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A Study on the Impact of Constraints from Exporters' Exporting Prowess on Source Distribution of China's Soybean Imports

—A Perspective from Seasonal Factors

Dayan Lin
College of Economics and Management, Nanjing University of Science & Technology

Guosong Wu
College of Economics and Management, Huaiyin Normal University

Jing Zhu, Fan Yang and Dominic A. Aniah
College of Economics and Management, Nanjing Agricultural University

Over two decades, distribution of China's soybean import sources changed significantly. Price as is implied in traditional HO theory is unable to justify that change. Instead, the seasonality of agricultural production may contributes more to changes on import source of soybean by seasonal supply constraints. Based on exporters' decision-making behavior, this paper analyzed the impact of constraints from exporters' exporting prowess on China's import source distribution from the perspective of seasonality, using monthly data of China and the three major soybean exporters from the year 2010 to 2013. Empirical results show that an exporting country takes up a significantly bigger share in China's soybean imports in its harvest season than in non-harvest season. Changes on import source result from dynamics of comparative advantage of exporting countries. Taking seasonal complementarities and comparative advantages of exporters into consideration, China may make good use of world resources and stabilize domestic supply of food.

1. Introduction

Over two decades, during which China has imported food on the rise, the distribution of import sources has changed significantly. A plethora of research indicates that distribution of import sources comes into being owing to importers' trade-off among prices, quality, services, supply stability, political relations, and substitute prices. Of those price is the main factor (Mercier & Gohlke，1995). H-O theory also suggests that absolute price differences between exporting and importing products determine a country's successful participation in international trade. In other words, the import source distribution relies primarily on price differentials of import sources. Take rice imports for instance, China expanded her imports of rice from Vietnam mainly because import price from Vietnam was relatively lower than that from Thailand since 2002. UN COMTRADE statistics show that the relative price of rice imported from Vietnam to Thailand dropped from 1.95 to 0.67 during the period from 2002 to 2011. China increased rice imports from Vietnam by 40.42 percent, with those from Thailand down by 41.43 percent yet. It was also true with corn and wheat. The relative price of wheat imported from Australia to Canada also dropped from 0.86 to 0.83, leading to an increasing share of Austrian wheat in Chinese market to 25.69 percent while Canada drop to 15.52 percent. The similar case went for corn imported from the United States who maintained her absolute advantages owing to lower prices compared with South Africa and other countries. Seen from that，changes in distribution of import sources of wheat and corn mainly derive from price variations among exporting countries.

However, China's soybean imports demonstrate a different scenario. Soybean prices imported from the United States, Brazil and Argentina are almost close in Chinese market due to large-scaled production of GMO soybeans by Brazil and Argentina and active soybean futures market（Margarido etal. 2007；Song, 2009; Luo, 2010）. Pair-wise ratios of prices among three countries are close to one, and ANOVA test shows no significant difference among three，nevertheless import source distribution underwent dramatic changes. Prior to 1996, 95% of China's soybean imports came from the United States, however, imports from Brazil and Argentina gained greater share of 40% and 15% respectively until 2012.

Under the circumstances that one commodity's price converges across the globe, its selection of soybean importers is no longer based on price advantages but on relative exporting prowess of

exporters, i.e. variations in export quantity among exporting countries to pursue profit maximization or cost minimization[①].Given the equilibrium price in the world market, supply of agricultural products, unlike industrial products, does not only depend on the input of factors of production but also on natural endowment especially constraints of seasonal patterns of crop production. Although most of food crops are reaped once a year, the same crop in different regions may vary in production seasons owing to high disparities in natural factors. Seasonal disparities result in different capacity of exporters to supply food to the world market at any given price level at the same time. If a country is a large food importer, then the difference will further determine its source distribution of imports.

We analyze the dynamics of source distribution of China's soybean imports, taking supply capacity of soybean exporting countries into consideration from the perspective of production season, using monthly data of China and the United States, Brazil and Argentina from the year 2010 to 2013. The findings demonstrate that constraints from exporters' exporting prowess measured by seasonal factors are the significant determinant of import distribution of China's soybeans. Different from previous literature focusing on prices, the paper considers the effect of supply capacity on distribution of soybean import sources, constrained by production season of exporting countries. AIDS model is widely employed to analyze distribution of import sources with a tacit assumption that prices differ among import sources. However, AIDS model is feeble to explain distribution of China's soybean import sources since prices are almost identical among those import sources. Therefore, we derive a new model to explain the determinant of distribution of import sources based on exporters' behaviors.

The paper is organized as follows. First, we review the literature. Section 3 presents the modified AIDS model to depict import source distribution. In section 4, we go on test the model using monthly official data. We present our results in Section 5 and check their robustness. In our concluding section, we briefly discuss what guidance our results could furnish of or the formulation of China's food security policy.

2. Literature review

In the long run many countries implemented export-led and import-substitution strategies so that the study of trade distribution surrounds the structure of exporting market (Massell，1970；

[①] The political economy in the area of importing and exporting is not within the scope of this study.

Tegene，1990；Love，1987). Little research is focused on distribution of import sources. A common view confirms that the degree of concentration of exporting markets makes a country vulnerable to those major exporting markets. It is difficult for the importing country to smooth the volatility of those markets through reverse fluctuations of other markets (Adams and Behrman，1982). On the contrary, other scholars contend that concentration of exports reduces transaction cost caused by political factors and finally attain export stability（Tegene，1990）.

Recently, distribution of China's soybean import sources aroused some scholars' interest. Song et al. (2006) compare the market power between American soybean suppliers and Chinese importers in international trade of soybeans. They agree that Chinese importers have a stronger power over American and South American soybean exporters. Because of seasonal complementarities between the United States and South America, in addition with Chinese supervision of imports, imports from South America have little impact on American exports. To sum up, few studies expound the dynamics of distribution of import sources. The paper is to explore the determinants of distribution of import sources in China's soybean market. It emphasizes the effect of supply capacity on distribution of soybean import sources, constrained by production season of exporting countries.

3. Theoretical Framework

The theory of comparative advantages posits that a country will produce and export comparatively advantageous goods. In a multi-country case, a country should import goods from a country with the greatest comparative advantage. Import source distribution relies on gaps in comparative advantage of import sources. Goods with a lower price would be favorable to importers. However, how does an importing country choose its import sources in the perfect competitive international market since prices of all the export sources are highly convergent? Selection of import sources reflects import demand from the perspective of importing country, taking prices into consideration.

However, a large importing country, to some degree, is also constrained by supply capacity of import sources. Importing agricultural goods is particularly evident owing to seasonality. In the free trade equilibrium, exporting prices are almost taken as given, but exporting costs of food products vary with different production seasons. According to production theory, given the cost, the output depends on factor prices and production technology. The theory applies to industrial

products, yet agricultural products require suitable season beyond those. It is hard to produce a large number amount of product in a non-harvest season as in the harvest season with the level of factor prices and technology stay the same. The direct result is that agricultural goods in non-harvest season are those stored for a long time since the date of harvest season. Export cost includes production cost in addition with inventory cost. If an exporting country is unable to raise export price in non-harvest season, the suitable way out is to reduce the volume of exports, even zero export. In this case, the importing country has to change its import source to meet its import demand. Hence, for food production, the imports source distribution may have correlation with the seasonal supply constraints of import sources.

As shown in Figure 1, we assume *PC* as production costs of agriculture products for a country both in harvest season and in non-harvest season [②]. The inventory costs of harvest season and non-harvest season are IC_s and IC_{ns} respectively (inventory time of agriculture products in non-harvest season is longer than in harvest season, as so when the production in two-season are equal, we have $IC_{ns}>IC_s$), the corresponding total cost and marginal cost are TC_s, TC_{ns} ($TC_{ns} > TC_s$) and MC_s, MC_{ns} ($MC_{ns} > MC_s$), respectively. P_w is the world price, then the exports of agricultural products in harvest season and non-harvest season are Q_s and Q_{ns} in market equilibrium state, where $P_w=MC_s$ and $P_w=MC_{ns}$. It is clear that $MC_{ns} > MC_s$ when marginal cost increases. In order to maximize profits, the export volume in non-harvest season must be less than that in harvest season, i.e. $Q_{ns}<Q_s$. In other words, because of inventory holding costs, exporters will reduce the volume of exports in non-harvest seasons. We consider the domestic consumption of agricultural products of country A is Qc, and it export *k* proportion of the rest of agricultural products to country B both in harvest season and in non- harvest season. Country B imports *M* in all seasons, then $k(Q_s\text{-Qc})/M$ *and* $k(Q_{ns}\text{-Qc})/M$ are the market share of country A in the country B's market in production season and in non-production season respectively, where $k(Q_s\text{-Qc})/M > k(Q_{ns}\text{-Qc})/M$. In a word, country B alters her import sources with agricultural production season of country A.

FIGURE 1 ABOUT HERE

H-O theory concludes price differentials majorly account for distribution of import sources for one country. In this case, Almost Ideal Demand System (AIDS) has been used extensively in

②The production cost includes fixed cost and variable cost. It is assumed that production costs in harvest season and in non-harvest season of are equal.

empirical analysis on differentials of import sources (Yang and Koo， 1994； Chang and Nguyen , 2002； Carew etal.,2004). AIDS model is developed according to achieving given utility level with minimum cost at a given price system and a utility level (Deaton， 1980). A tacit assumption of AIDS model is that prices vary across import sources. However, as above mentioned, popularity of GMO soybeans and futures trade, import soybean prices from all exporters are close to each other. Price already loses its function of benchmark in the process of selecting soybean suppliers. It is necessary to search for a suitable model to analyze China's soybean imports. From the perspective of seasonality, we derive a new model to examine the factors of import source distribution, starting from exporters' decision.

Exporters choose current and future export volume to achieve the maximum profits at a given quantity of production. We describe a representative exporter's problem in country *i* with its production y^{id} as follows:

$$Max\pi_{id} = \pi(q_0^{id}) + \beta\pi(q_t^{id}) = p_0 q_0^{id} + \beta(p_t^e - ic^{id})q_t^{id} - pc^{id} y_0^{id} . 0 < \beta < 1$$

$$\text{s. t.}\, q_0^{id} + q_t^{id} = y^{id} \tag{1}$$

where p_0 and p_t^e are the current price and the expected future price. The unit production costs and inventory costs③ are pc^{id} and ic^{id} . q_0^{id} is current volume of exports; q_t^{id} is future exports volume and β is preference factor as a constant.

According to Equation (1), we can get country *i*'s present value of total export profits:

$$Max\pi_i = p_0 q_0^i + \beta(p_t^e - ic^i)(y^i - q_0^i) - pc^i y^i . 0 < \beta < 1$$

$$\text{s. t.}\, q_0^i + q_t^i = y^i \tag{2}$$

Assuming that exporters set their expected future prices p_t^e based on future prices, cost of carry theory implies that future prices are equal to the sum of spot price p_0, financing costs r_t, the risk-free interest rate revenue, warehousing costs w_t, including storage costs, anti-corrosion costs, insurance costs, loss costs and profit due to inventory of the goods sle_t. $p_t^e = p_0(r_t + w_t + sle_t)$. Where r_t, w_t and sle_t are functions of inventory time *t*: *rt=r*t, wt=w*t,*

③The inventory Carrying Cost refers to cost related to logistics activities, caused mainly by activities of inventory control, packaging, waste disposal and so on, which is composed of financing costs, inventory service cost (insurance and taxes), storage cost and inventory risk cost. Because inventory service cost and inventory risk cost are relatively small, this paper mainly consider financing costs and storage cost.

$sle_t = sle*t$ (working, 1949). Of these, r is risk-free interest rate; w is storage rates; sle is convenience yield, and sle is a function of inventory level I, which depends on the quantity possessed by all countries and current quantity of exports (Thompson, 1986), $\text{sle} = \alpha I = \alpha \sum_{i=1}^{n} (y^i - q_0^i)$. So $p_t^e = p_0[r\text{t} + w\text{t} + (\alpha \sum_{i=1}^{n} (y^i - q_0^i)]$. Hence, lengthened inventory time will directly raise the expected price.

As for agricultural products, inventory time t is mainly decided by production season *season*: $t=f\ (season)$. In harvest season, the average inventory time is short, but long in non- harvest season. Assuming that inventory costs only include financing costs and warehousing costs:

$$ic^i = c_0(r_t^i + w_t^i) = p_0(r_t^i + w_t^i) = p_0(r^i t^i + w^i t^i)$$

Then Equation (2) can be further written as:

$$\max \pi_i = p_0 q_0^i + \alpha\beta \text{f}(season^i) p_0 (\sum_{i=1}^{n} y^i - \sum_{i=1}^{n} q_0^i)(y_0^i - q_0^i) - pc^i y_0^i \qquad (3)$$

Market is assumed to be an oligopoly market, where each exporting country decides his own quantity of exports q_0^i according to their expectation of other countries' volume of exports q_0^{ej}. The actual export volume of all countries is equivalent to other exporting countries' expectation of their exports amount $q_0^{ej} = q_0^j$ (Cournot,1983). So the world's total export volume is

$q_0 = q_0^i + \sum q_0^j$ ($j \neq i$)

$= \sum_{i=1}^{n} q_0^i$ .We further assume world exporting price is

$p_0(q_0) = p_0(q_0^i + \sum q_0^j) = a - b(q_0^i + \sum q_0^j) = a - b\sum_{i=1}^{n} q_0^i$

, then Equation (3) can be written as:

$$\max \pi_i = (a - b\sum_{i=1}^{n} q_0^i) q_0^i + \alpha\beta \text{f}(season^i)(a - b\sum_{i=1}^{n} q_0^i)(\sum_{i=1}^{n} y^i - \sum_{i=1}^{n} q_0^i)(y^i - q_0^i) - pc^i y_0^i \quad (4)$$

Assuming n symmetric export countries whose response function to other exporting countries is identical. The export level of every country is equivalent, i.e. $q_0^1 = \ldots = q_0^i \ldots = q_0^n$, then Equation (4) can be written as:

$$\max \pi_i = (a - bnq_0^i)q_0^i + \alpha\beta \mathrm{f}(season^i)(a - bnq_0^i)(\sum_{i=1}^{n} y^i - nq_0^i)(y^i - q_0^i) - pc^i y^i \qquad (5)$$

According to first order conditions, we solve the problem as follows

$$x_0^{\mathrm{i}} = f(n,\ season^i, \sum_{i=1}^{n} y^i, y^i) \qquad (6)$$

y_0^i would be highly related to $\sum_{i=1}^{n} y^i$ if it is large, then it may cause multicollinearity, hence, we transform Equation (6) to:

$$x_0^{\mathrm{i}} = f(n,\ season^i, \sum_{j=1}^{n-1} y^j, y^i), j \neq i \qquad (7)$$

We further assume that country *i* exports *k* proportion of its production to the importing country, and the total imports is M_0, then the share of country *i* in the target market is:

$$w_0^{\mathrm{i}} = \frac{kq_0^{\mathrm{i}}}{M_0} = \frac{kf(n,\ season^i, \sum_{j=1}^{n} y^j, y^i)}{M_0} = g(n,\ season^i, \sum_{j=1}^{n} y^j, y^i, M_0), j \neq i \qquad (8)$$

4. Model specifications and data description

As illustrated in Section 3, in harvest season, export profit may be high because the inventory time is short and inventory costs are low. On the other hand, exporting profit may also be low due to large supply. Thus, exporters may expand or reduce export in harvest season, leading their share in importing country's market either increase or decrease in harvest season. The situation in non-harvest season is just the opposite. Export profits and market share are either low due to rising inventory cost or high due to shrinking supply. It can be estimated that net effect of seasonal factors in a country's exports and its market share depends on the relative role of inventory time in inventory carrying costs and in convenience yield. Since an exporting country is unable to increase export price even in non-harvest season in a highly competitive world market, convenience yield may be limited. Net effect of inventory time on a country's exports may be negative. Therefore, market share of one import source may decline during non-harvest season.

In order to investigate these questions, we exploit both time-series and cross-sectional variation in the data and present a series of panel and cross-section regressions that follow our theoretical model.

According to Equation (8), one country's current share in an import market depends on the number (*n)* of import sources, domestic production season(*season*), the number of products possessed by all import sources (y^i and $\sum_{j=1}^{n} y^j$) as well as the importing country's total import amount(M_0). Thus our baseline panel growth regression takes the following form:

$$w_0^{\mathrm{i}} = \beta_0 n + \beta_1 season^i + \beta_2 \sum_{j=1}^{n} y^j + \beta_3 y^i + \beta_4 M_0 + \varepsilon_0^{'}, j \neq i \tag{9}$$

Monthly data span the period 2010 to 2013 on market share, stocks, soybean production season of three major soybean suppliers, the United States, Brazil and Argentina④, as well as the volume of China's soybean imports, including total amount and from three countries. Market share is the ratio of volumes of soybean imports to China from the three import sources to China's total imports. Monthly storage is calculated by annual yield and monthly cumulative harvesting rate. Season is measured by the inverse of average inventory time, which is calculated by production, consumption, inventory, imports and exports of annual data, quarterly data or monthly data of China and the three countries⑤.Inventory time of current month is taken a value of 0 at the beginning of harvest, a value of 1 in the first month after harvesting, 2 in the second month, and so on.

The data are sourced from the United Nations Commodity Trade Statistics Database (UN Comtrade), United States Department of Agriculture Foreign Agricultural Service(USDA - FSA), the Food and Agriculture Policy Research Institute (FAPRI), United States Department of Agriculture Economics, Statistics, and Market Information System, as well as United States Department Agriculture of weekly crop progress report. The shares of the United States, Brazil and Argentina in China's soybean market are approximately 49.18%, 35.92% and 14.39% respectively. The average inventory time for soybean in the three import sources is 6.81 months,

④ The US, Brazil and Argentina are among the 3 major soybean supplier which exceed 25% for China's soybean import from 2000-2012.

⑤ The calculation is as follows: firstly, calculate monthly consumption and market supply according to annual data about consumption and yields. Monthly consumption is equivalent to annual consumption over 12. Monthly market supply equals annual yields multiplied by two-month lagged harvest. Secondly, monthly stock size is derived by quarterly data, among which Brazilian and American data are annual. Monthly storage is the sum of preceding quarterly storage (annual storage for Brazil and the United States), market supply and import volume of preceding month, deducting consumption and export volume of preceding month. Thirdly, average inventory cost of current month = (storage of preceding month * inventory time of current month)/ total storage of current month. Total storage of current month is the sum of storage of preceding month, market supply and import volume of current month.

6.07 months and 4.93 month respectively. The average monthly soybeans yield of the three import source is 7.37 million tons, 4.82 million tons and 4.16 million tons respectively, with their monthly average export volume of 3.24 million tons, 2.57 million tons and 0.79 million tons; and China's monthly average soybean imports volume is 4.55 million tons. The average number of countries that export soybean to China is 5.51. Descriptive statistics of all the variables are seen in Table 1.

TABLE 1 ABOUT HERE

5. Results and discussions

5.1 The impact of Seasonal Factors on the import source distribution

Variables influencing China’s import demand for soybean would directly affect soybean export from US, Brazil and Argentina to China, so random disturbance terms in three soybean market share equations may be related to each other, resulting in autocorrelation problem among three countries. Therefore, we made LM test first to examine the potential problem of within-group correlation. The result rejects the null hypothesis of independence. Next, we selected SUR method again to estimate Equation (9).

TABLE 2 ABOUT HERE

According to Table 2, the model fits data well. The coefficients of the key variable (*season*) in the three market share equations are positive and significant at 1% level, i.e. production seasons have a significant positive effect on the share of three import sources in Chinese soybean import market. As soybean is large in volume, heavy in quantity, but low in price, and difficult to store, its unit value is far lower than industrial products， leading to its inventory carrying costs and transportation costs are relatively high. So saved inventory costs due to large supply are larger than profit margins contained by large supply in production season. In non-harvest season, increased inventory costs due to prolonged inventory time are larger than the increase in convenience yield due to low supply. Long inventory time undermines soybean exports of China's suppliers and their share in China's import market as a whole.

Because The United States is situated in the northern hemisphere, while Brazil and Argentina, in the southern hemisphere. Their production seasons of soybean are different. The United States usually harvests soybean starting from September, while harvest season of the South American countries (Brazil and Argentina) starts from April onwards. After harvest, inventory costs keep rising with long storage time。However, a highly competitive world soybean market, exporters are difficult to adjust exporting prices accordingly， so export profits decline with the prolong period of storage, and exporters have little choice but to steadily reduce soybean supply. In order to maximize profits, American soybean exporters slow down the speed of exports, thus, the export of soybeans is able to continue to next April. Similarly, the South American countries mainly export soybeans from May to September (see Figure 2).[⑥] Eventually China has to gradually change her import sources with the production season in order to meet its total import demand even when exporting prices of the United States, Brazil, and Argentina are nearly identical (see Figure 3). China mainly imports soybean from the United States from October up to next April, and from Brazil and Argentina from May up to September annually (see Figure 4).

FIGURE 2 ABOUT HERE

FIGURE 3 ABOUT HERE

FIGURE 4 ABOUT HERE

American share dropped significantly with the incremental number of import sources in China, meanwhile emerging markets such as Brazil and Argentina gain more shares, weakening the market power of the United States. In the three market share equations, China's soybean imports have a negative effect on American market share, but a positive effect on Brazilian and Argentinean market shares. In other words, fall in demand for American soybeans is offset by expansion in demand for Brazilian and Argentinean soybeans in China's market. China imports more and more soybeans from Brazil and Argentina.

Moreover, the findings indicate that an increase in American yield boosts the share in China and at the same time inhibits the expansion of Brazilian share while Brazilian yield has a weaker negative effect on American share. An increase in Argentinean yield erodes Brazilian share most.

[⑥]Soybean should be harvest, dried, listed after its maturity, so the time of soybean to market is 1-2 months lagged behind its maturity.

The negative effect of Argentina's yield on American share is the smallest. Thus, there is a strongest substitution relation between Brazil and Argentina and the United States in China's soybean import market; substitutions between the United States and Argentina come second. The United States remains a dominant position in China's soybean import market, Brazil second and Argentina the least.

5.2 Robustness Test

5.2.1 The estimation result of PCSE method

In order to examine the robustness of our results we redo the analysis by using a single equation approach. According to Hausman test, amended Wald test, Wooldridge test and Breusch-Pagan LM test, we choose the PCSE method to estimate Equation (9) to obtain a valid estimation.

The results are reported in Table 3. The size and sign of coefficients are consistent with the results in Table 3 as a whole. In particular, production season has a significantly positive relationship with a country's share in China's soybean import market. The market share is significantly higher in harvest season than in non- harvest season. The increased number of import sources and China's total soybean imports decrease the share of one country in China's soybean import market. At the same time, more yields increase the share of one country in China's soybean import market and cripple others' market share. There is substitution relation between import sources in China's soybean import market.

TABLE 3 ABOUT HERE

5.2.2 The impact of import prices on the import source distribution

In order to further identify the vital role of seasonal factors in China's soybean import source distribution, a modified AIDS model is used to analyze China's soybean import source distribution:

$$w_{it} = a_{it} + \sum_{j=1}^{n} \gamma_{ijt} \log p_{jt} + \beta_{it} \log(x_t / P_t) + \varepsilon_{it} \qquad (10)$$

Where w_{it} denotes the share of import source *i* in China's soybean import market; p_{jt} denotes the price of soybean imported by Chin*a* from country *j* (*j = 1, N*); x_t represents total amount of

soybean imported by China. P_t represents Chinese soybean import price levels, calculated by the amended Stone price index (Moschini, 1995).

By the same token, we ran LM test to suggest the rejection of independent conditions⑦. Finally we ran SUR regression to estimate Equation (10). Table 4 shows that equations of the three market shares fit less than 25% and the AIDS model does not fit into China's soybean import source distribution. Coefficients of prices for US soybean, Brazilian soybean and Argentina soybean are mostly not significant, suggesting that soybean prices of import sources do not affect China's soybean demand significantly. This is consistent with our expectations. As international soybean market is highly competitive, soybean export prices of the three countries are very similar to each other, and then have little impact on China's soybean import source distribution.

TABLE 4 ABOUT HERE

Competition of international market provides opportunities for multi-national corporations to participate in international industrial division. Large MNEs have become the main body of grain logistics and trade in the world. In the world soybean market, the ABCD four food dealers⑧, have dominated more than 80% of the supply and the trade of soybean in the United States, Brazil and Argentina. In the supply chain, the four dealers manipulate the production and the acquisition of South American soybean via providing fertilizers, pesticides and other factors of production, as well as loans to soybean farmers in these regions directly. In the meantime, they also control the storage and international transport of soybeans by establishing warehouses, roads, ports and other infrastructure. Therefore, if soybean export price in one country is lower than other countries, four dealers can adjust its soybean export strategy immediately, and export more soybeans from countries with higher prices to China, leading to eventual price convergence.

6. Conclusions and policy implications

This article explores the effect of production season on distribution of import sources based on exporters' decision-making behavior, using monthly data of China and her three major soybean exporters—the United States, Brazil and Argentina from the period 2010 to 2013. Empirical

⑦ $\chi^2 = 27.84$

⑧ ABCD refers to ADM(Archer Daniels Midland), Bunge, Cargill and Louis Dreyfus.

results show that seasonality is an important factor that influences distribution of China's soybean import source. Soybean market share of one country in production season is significantly greater than in non-production season. In non-harvest season, the convenience yield due to the drop of soybean supply is less than the increasing inventory cost caused by the prolonged inventory time in the soybean world market.

Over time, population growth and urbanization raise the demand for food in China. For the purpose of long-term sustainable utilization of international food resources, it is suggestive that China should treat distribution of food import sources strategically. Chinese importers may select foreign suppliers according to seasonal changes of suppliers' countries. Importers should develop a new import source with seasons different to existing sources to avoid single market risk and volatility. In the long term, diversification of production seasons in import sources will guarantee food security of China.

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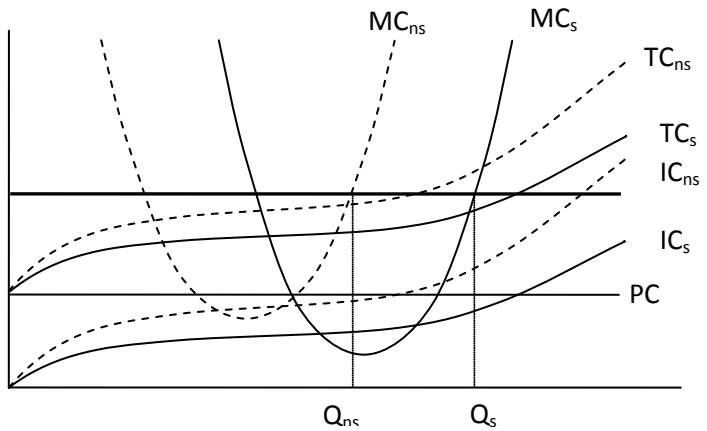

Figure 1: Production Season and Import Source distribution

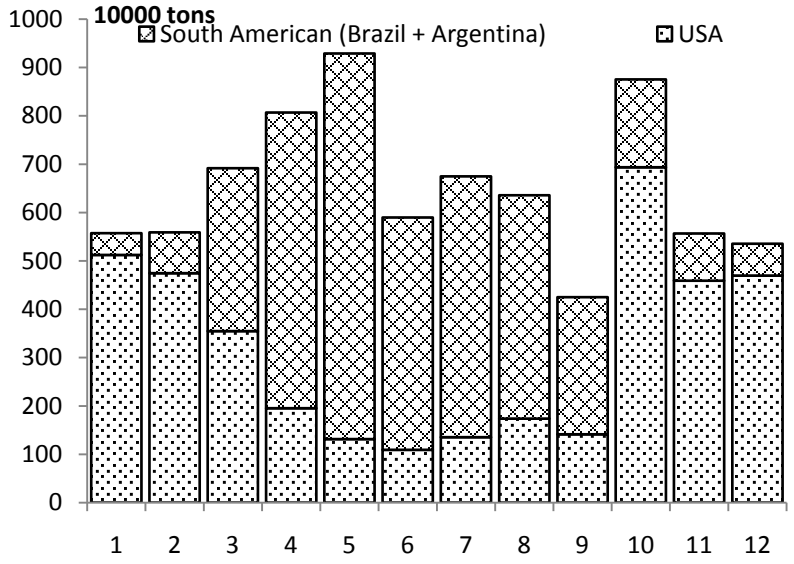

Figure 2: Average Monthly Exports of Soybeans of USA and South America (2010-2012)

Data Source: UN comtrade

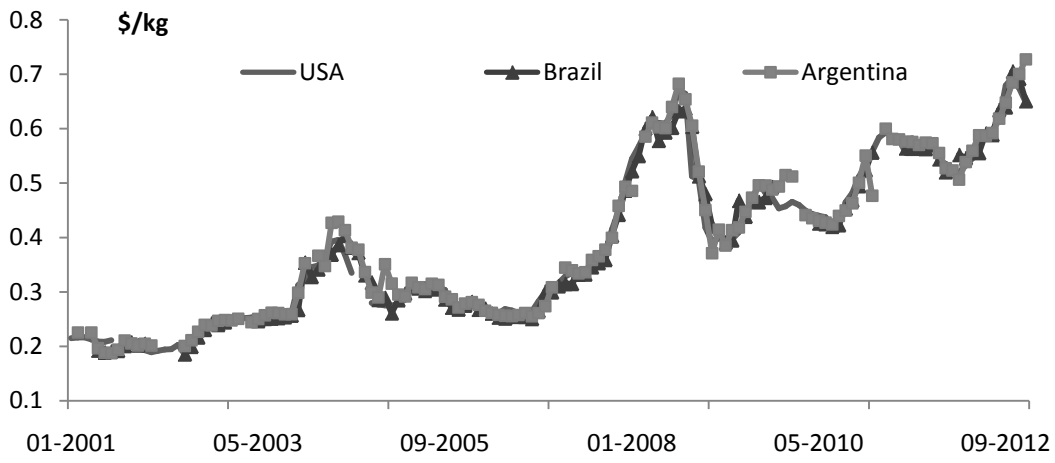

Figure3: China's Soybean Monthly Import Prices (2001-2012)

Data Source: China Customs

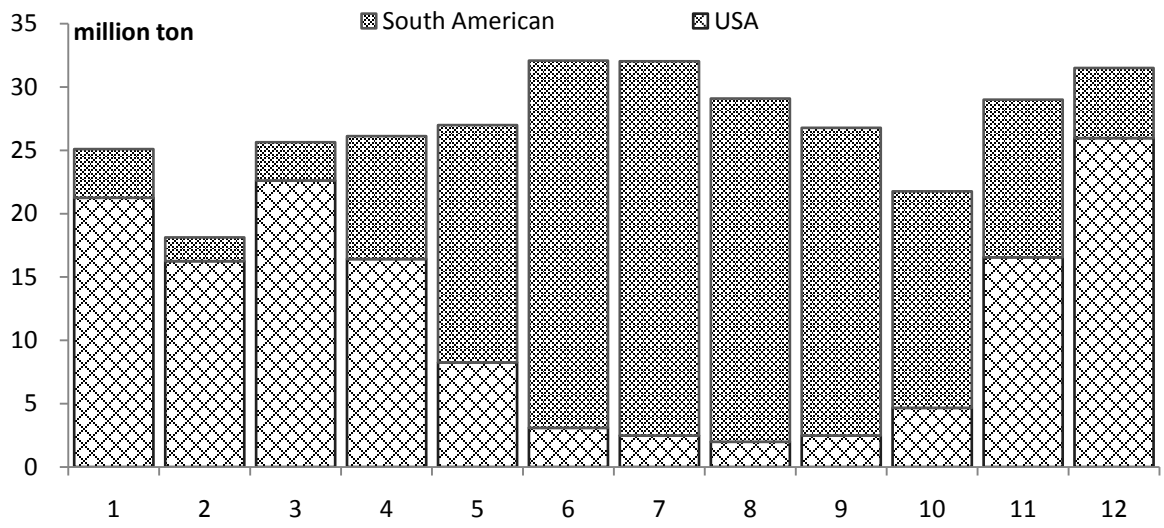

Figure 4: Monthly Import Source distribution for China's Soybean (2001 – 2012)

Data Source: China Customs

Table 1: Descriptive statistics of Variables

Variables	Unit	Mean	Std.	Min.	Max.
w_{0usa}	(%)	49.18	36.90	0.98	99.97
$w_{0brazil}$	(%)	35.92	26.85	0.00	76.18
$w_{0argentina}$	(%)	14.39	14.11	0.00	49.88
t_{usa}	(month)	6.81	6.69	0.00	19.56
t_{brazil}	(month)	6.07	5.88	0.00	39.32
$t_{argentina}$	(month)	4.93	3.91	0.00	11.02
y_{0usa}	(million tons)	7.37	13.50	0.00	36.24
$y_{0brazil}$	(million tons)	4.82	9.73	0.00	35.30
$y_{0argentina}$	(million tons)	4.16	7.19	0.00	22.33
x_{0usa}	(million tons)	3.24	2.06	0.77	8.32
$x_{0brazil}$	(million tons)	2.57	1.95	0.03	7.29
$x_{0argentina}$	(million tons)	0.79	0.84	0.00	2.76
M_0	(million tons)	4.55	0.87	2.32	6.20
n	(no.)	5.51	1.41	2.00	8.00

Data sources： UN comtrade, USDA and FAPRI

Table 2: Estimated results of PCSE method

	W_{US}	W_{Brazil}	$W_{Argentina}$
n	-4.742**	6.308***	5.273*
	(-2.63)	(3.30)	(2.42)
season	3.556***	1.123***	2.327***
	(10.55)	(5.28)	(4.73)
Y_{USA}	0.598	-0.843***	-0.537
	(1.73)	(-2.64)	(-1.63)
Y_{Brazil}	-0.800**	0.388*	-0.521***
	(-3.64)	(2.19)	(-3.56)
$Y_{Argentina}$	-0.172	-0.885*	0.164
	(-0.84)	(-1.82)	(0.97)
M	-3.845	4.277	0.530
	(-1.14)	(1.13)	(0.17)
Constant	118.0***	-16.47	14.75
	(9.40)	(-1.12)	(1.14)
R^2	0.90	0.79	0.48
LM test	8.64(0.03)	between-group autocorrelation	

Notes: (i) * * *, * and * indicate the significance level of 1%, 5% and 10% respectively.

(ii) The value in parentheses is P-value.

Table 3: Estimated results of PCSE method

Variable	Coefficient	Standard error	Z statistics	P value
n	- 0.872	1.205	- 0.72	0.47
season	1.771 * * *	0.326	5.44	0.00
Y_i	0.393 * *	0.169	2.33	0.02
$\sum y_j$	- 0.332 * * *	0.119	- 2.80	0.01
M	- 1.374	1.833	- 0.75	0.45
Constant	- 56.45 * * *	9.833	5.74	0.00
Hausman Test	48.50 (0.00)	Fixed effect		
Amended Wald Test	1.94 (0.58)	With the variance		
Wooldridge Test	25.14 (0.04)	Within-group first-order autocorrelation		
LM Test	8.64 (0.03)	Between-group autocorrelation		
Wald chi^2	68.49 (0.00)			
R_2	0.42			

Notes: (i) * * *, * and * indicate the significance level of 1%, 5% and 10% respectively.

(ii) The value in parentheses is P-value.

Table 4: Estimated results of AIDS model

	W_{US}	W_{Brazil}	$W_{Argentina}$
China's soybean imports expenditure	-1.649*	-0.732	0.745**
	(-0.97)	(-0.87)	(2.10)
USA soybean prices	-8.358	4.158	3.281
	(-5.877)	(0.82)	(1.53)
Brazilian soybean prices	13.008**	-7.019	5.309**
	(5.798)	(-1.40)	(2.51)
Argentina soybean prices	3.437	2.267	-1.154
	(2.982)	(0.88)	(-1.06)
Constant	-772.2	398.0	375.1**
	(-1.56)	(0.93)	(2.07)
R^2	0.24	0.10	0.37
LM test	27.84 (0.00)	between-group autocorrelation	

Notes: (i) * * *, * and * indicate the significance level of 1%, 5% and 10% respectively.

(ii) The value in parentheses is P-value.