Impact of technical barrier on agricultural cost and production: a simulation method

Tao Zhang
Dr. in Economics
Institution: Macao Polytechnic Institute
Address: School of Public Administration A109, Macao Polytechnic Institute, Macao.
E-mail: taozhang7608@hotmail.com

Abstract:

This paper explores possible economic impacts on China’s agricultural producers that would be triggered by compulsorily complying with Japan’s stricter trade standards. Although the impacts of technical measures have been widely acknowledged in developed countries, China lags far behind the developed countries at this point. This paper begins with a discussion of potential effects from the technical barrier on developing countries. Specifically, the paper investigates the potential influence of Japan’s stricter MRL on exports of vegetables in China. Then, it proposes an econometric-simulation framework which could be used to analyze the impacts of pesticide reduction approaches on vegetable cost and production. The model is based on econometric production regressions estimated with spatially referenced, statistically representative samples of farms in China. The research results indicate that a potential accession to Japan’s market with technical barrier would cause great damage to the output and profit of China’s vegetable production under certain efficiency and technology in a short term.

Keywords: Technical Barrier. Cost. Production Function.

1. Introduction

Currently, the structural change in the global agricultural-product trade has been taking place with fruit and vegetables becoming more valued. As a developing country, China faces a substantial opportunity to develop its export-oriented vegetable industry. Traditionally, exports of highly valued food such as fruit and vegetables are beneficial to developing countries, especially, for balancing their international trade. After becoming the member of WTO, the Chinese government has stressed the importance of high-value agricultural products in order to adapt to the new global trade environment. However, the trade performance of developing countries depends on the accession to the markets in developed countries (Henson Spencer; et. al., 2000; Anne-Célia Disdier et. al., 2008).

According to the terms of World Trade Organization agreements, any country can prevent imports that may harm its environment, population, or animals, and any country can forbid its imports from countries whose products may potentially damage or are suspected of...
damaging its environment. Therefore, the technical measures, such as SPS (Sanitary and Phyto-Sanitary measures), are permitted in accordance with the WTO rules, and have been widely adopted (Qiu Zeyuan et. al., 2001; Anne-Célia Disdier et. al., 2010a and 2010b).

As for exports, a developing country must become to recognize that SPS measures are a particularly important issue because consumers are increasingly considering information on the safety and process attributes of food in making their decisions. Demand for healthy and safe food products has been increased, especially in developed countries. However, even though the impacts of technical measures have been widely acknowledged in developed countries, China lags far behind the developed countries at this point.

The quality of some China's agro-products has not met the internationally popular CAC (Codex Alimentarius Commission) Standard on food hygiene. At the same time, in order to gain the access to the markets in developed countries, China’s agro-products would face more formidable requirements which vary from country to country. On the other hand, for lack of environmental awareness, some Chinese industries have already seen their market share abroad reduced. Increasingly formidable technical measures set by import countries have created a pressure on China's agro-product exporters.

Nowadays, the maximal residue limits (MRL) may be one of the most commonly confronted technical measures for China’s vegetable growers and exporters (Yuan Li; John Beghin, 2014; Guoxue Wei et. al., 2012). In 2001 China's tea exports to the European Union dropped by 37 percent on an annual basis because of intensified import MRL criteria of EU (Zhao Yuhong, 2007b). Another important country which imports a large quantity of vegetables from china is Japan, whose vegetable import amounts to 1 million tons per year. As a result, Japan and other developed country’s technical measures have caused an intensive impact on China’s export of agriculture and food products both in terms of economic performance of individual companies and the individual farmers.

Such trade barrier, using harsh technical standards, was also called green barrier. There are some available studies which debate on the green barrier and China. Although most of them discuss the tremendously adverse influence of green barrier on China’s international trade and propose the reformation of China’s domestic production system, nearly none of them provide the detailed evaluation on the impact of such barrier (or conforming to the harsh requirement by these barriers) on China’s own production system.
For example, Wang and Liu in 2007 discussed the green barrier from the standpoint of sustainability (Wang; Liu, 2007). Li Zheng-yue and his colleagues debated on the influence of green barrier on China’s national economy, especially on its international trade (Li Zhengyue et. al., 2009). Zhao Yuhong analyzed the green barrier and China’s trade from the standpoint of law and trade (Zhao Yuhong, 2007a; 2007b). This study, apart from above discussions, further includes a simulation analysis to assess the impact of green barrier on production system. In addition, it applies this simulation model in a case study of vegetable trade friction between Japan and China in recent years.

In 2001, Japan and EU promoted their MRL standards sharply, which resulted in a decline of China’s vegetable exports to these areas. Modifications in the MRL standard of these areas create a long term impact on exports of China’s agriculture and food products. Even though Japanese government insists that Japan regulate only to the extent necessary to protect public health and safety or other legitimate objectives, Chinese growers still consider the new stricter MRL and other standards as discriminatory manner and unnecessary restriction.

After Japan executed the stricter MRL standard to manage the vegetable import in April 2001, China’s export to Japan was severely stifled. For example, in KOUBE Port, there were more than 200 containers inspected every day in 2000, but only 41 in 2001. As a result, the performance of many industrial processors in China had declined. Some of them were bankrupted. Donghe, one of vegetable processors in China, gained at least 60 million Yuan as company’s income in 1998 and exported 3500 tons’ Japanese Onion in 2000. However in 2001 from January to May there were only 400 tons of Japanese Onion exported to Japan for the stricter MRL measures. Donghe had lost about 3 million Yuan in this period.

Confronting the impact that came from the foreign stricter MRL requirement, Chinese specialists began to concern this issue in accordance with common international practices. Therefore, converting China’s domestic production system into the form conforming to international practices or requirements had become a crucial task. Chinese farmers are now learning how to comply with such technical measures. Therefore, the entrepreneurs became to pay more attention to the environmental aspects of their products and some enterprises already greatly enhanced their competitiveness by manufacturing products having high quality and being environmentally sound.

In addition to above awareness, some endeavors have been taken up to improve China’s agricultural structure. Chinese government had pinpointed green food and organic
food as a vanguard to break the technical barrier and therefore boost food exports, even though these products made up only a few percent of total agricultural exports in China. With a greatly improved awareness of the importance of food safety, China’s government is aiming to raise the output of green food and organic food. Meanwhile, the Ministry of Agriculture is considering stipulating a new rule on the quality and safety of agricultural products according to foreign MRL requirement. Therefore, China is going to build a nationwide network providing monitoring, technical services and quality inspection of green food producers.

However, the term "green food" only appeared in China in the past few decades. China’s agricultural sector would still be vulnerable to competition since the applied quantity of pesticides was rather high. Indeed, China has greatly increased the yield of crops during the past several decades as a result of increases in the use of agricultural chemical pesticides. After the 1970s, China’s farmers began to use more pesticides to offset and avoid damage inflicted by insects and diseases.

Therefore, in this period, pesticides were applied primarily based on their efficacy rather than on potential impacts to human health and environment. As a result, pesticide residues have led to widespread health risk to public. For example, in Yangzi river area vegetable growers used about 2-3kg of chemical pesticides for every 667 square meters per farming season. Moreover, some of these growers applied 5kg of pesticides for every 667 square meters per farming season. In the north area of China, for example in Beijing, the vegetable growers applied over 9kg of pesticides for every 667 square meters per farming season.

In a survey by Agricultural Ministry of China in May 2000, 30% of the 1293 samples containing over-tolerance residues were detected. In the same year, for 123 samples detected by Product Quality Monitoring Bureau of China, about 27.6% of them contained over-tolerance residues. In addition, about 26 of the 103 vegetable samples contained violative chemical residues which were not permitted to be used. In another survey by Product Quality Monitoring Bureau of China in 2001, about 47.5% of the 181 domestic surveillance samples had over-tolerance residues. Furthermore, while the rising level of pesticide input certainly had helped raising output, the high levels of pesticide use also had a number of adverse consequences.

The abused use of pesticides creates substantial health impairs in agricultural producers and consumers. China has a high proportion of the population involved in agriculture and there are thousands of pesticide poisonings each year for poor pesticide
handling techniques or unwieldy equipment. Obviously, heavy pesticide input costs farmers’ and consumers’ health as well as the environment.

Therefore Chinese producers have to reduce the pesticide use if they want to make their agro-products satisfying the foreign stricter MRL requirements and the demand of consumers. However, since China’s high vegetable yield comes from the intensive application of chemical pesticides, to reduce the pesticide input would definitely influence the output adversely under certain efficiency and technology. In other words, if the efficiency and technology could be greatly improved, China’s vegetable (or other crops) yield would not be severely influenced even though the pesticide inputs were reduced. Such viewpoint was debated and certified in some other studies (Zhang; Xue, 2005, Zhang, 2008a; 2008b). This study is going to analyze another possible route of pesticide reduction, which is the adverse impact on the output while the technology and efficiency are fixed.

It introduces an input-output production model for evaluating impacts of stricter MRL standard on vegetable plant systems in China. The paper analyzes the impacts of reducing the pesticide use on the China’s vegetable systems for being adaptable to the stricter MRL standards in exchange for the accession to Japan and European Union markets in the short run.

After the desired quantity of pesticide input is specified, the model simulates the impact of reducing pesticide input on the output and profit. We select the cross-sectional data of vegetable plant systems in China. The estimated result could provide decision makers and vegetable growers more options to deal with risks in the marketing process. In addition, with the increasing awareness of adverse consequences caused by high level of pesticide use, China’s consumers promote the demand for healthy and safe food products and thus a stricter MRL standard might also be issued in domestic market in China in the long run.

Therefore, although the main purpose of our paper focuses on the impact of modified production behaviors on output for the satisfaction of ‘green barrier’ in the short run, the estimated result also has some policy implications for the whole vegetable production system in the long run.

2. Simulation Framework

Under the pressure of international competition, China’s growers and pest management practitioners have to consider the side-effect of the pesticide residues. Therefore,
Impact of technical barrier on agricultural cost and production: a simulation method

Zhang, T.

various environmental policies have been proposed. As for pesticide use, there is more than one approach to reduce the pesticide residues.

The biological control agent is probably a reasonable alternative, but it will increase costs and yield weak effect. Another approach is to control the applied quantity of agricultural chemicals, which is a more preferable way.

However, both approaches discussed above have a reverse influence on the output. Meanwhile, in order to circumvent the complex issue in the analysis, the second approach was preferred in the model. As discussed above, such policies aiming at reducing the use of pesticide might influence the output.

Therefore, there should be a negative interaction between effects of production practices and environmental policies. In addition, since the increasing agricultural production in China was accomplished by the large volumes of pesticide input in the past few decades, the impact of reducing chemical input on output might be intensive. However, there is no available method to assess such impacts on the output and profit. Since a farmer’s response to changed profit and output under certain conditions is uncertain, we have to propose some assumptions in order to simplify the quantitative framework.

Under the MRL constraints, the decision-makers are mainly concerned with the uncertainty of economic result. The whole simulation framework is constructed by using a production function to capture the relationship between input and output. Then, after the coefficients were obtained, the impact of a marginal change in pesticide input on the output and profit would be deduced by simulation method.

The simulated output for compliance with reduced pesticide input could be compared with original output value. And, the reverse influence of stricter MRL standard on the output and profit will be debated. In the framework, a hypothesis is proposed that, besides the pesticide input and related labor input, other inputs of planting would not change.

Another fundamental assumption in simulation proceed is that the efficiency and technology levels of production are the same across the period of changing pesticide input. An equivalent way of stating this assumption is that a given level of inputs will produce the same amount of output. If this is the case, then production sets differ across the period only because of differences in inputs.

The production function was defined as \( G = F(x_1, x_2, x_3, x_4, x_5) \). Five inputs in the function include labor, seed, green fertilizer, chemical fertilizer, and pesticide. Since all the data collected are based on the same acreage (one MU in China is equal to about 667 square
meters), the land input is not included in the function. As we want to get the variation of the production, we approximate \( \Delta G \) using an M-Taylor series expansion as

\[
\Delta G = F'_1 \Delta X_1 + F'_2 \Delta X_2 + F'_3 \Delta X_3 + F'_4 \Delta X_4 + F'_5 \Delta X_5 + 1/2 [F''_{11} \Delta X_1^2 + F''_{22} \Delta X_2^2 + F''_{33} \Delta X_3^2 + F''_{44} \Delta X_4^2 + F''_{55} \Delta X_5^2 + 2F''_{12} \Delta X_1 \Delta X_2 + 2F''_{13} \Delta X_1 \Delta X_3 + 2F''_{14} \Delta X_1 \Delta X_4 + 2F''_{15} \Delta X_1 \Delta X_5 + 2F''_{23} \Delta X_2 \Delta X_3 + 2F''_{24} \Delta X_2 \Delta X_4 + 2F''_{25} \Delta X_2 \Delta X_5 + 2F''_{34} \Delta X_3 \Delta X_4 + 2F''_{35} \Delta X_3 \Delta X_5 + 2F''_{45} \Delta X_4 \Delta X_5] \\
\]  

--------- (1)

In this paper we use Cobb-Douglas function which can be written as follows:

\[
F(X) = \prod_{i} X_{i}^{\alpha_{i}} \quad \text{-------(2)}
\]

\( X_i \) represents the input variable. “\( F(X)=G \)” is the output value of vegetables.

We approximate this function using function (1) and to make it simple we divide the approximated function by function (2) to yield the ratio, \( \Delta G/G \). And then, it can be rewritten that:

\[
\Delta G = \left[ \sum_{i=1}^{n} \left( \alpha_{i} \frac{\Delta X_{i}}{X_{i}} \right) + \sum_{i=1}^{n} \left( 0.5 \alpha_{i} (\alpha_{i} - 1) \Delta X_{i}^2 / X_{i}^2 \right) + \sum_{i=1}^{n} \frac{\alpha_{i} \alpha_{j} \Delta X_{i} \Delta X_{j}}{X_{i} X_{j}} + \sum_{i=1}^{n} \frac{\alpha_{i} \alpha_{j} \alpha_{k} \Delta X_{i} \Delta X_{j} \Delta X_{k}}{X_{i} X_{j} X_{k}} \right] \times G \\
\]  

--------- (3)

In this function, \( i=1, 2, 3, 4, 5; \) (i-1)= 2, 3, 4, 5; (i-2)=3, 4, 5 ; (i-3)=4, 5; (i-4)=5.,

Where \( G \) is the output value of the farm plan, \( \Delta G \) is the variation of output value, \( \Delta X_{i} \) is the variation of input, and \( \alpha_{i} \) is the parameter for each variable.

In Chinese agriculture, farmer’s final decisions on total inputs may be influenced intensively by government. In this model we know that the land allocation is the parameter which changes with pesticide input. Therefore, we are interested in the variation of the pesticide input.

However, here, to make above complicated function simple, we assume that when pesticide input \( (X_{5}) \) is reduced the only variable which changes with pesticide input is labor input\( (X_{1}) \). Thus, the function (3) can be simplified as

\[
\Delta G = \left[ \alpha_{1} \Delta X_{1} / X_{1} + \alpha_{5} \Delta X_{5} / X_{5} + 0.5 \alpha_{5} (\alpha_{5} - 1) \Delta X_{5}^2 / X_{5}^2 + \frac{\alpha_{5} \alpha_{5} \Delta X_{5} \Delta X_{5}}{X_{5} X_{5}} \right] \times G \\
\]  

--------- (4)

Thus, the profit can be defined as \( W = G - \Sigma X_{i} \), where \( \Sigma X_{i} \) is the total cost of inputs. Here, \( W \) is profit, \( X_{i} \) is the cost of input, and \( \alpha_{i} \) is the coefficient of variable. The above function can be rewritten as \( \Delta W = \Delta G - \Delta \Sigma X_{i} \). Then, this function can be joined with function (4) to form a new function as follows:

\[
\Delta W = \left[ \alpha_{1} \Delta X_{1} / X_{1} + \alpha_{5} \Delta X_{5} / X_{5} + 0.5 \alpha_{5} (\alpha_{5} - 1) \Delta X_{5}^2 / X_{5}^2 + \frac{\alpha_{5} \alpha_{5} \Delta X_{5} \Delta X_{5}}{X_{5} X_{5}} \right] \times G - \Delta (\Sigma X_{i}) \\
\]  

--------- (5)
Finally, the profit change arises where the variation of production is necessarily related to coefficient, output, inputs and variations of inputs.

This function could be applied to evaluate the economic impact of input change on profit in China’s vegetable plant systems.

3. Data and Model Application

The simulation model is based on econometric production regressions estimated with spatially referenced, statistically representative samples of farms in China. A cross-sectional database for simulation was developed.

Generally, this model should permit concentrating on two data aspects of pesticide use. First, pesticide and other input data – constructing cost per unit area -- drive the model. Second, the intensity of reducing pesticide input in planting vegetable is necessary for simulating the output and profit variations.

The model selects the quantity of the pesticide reduction for satisfying the target MRL. However, although such data are easily obtained from a number of sources in developed countries, it is very difficult to find the relevant data in China. Being different from US and other developed countries where a considerable amount of pesticide residue information is collected by the USDA Pesticide Data Program (PDP) and other monitoring programs, China rarely detects or collects such data.

There are only few field trials conducted to probe possible relationship between residues and the applied amount of pesticides dispersedly in China. Pesticides in these studies are normally applied under the control of researchers and the data of these trials cannot represent the real status. So here, we cite a hypothesis made by Ma Zhiqiang and Wang Wenqiao (Ma; Wang, 2002) that Chinese growers should make a 50%~75% reduction in the quantity of pesticide input in order to meet the stricter MRL requirement.

The input and output data set in the paper covers 20 important regional areas in China. Some areas such as Xizang are not included in the model since they can not represent the overall productivity level in China. The data set is based on the sample survey by state planning and development commission of China in 2012.

The vegetables analyzed in the model include garlic, sweet pepper, potato, cabbage, cucumber, spinach and tomato. All of them are important products for both export and domestic market in China. Labor input is measured as the cost of labor for one farming
season. The labor price is based on the local level when we estimate the production function. Seed input is an essential input in China’s vegetable production, because the price of vegetable seed is greatly higher than grain seed in China. The chemical fertilizer and green fertilizer are also included, both of which are important for vegetables. Pesticide is our target input and the model is concentrated on it.

Using above data, we firstly estimate vegetable production functions. The regression results are used to draw inferences about impacts of reducing pesticide input. According to the model, the production function can be written as follows:

\[ \ln G = \alpha_0 + \sum \alpha_i \ln X_i + \epsilon \]

In this linear function, \( \alpha_0 \) is constant. \( X_i \) represents input variable. Here, we use WLS (weighted-least square) to estimate the function in order to delete the Heteroskedasticity in random errors.

Based on the estimated coefficients for \( \alpha_i \) reported in table 1, we are able to calculate the impacts of pesticide reduction. With the reduced pesticide input, we assume that the only influenced input besides the pesticide input is labor.

4. Results and Implications

The estimated coefficients and t-statistics of seven vegetable breeds are listed in table 1. The coefficients in table 1 show the relationship between output and input. All the coefficients for pesticide input in table 1 are positive, indicating that the increase in pesticide input would result in an increase in the production.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>R-squared</th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garlic</td>
<td>3.734</td>
<td>2.684</td>
<td>0.999977</td>
<td>29171.97</td>
</tr>
<tr>
<td>Bolt</td>
<td>-0.148</td>
<td>-0.546</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td>0.198</td>
<td>1.454</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.923</td>
<td>4.021</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.222</td>
<td>-1.872</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.492</td>
<td>3.610</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.4.6.1. Sweet Pepper

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>R-squared</th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.729</td>
<td>8.425</td>
<td>0.999932</td>
<td>31935.10</td>
</tr>
<tr>
<td>0.246</td>
<td>2.558</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.030</td>
<td>-0.433</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.108</td>
<td>1.828</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.090</td>
<td>-1.174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.330</td>
<td>4.908</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.4.6.1. Potato

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>R-squared</th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.222</td>
<td>4.031</td>
<td>0.999932</td>
<td>31935.10</td>
</tr>
<tr>
<td>0.700</td>
<td>7.754</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.062</td>
<td>1.164</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.253</td>
<td>2.484</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.257</td>
<td>-3.190</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.003</td>
<td>0.051</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This is an important result as it tells us that reducing the pesticide input for conforming to the barrier requirements would surely impair the output and thereby profit. For example, the elasticity ($\alpha_5$) of sweet pepper is 0.33, which implies that a 10% decrease in the natural logarithm of pesticide input induces roughly an increase of 3.3% in the natural logarithm of the output value.

From table1 it is obvious that all the t-statistics of $\alpha_0$ are higher than 2, representing that all the coefficients of $\alpha_0$ are statistically highly significant. Except for the potato, the coefficients of the pesticide input for all other vegetable breeds are statistically significant, indicating that the pesticide has tremendous effects on vegetable production. It also can be discovered that all the coefficients of tomato and cucumber are highly significant and the t-statistics of them are all higher than “3”.

Thus, it could be concluded that the pesticide reduction measures did not have clear influence on potato, which might result from the natural traits of this breed as it did not need a large quantity of pesticides to wipe out insects and virus. The highest t-value of pesticide input coefficients in all seven vegetables comes from cucumber, a breed of vegetable demanding a large amount of pesticides in growing process.
The elasticity values of green fertilizer input are all positive for 7 vegetables, showing that the vegetable growers should increase the green fertilizer input. As discussed above, although the data of 7 vegetable breeds are provided and estimated in this study, only from the estimated result of potato production function it could be found that the pesticide use is manifestly irrelevant with productivity. From this result, the coefficient of pesticide input in its production function is only 0.003 and the t statistic of this variable is highly insignificant.

This result further indicates that reduced pesticide input would not have obvious impact on potato production, and therefore the stricter MRL measures (as a mainly used green barrier) should not influence China’s potato producers greatly.

The specified changes in pesticide input are used in the model to simulate the loss of output value for seven vegetables. Based on the estimated coefficients reported in table1, these simulated output changes could tell us the impacts of reducing pesticide input measures for the satisfaction of the stricter standard obligated by green barrier. In the simulation process, the output change rates are calculated by function (3). Here, we use ratio, dG/G, to represent the variations of output value.

From table 2, all these calculated ratios are negative for seven vegetables, indicating that pesticide reduction measures have had a consistently negative impact on production and thereby implying that under certain input price and production technology the measure of reducing pesticide input will result in a decreased output value in most vegetables.

| Table 2: Impact of reducing pesticide input on the value of output |
|----------------------|------------------|------------------|-----------------|------------------|------------------|------------------|
| garlic              | sweet-pepper     | potato           | cabbage         | cucumber         | spinach          | tomato           |
| ΔG/G 50% pesticide input | ΔG/G 75% pesticide input |
| garlic              | sweet-pepper     | potato           | cabbage         | cucumber         | spinach          | tomato           |
| reducing 50% pesticide input | reducing 75% pesticide input |
| ΔG/G 50% pesticide input | -0.2447          | -0.1757          | -0.0281         | -0.0581          | -0.1247          | -0.1542          | -0.0974          |
| ΔG/G 75% pesticide input | -0.3710          | -0.2634          | -0.0378         | -0.0882          | -0.1866          | -0.2338          | -0.1447          |

Therefore, compared to existing vegetable output in China, the output value and profit of these seven vegetables would be influenced due to such measures. In addition, the measure of promoting the intensity of pesticide reduction from 50% to 75% results in an enhancement in the impact of measures on output value and profit. However, some farmers, such as the growers of potato, may not be suffered severely from the productivity loss, due to natural traits of this crop. One possible method to keep the production and output while reducing
pesticide input for most vegetables is to improve the efficiency or technology greatly. However, it is difficult to obtain such strategic object in the short term.

<table>
<thead>
<tr>
<th>Table 3: Impact of reducing pesticide input on the profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garlic</td>
</tr>
<tr>
<td>ΔW</td>
</tr>
<tr>
<td>ΔW</td>
</tr>
</tbody>
</table>

From table 3, the results of estimation by function (5) revealed that the profits of seven vegetables will also be decreased for the adoption of reducing pesticide use. In addition, from table 2 the impacts of reducing pesticide input on the value of output varied sharply among seven vegetables.

The output losses of cabbage and potato are lower than the losses in the other vegetables, although they are both negative too. Moreover, the impacts of such measures on the profit, listed in table 3, are clear and obvious, especially for garlic, sweet pepper, tomato, and cucumber. Though a similar pattern is observed in other vegetables, the intensities of decrease in profitability for above four vegetables will be substantially higher than those of the other vegetables.

In China, where vegetables (such as garlic or tomato) are farmed in monoculture systems, a 75% decrease of pesticide input in planting sweet pepper for conforming to the stricter MRL requirement will result in a decrease of 592 Yuan in profit per 667 square meters. The profit of sweet pepper in 2012 is about 2000 Yuan per 667 square meters according to our survey. Therefore, a 75% reduction in pesticide use will make growers lose nearly 25% of their profits. Even though changes in nationwide profitability depend on the share of vegetables planted for the export and the demand of the “green food” in total domestic vegetable consumption, after Japan imposed stricter MRL requirement to vegetable imports, the decreased profits of exporting vegetables have led growers and companies in China to invest in other agro-products. The marketing targets of some trade companies and growers in China have been turned to China’s domestic consumers.

Effectively satisfying the target MRL standard requires understanding both the level and the nature of China’s own vegetable plant systems. Although farming systems are
uncertain for achieving the satisfaction of target MRL, most of them would face output loss in order to meet stricter MRL standard. From table 2 it can be discovered that some of vegetable breeds suffer more seriously than the others, such as garlic and sweet pepper. Therefore there is a drawn conclusion that the intensities of impacts on different vegetable breeds would be different.

From table 2 and table 3 it shows that the growers of sweet pepper and garlic should turn to plant potato or cabbage since these two vegetables have the strongest resistance to the adverse influence of pesticide reduction. However, this policy is unpractical for many farmers. As widely recognized, the growth of vegetables is constrained by many natural conditions which cannot be easily changed such as soil and climate. Moreover, for a considerably long period of time, China’s agricultural productivity was rather low due to the planned economy. And therefore, food supply was in a constant state of shortage. The ability to utilize the international market was also confined due to self-sufficient policy.

Thus the basic policy for the government had been to motivate all possible forces to increase output and solve the food security problem in a long run. The transformation of the policy to meet the requirement of foreign standards and harsh demand of green food is a very difficult issue, especially on the level of local governments and farm households. Thus, decision makers in China must think over and balance the problem rather carefully.

One potential method to cope with this problem is to drive the agricultural industrialization. Such method mainly includes the integration of trader, processor and farmers, so as to reduce costs, promote quality, and thereby improve competitiveness. In addition, it is proposed to establish vegetable production base of green products. In these ‘green’ production bases, with the advantage of improving technology and efficiency as well as implementing stricter planting standards, ‘green’ products could be planted.

5. Conclusion

The paper has explored the impacts of environmental measures conforming to stricter MRL requirements on vegetable production in China under the assumption of certain technology and efficiency. It simulates the possible economic effects of MRL restrictions on the vegetable production.

In the case of vegetable exports from China to Japan, the economic impact of prolonged restrictions has been intensified. On the macro level, the international trade and the
whole vegetable production system will obviously be influenced. The paper explores the importance of market accession if China as a developing country is going to exploit opportunities for high—value food exports to developed countries. Indeed, food safety and other technical measures could possibly impose a heavy burden on developing countries due to their constrained ability to comply with. In addition, with the increasing income of China’s domestic consumers and the demand for safer food, such stricter MRL measure has the potential to be concerned in China’s domestic market. For vegetable growers, high-value agricultural product processors and export-oriented industries, this is a particularly important issue.

The paper highlights the pesticide reduction measures and their possible effects. A simulation framework is proposed in this paper to evaluate the economic impacts of these measures on vegetable plant systems in China. From our estimated results, the pesticide reduction measures would have a substantial impact on the output value of vegetables. Furthermore, the estimated result shows that some vegetable breeds, such as garlic and sweet pepper, suffer more severely than the others. It is hoped that this paper and its estimated result could provide decision makers and growers with some useful implications in handling uncertainty and risk in their production and marketing process.

6. References


HENSON, S.; BROUDER, ANN-MARIE; MITULLAH, W. Food safety Requirements and Food Exports from Developing Countries: The Case of Fish Exports From Kenya to The European Union. *American Journal of Agricultural Economics*, v. 82, n. 5, p. 1159-1169. 2000.


YUAN, LI; JOHN, BEGHIN. Protectionism indices for non-tariff measures: An application to maximum residue levels. *Food Policy*, v. 45, p. 57-68. 2014.

ZHAO, YUHONG. Overcoming “Green Barriers”: China’s First Five Years into the WTO. *Journal of World Trade*, v. 41, p. 535-558. 2007a.

