, meaning that they will drift randomly rather than return to a mean value. Moreover, the price difference is often stationary, in this case the price is said to be integrated to degree one or I (1). Let p_t^d be the soybean and maize prices in china, and p_t^g be the global market prices. If both p_t^d and p_t^g are I (1) and there the linear combination of them is I (0), we say the two price pairs are cointegrated (Engle and Granger, 1987). Granger and Engle suggest estimating the cointegration relationship using regression and one of the price is exogenous. What's more, Engle-Granger testing procedures have small sample biases for lacking well-defined limiting distribution (Banejeree et al, 1986). While Johansen's multivariate testing procedure, take into account the error structure of the underlying process and loosen the exogenous condition. Starting from a standard VAR model with lag length k, Vector Error Correction Model (VECM) can be derived as follows:

$$\mathbf{P_t} = \boldsymbol{A_0} + \boldsymbol{A_1}\mathbf{P_{t-1}} + \boldsymbol{A_2}\mathbf{P_{t-2}} + \cdots + \boldsymbol{A_k}\mathbf{P_{t-k}} + \boldsymbol{\varepsilon_t} \qquad \mathbf{t=1,\ldots,T} \qquad \mathbf{(1)}$$

In our paper $\mathbf{P_t}$ is a vector of endogenous prices, $\mathbf{P_t}=\begin{pmatrix} p_t^d \\ p_t^g \end{pmatrix}$, $\boldsymbol{A_t}$ are matrices of unknown parameters, $\boldsymbol{\varepsilon_t}$ are white noise disturbance terms. Formula (1) can be rewritten as the following when taken first difference:

$$\Delta\mathbf{P_t} = \boldsymbol{\pi_0} + \boldsymbol{\pi_1}\Delta\mathbf{P_{t-1}} + \cdots + \boldsymbol{\pi_{k-1}}\Delta\mathbf{P_{k-1}} + \boldsymbol{\pi}\mathbf{P_k} + \boldsymbol{\varepsilon_t} \qquad \mathbf{(2)}$$

Where $\boldsymbol{\pi_0} = \boldsymbol{A_0}$, $\boldsymbol{\pi_i} = -\left[\boldsymbol{I} - \sum_{j=1}^{k-1} \boldsymbol{A_j}\right]$ and $\boldsymbol{\pi} = -\left[\boldsymbol{I} - \sum_{j=1}^{k} \boldsymbol{A_j}\right]$. The rank of $\boldsymbol{\pi}$ provides the basis for determining the presence of cointegration: here if rank ($\boldsymbol{\pi}$) =0, the prices are not cointegrated and a VAR in first differences; if rank ($\boldsymbol{\pi}$) =2, the prices are stationary and the model is equivalent to a VAR in levels; if rank ($\boldsymbol{\pi}$) =1, the prices here are cointegrated. Usually we decompose $\boldsymbol{\pi}$ as $\boldsymbol{\pi} = \boldsymbol{\alpha\beta'}$, and $\boldsymbol{\alpha}$ is the matrix of the speed of adjustment coefficients and $\boldsymbol{\beta}$ is the cointegration vectors. The one-lagged long run disequilibrium term VECM model can be written as:

$$\Delta \mathbf{P_t} = \boldsymbol{\alpha\beta'}\mathbf{P_{t-1}} + \sum_{i=1}^{k-1} \boldsymbol{\pi_i} \Delta \mathbf{P_{t-i}} + \boldsymbol{\varepsilon_t} \qquad \textbf{(3)}$$

In our analysis $\mathbf{P_t}$ contains only two prices p_t^d and p_t^g, we will have the following long-run relationship:

$$\boldsymbol{\beta'}\mathbf{P_{t-1}} = [\beta_0\ \beta_1\ \beta_2]\begin{pmatrix} \mathbf{1} \\ p_{t-1}^d \\ p_{t-1}^g \end{pmatrix} = \beta_0 + \beta_1 p_{t-1}^d + \beta_2 p_{t-1}^g = Z_{t-1} \qquad \textbf{(4)}$$

Where Z_{t-1} is a stationary process, when normalizing with respect to β_1 the long-run spatial price relationship can be written as following:

$$p_t^d = \gamma + \beta p_t^g + u_t \qquad (5)$$

Where $\gamma = \beta_0/\beta_1$ and $\beta = \beta_2/\beta_1$, so β measures the long-run equilibrium relationship, we call it the long-run co-integrating parameter. Since the prices are expressed in logarithms, β measures the long-run price transmission elasticity of the domestic price with respect to the global price. If β is close to one, we can say that the two market are well cointegrated. The price fluctuations in one market completely transmit to the other. The ECM model can be written as follows:

$$\Delta p_t^d = \alpha\, \mu_{t-1} + \sum_{j=1}^{k} \vartheta_{ij} \Delta p_{t-j}^d + \sum_{j=1}^{k} \theta_{ij} \Delta p_{t-j}^g + \varepsilon_i \qquad (6)$$

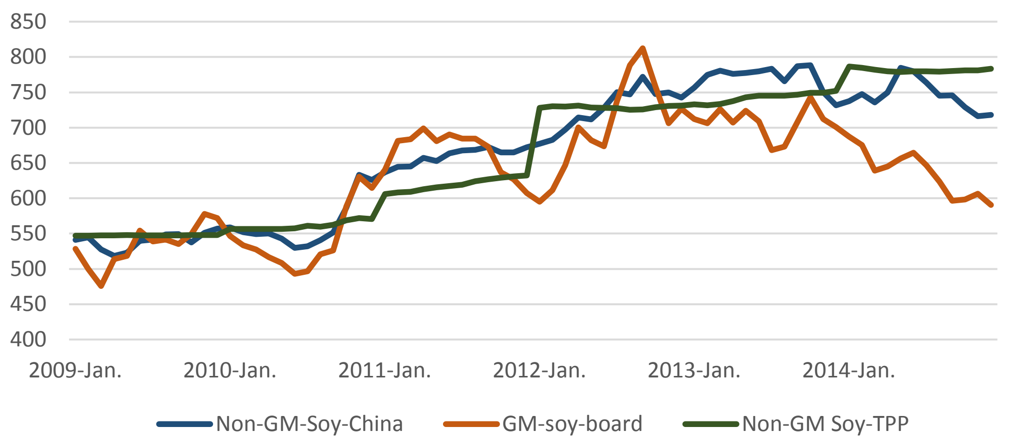
The ECM states that changes in p_t^d depend not only on changes in p_t^d and p_t^g, but also on the disequilibrium in the previous period. Where μ_{t-1} represents the extent of disequilibrium between level of p^d and p^g in the previous period. Usually -1< α <0, if the error is positive, meaning the domestic price is high given the long-run relationship, the negative value of α helps to bring the domestic price back to the long-run equilibrium. If α close to -1, we can imply that short-term disturbance can quickly return to equilibrium, and two markets link more closely. The coefficient on changes in the global price (θ) is the short-run elasticity of domestic price relative to the global price. Θ is the autoregressive term of the lagged changes in the domestic price. Here a half-life can be computed by h=log(0.5)/log(1+ α), which is an index of valuing the time that is needed for a given shock to return to half its initial value.

From figure 4, we can see that the TPP price[2] act as an implicit downward threshold for the international price and domestic non-GM soybean price just follow the international price when it above the TPP price. In order to see the TPP's influence on the soybean market, we use a threshold model allowing for regime shift to test this hypothesis. The models stem from the theoretical consideration: the non-GM price is assumes to be linked to either the boarder price or the TPP price depending on which of them is higher. The threshold model allowing for regime shift can be written as the following:

$$\Delta P_t^w = \alpha_1 Z_{t-1} + \alpha_2 Z_{t-1}\, \mathrm{I}\left(\mathrm{P}_{t-1}^{\mathrm{board}} > \mathrm{P}_{t-1}^{\mathrm{TPP}}\right) + \sum_{i=1}^{k} \Delta p_{t-i}^{w} + \varepsilon_t \qquad (7)$$

Where Z_{t-1} is the lag of the price difference between board distribution price and domestic non-GM soybean wholesale price. The $Z_{t-1} = (\mathrm{P}_{t-1}^{\mathrm{board}} - \mathrm{P}_{t-1}^{\mathrm{w}})$, $\mathrm{I}(\cdot)$ is the indicator function, which means when $\mathrm{P}_{t-1}^{\mathrm{board}} > \mathrm{P}_{t-1}^{\mathrm{TPP}}$ $\mathrm{I}(\cdot)=1$ otherwise $\mathrm{I}(\cdot)=0$. If α_2 is larger than α_1 and significant, we can indicate that the board price can have its influence on non-GM soybean price only if the it above the TPP price. We should point out that both α_1 and α_2 should be negative for non-GM soybean wholesale price and positive for the board price. And Z_{t-1} act just like the lag of the error correction term.

Figure 4. Soybean Prices in China after 2008 (US$/MT)



Source: The temporary procurement price (TPP) is based on official documents from the State Administration of Grain and the National Development and Reform Commission, the TPP price in 2014 changes to target price.

Cointegration analysis under specific policy regimes

Table 2 and Table 5 show the results of the unit root and Johansen Cointegration test for weekly and monthly price data, respectively. Table 3 is the (error correction model) ECM

[2] The temporary procurement price (TPP) is based on official documents from the State Administration of Grain and the National Development and Reform Commission, the TPP price in 2014 changes to target price.

analysis of soybean results under specific policy regimes. For the weekly data, the two price are cointegrated under each regime. The long-run equilibrium coefficient is 1.02 for full sample result (Table 3), meaning that the price transmission elasticity is 1.02, so if the international price increases by 1 percent, the domestic wholesale price will increase by 1.02 percent. Just as what we can infer from figure 1 that in regime 2 the two price pairs are well cointegrated with each other and they just show a weak co-movement phenomenon in regime 3, for the long-run equilibrium coefficient is much larger than one and the adjusting parameter is the smallest one. In regime 2 the long-run equilibrium is 0.98, we can infer that the price shock from international can completely transmit to domestic non-GM soybean market. Moreover the absolute value of short-run adjusting parameter is the largest one, meaning that the feedbacks from prior disequilibrium are the fastest ones. One possible explanation for this is that the price difference is so large in this regime, and the traders keep attention to the price changes and respond quickly. Another important possible reason is that the policy intervention is the least one in this regimes, for cutting the tariff from 3% to 1%, which make domestic market nearly totally open to the world market.

Table 4 is ECM analysis of maize. What surprise us is that the price pairs are cointegrated with each other in regime 2, for there are a serial policy interventions in this regime. A possible explanation is that although the domestic maize price just has a moderate increase, the trend of the two price pair is the same, they both experienced a relatively sharp increase and fall in this period. At the same time we can see that the long-run parameter is just 0.25 for weekly data, which we can infer that there is only a relatively low degree of cointegration. Another contrary to intuition finding is that China exports a lot of maize in regime 1, while there is no price co-movement. One explanation is that we use domestic wholesale market prices and the export VAT rebate in this period influences the price gap between the two markets. Another issue is that China mainly exports to the neighboring countries and there is almost no direct trade between China and USA in this period. So price transmission is expected to be only indirect via equilibrium effects on the world market. After 2009 China became a maize importer with over 90% of the imported maize coming from the USA. Finally, our analysis indicates that there is long-run equilibrium relationship in regime 3. As the maize market is not completely open, there is only a low degree of market cointegration and the long-run parameter is much smaller. In regime 4, maize price drift away from the international price, due to ban on GM-maize. We can see that the feedback to disequilibrium is quick during the food price crisis for maize, too. For soybean we can say that this may due to an unregulated market, but one more feasible explanation is that during this period the price difference is so large and market trader see more profit opportunity and take simultaneously actions to response to the price changes.

We can draw similar conclusions from monthly data (Table 6 and Table 7). For soybean there is just a low degree of cointegration relationship in regime 3.

Finally, we analyze the role of the TSP. From table 8 we can see that α_2 is larger than α_1 and significant for non-GM soybean wholesale price. This means that the board price is decisive for domestic wholesale prices only if it is above the TTP price (and the TPP price is therefore not binding). As all other coefficients on the boarder price are insignificant, the domestic non-GM price does not influence the board price.

Concluding remarks

The subsample analysis indicates that government's effort to dampen the world-to-domestic price transmission effort was attained on the maize market, and have little power to influence the soybean price market. The feedback to disequilibrium is quick during the food price crisis for maize and soybean, mainly due to during this period price difference is so large and the traders keep attention to the price changes and respond quickly. The TPP price acts as a down threshold for the board price, the board price can influence domestic non-GM soybean price only if it above the TPP price, otherwise non-GM soybean price just follow the TPP price. The TTP price do have some influence on domestic non-GM soybean price, but the cost is huge. The import volume increased afterwards cause a huge increase of government budget.

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Table 2. Unit Root and Johansen Cointegration Test (weekly)

Market pairs	No. of obs	Unit root test	Test type (C,T,K)	trace statistics	Maximum rank
Soybean: full sample					
H_0 :r=0 VS H_1: r>=1	681	I(1)	(C,0,3)	34.87**	1
H_0 : r<=1 VS H_1: r>=2				2.49	
Soybean: regime 1					
H_0 :r=0 VS H_1: r>=1	324	I(1)	(C,0,2)	30.32**	1
H_0 : r<=1 VS H_1: r>=2				1.80	
Soybean: regime 2					
H_0 :r=0 VS H_1: r>=1	74	I(1)	(C,0,1)	18.20*	1
H_0 : r<=1 VS H_1: r>=2				2.00	
Soybean: regime 3					
H_0 :r=0 VS H_1: r>=1	283	I(1)	(C,0,1)	24.73**	1
H_0 : r<=1 VS H_1: r>=2				3.37	
Maize : full sample					
H_0 :r=0 VS H_1: r>=1	681	I(1)	(C,0,2)	11.62	0
H_0 : r<=1 VS H_1: r>=2				1.77	
Maize: regime 1					
H_0 :r=0 VS H_1: r>=1	324	I(1)	(C,0,2)	5.46	0
H_0 : r<=1 VS H_1: r>=2				0.03	
Maize : regime 2					
H_0 :r=0 VS H_1: r>=1	74	I(1)	(C,0,1)	16.62*	1
H_0 : r<=1 VS H_1: r>=2				1.32	
Maize: regime 3					
H_0 :r=0 VS H_1: r>=1	229	I(1)	(C,0,2)	24.99**	1
H_0 : r<=1 VS H_1: r>=2				3.02	
Maize : regime 4					
H_0 :r=0 VS H_1: r>=1	54	I(1)	(C,0,1)	13.35	0
H_0 : r<=1 VS H_1: r>=2				4.75	

Note: ** and * represent statistically significant at 1% and 5%, respectively.

Table 3. Spatial Price Transmission of Soybean on Each Regimes (weekly)

Regimes	Long-Run Relationship		Error Correction Model if long-run relationship is confirmed	
	Exist (Yes or no)	If yes, then long-run adjustment	Speed of adjustment	Half-life
Full sample	Yes	1.02**	-0.03**	22.8 week
Before Jun. 2007	Yes	0.85**	-0.05**	13.5 week
Jul. 2007 to Dec. 2008	Yes	0.98**	-0.09**	7.3 week
Jan. 2009 to Dec. 2014	Yes	1.22**	-0.02**	34.3 week

Note: ** and * represent statistically significant at 1% and 5%, respectively.

Table 4. Spatial Price Transmission of Maize on Each Regimes (weekly)

Regimes	Long-Run Relationship		Error Correction Model if long-run relationship is confirmed	
	Exist (Yes or no)	If yes, then long-run adjustment	Speed of adjustment	Half-life
Full sample	No			
Before Jun. 2007	No			
Jul. 2007 to Dec. 2008	Yes	0.25**	-0.13**	5.0 week
Jan. 2009 to Oct. 2013	Yes	0.63**	-0.05**	13.5 week
Nov. 2013 to Dec. 2014	No			

Note: ** and * represent statistically significant at 1% and 5%, respectively.

Table 5. Unit Root and Johansen Cointegration Test (monthly)

Market pairs	No. of obs	Unit root test	Test type (C,T,K)	trace statistics	Maximum rank
Soybean: full sample					
H_0 :r=0 VS H_1: r>=1	168	I(1)	(C,0,3)	39.26**	1
H_0 : r<=1 VS H_1: r>=2				2.01	
Soybean: regime 1					
H_0 :r=0 VS H_1: r>=1	78	I(1)	(C,0,3)	30.07**	1
H_0 : r<=1 VS H_1: r>=2				1.51	
Soybean: regime 2					
H_0 :r=0 VS H_1: r>=1	96	I(1)	(C,0,3)	27.27**	1
H_0 : r<=1 VS H_1: r>=2				1.47	
Soybean: regime 3					
H_0 :r=0 VS H_1: r>=1	72	I(1)	(C,0,3)	19.31*	1
H_0 : r<=1 VS H_1: r>=2				2.42	
Maize : full sample					
H_0 :r=0 VS H_1: r>=1	168	I(1)	(C,0,2)	11.94	0
H_0 : r<=1 VS H_1: r>=2				0.83	
Maize: regime 1					
H_0 :r=0 VS H_1: r>=1	78	I(1)	(C,0,2)	10.02	0
H_0 : r<=1 VS H_1: r>=2				0.01	
Maize : regime 2					
H_0 :r=0 VS H_1: r>=1	96	I(1)	(C,0,2)	13.77	0
H_0 : r<=1 VS H_1: r>=2				1.27	
Maize: regime 3					
H_0 :r=0 VS H_1: r>=1	72	I(1)	(C,0,2)	12.92	0
H_0 : r<=1 VS H_1: r>=2				2.72	
Maize : regime 4					
H_0 :r=0 VS H_1: r>=1	58	I(1)	(C,0,4)	16.18*	1
H_0 : r<=1 VS H_1: r>=2				1.99	

Note: ** and * represent statistically significant at 1% and 5%, respectively.

Table 6. Spatial Price Transmission of Soybean on Each Regimes (monthly)

Regimes	Long-Run Relationship		Error Correction Model if long-run relationship is confirmed	
	Exist (Yes or no)	If yes, then long-run adjustment	Speed of adjustment	Half-life
Full sample	Yes	1.05**	-0.10**	6.6 month
Before Jul. 2007	Yes	0.91**	-0.23**	2.7 month
Before Jan. 2009	Yes	1.02**	-0.14**	4.6 month
Jan. 2009 to Dec. 2014	Yes	1.31**	-0.05*	13.5 month

Note: ** and * represent statistically significant at 1% and 5%, respectively.

Table 7. Spatial Price Transmission of Maize on Each Regimes (monthly)

Regimes	Long-Run Relationship		Error Correction Model if long-run relationship is confirmed	
	Exist (Yes or no)	If yes, then long-run adjustment	Speed of adjustment	Half-life
Full sample	No			
Before Jul. 2007	No			
Before Jan. 2009	No			
Jan. 2009 to Dec. 2014	No			
Jan. 2009 to Nov. 2013	Yes	0.50**	-0.13**	5.0 month

Table 8. A Threshold Model allowing for Regime Shift

	weekly		monthly	
	ΔP_t^w	ΔP_t^{board}	ΔP_t^w	ΔP_t^{board}
α_1	0.01	-0.06	0.03	-0.09
	(0.01)	(0.04)	(0.03)	(0.06)
α_2	0.08*	-0.02	0.14*	-0.28
	(0.03)	(0.02)	(0.07)	(0.14)
N	246	291	72	72
R-squared	0.19	0.13	0.32	0.33
LM test	0.45	0.39	0.46	0.16

Note: ** and * represent statistically significant at 1% and 5%, respectively. The standard variance is in the parentheses.

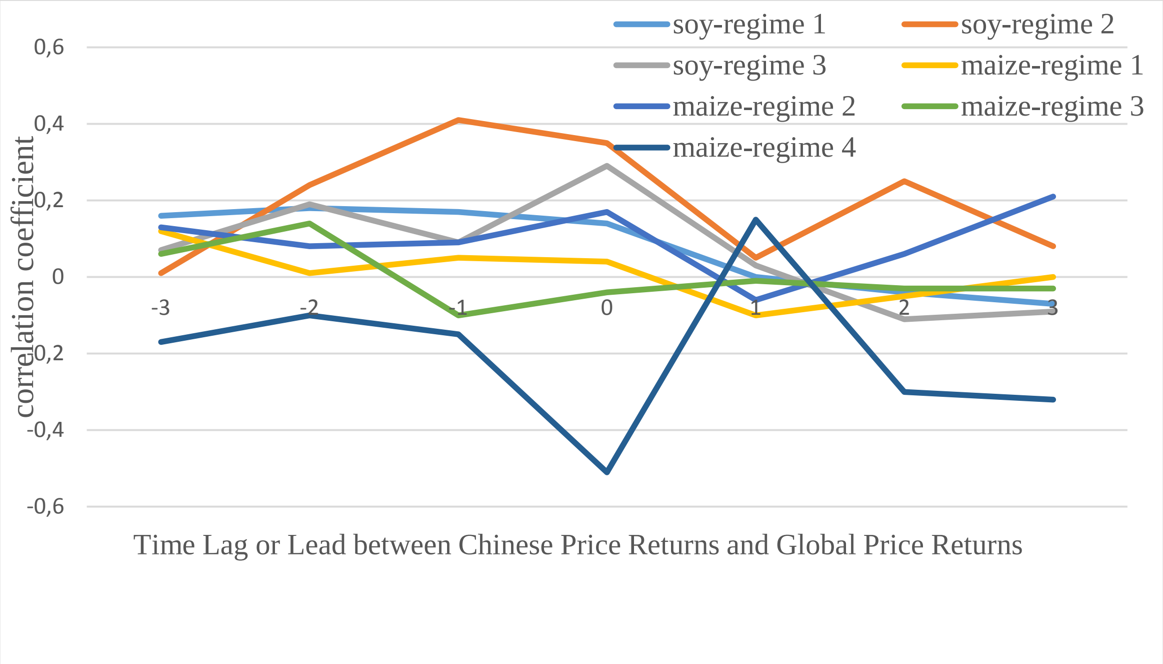
Table 9. The temporary procurement prices under Temporary Storage Program, US$/MT

	2008	2009	2010	2011	2012	2013	2014
Maize	216	220	251	307	336	362	365
Soybean	532	547	561	619	729	743	781

Source: Authors' reviews based on official documents from the State Administration of Grain and the National Development and Reform Commission.

Appendix

Figure 5. Correlation between international price changes and Chinese price changes for Soybean and maize under different regimes



Note. Logarithmic price changes are considered. A time lag of '-2' indicates the correlation coefficient between Chinese price change and two-period lagged price change at the US market; '+2' indicates the correlation between Chinese price change and two-period led price change at the US market.