

# Effects of Food Import and Source Diversification on Food Security

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The purpose of this paper is to analyze the effects of food import and source diversification on the stability of food price. The paper shows that high import reliance is helpful to reduce the price variability for banana, pineapple, tomato, spice, poultry meat, wine, maize, and bovine meat, whereas there are some exceptions like cabbage. This means that self-sufficiency for most of the foods is not good for the stability of price.

As for diversification of food import source, diversification is helpful to reduce the variability of import price for banana, pineapple, tomato, spice, poultry meat, wine, apple, grape, orange, tea, pig meat, tobacco, and cabbage. In addition, a country should diversify more its import source in order to stabilize import price when it is importing food from developing countries than when it is importing from developed ones. This is probably because developed countries, with better infrastructure for agriculture, can maintain more stable production and price.

## 1. Introduction

According to economic statistics system of the Bank of Korea, Korean import price index of food jumped up sharply by 36.84% between February 2007 and February 2008, while it went up by 14.98% between February 2006 and February 2007. The fluctuation of food import price as such could cause food security problem. In other words, since a sharp increase of food import price triggers high jump of consumers' food price, those who cannot afford to buy the food will have difficulties in managing their daily lives.<sup>(1)</sup> Food and Agriculture Organization(2003) defined the concept of food security as the problem of availability, accessibility, and price stability for food.<sup>(2)</sup> This paper focused on the price stability of food security.

In order to solve the problem of the current food price stability, voices for increasing food self-sufficiency are growing as one of solutions for it. According to 32<sup>nd</sup> session of committee on

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(1) see 이중웅 · 성명환 · 이규천(2000).

(2) see Food and Agriculture Organization(2003).

world food security in 2006 for follow-up to the World Food Summit in 1996, Japan will increase food self-sufficiency rate for preparing against future food security derived from its high food import reliance. Lee(2008) stated that high food import reliance should be reduced by maintaining appropriate level of food self-sufficiency and food inventory.<sup>(3)</sup> However, maize import price of UK, whose maize import reliance was 91.3% in 2000, was more stable from 2000 to 2005 than that of Philippines whose maize import reliance was 9.7%.<sup>(4)</sup> This case shows opposite phenomenon from those arguments. Therefore, whether food security can be obtained through the strengthening of food self-sufficiency is an empirical problem.

There may be another solution for the food price stability: diversification of food import source. Lee(2000) stressed that diversification of import source needs to be regarded as one of various means to enhance Korea's food security.<sup>(5)</sup> Caribbean Food and Nutrition Institute and Food and Agriculture Organization(2007)<sup>(6)</sup> used Herfindahl Hirschman Index<sup>(7)</sup> to investigate how much food import sources of Caribbean countries are diversified. However, none of the previous researches investigated the causality between the diversification of food import source and the stability of food import price. Accordingly, securing food price stability through the diversification of food import source needs to be tested through an empirical analysis.

The objective of this paper is to investigate the effects of import reliance and diversification of import source on food security in terms of food import price. The paper introduces a theoretical framework in section 2, and demonstrates the empirical evidences through world data in section 3. A brief conclusion is offered in section 4.

## 2. Theoretical framework

Food security could be approached by three dimensions such as 'availability', 'accessibility', and 'stability'. If the concepts of food security are taken into account with food trade, the

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(3) see 이근태(2008).

(4) Own estimation from data of Food and Agriculture Organization.

(5) see 이채욱(2000).

(6) Caribbean Food and Nutrition Institute and Food and Agriculture Organization(2007).

(7) As an index made by Orris C. Herfindahl and Albert O. Hirschman, it is defined as sum of the squares of the market shares of each individual firm. It is used as a measure of the size of firms in relationship to the industry and an indicator of the amount of competition among them.

implications are as follows.

If a country is short of food supply due to deficiency of supply vis-a-vis demand, the country can improve food availability by importing the food it needs. Furthermore, the consumers of the country also get benefits from lower food price. This is closely related to food accessibility. Considering the production cost, it can be more costly to produce the food needed for consumption than to import it. If the country produces the food, food price may be higher. Consequently, the number of consumers who cannot afford to buy the food may increase more than in case of importing the food. Therefore, food trade is helpful for food accessibility.

By the way, although food trade gives those benefits in terms of food security, it also yields side effects. The more the country depends on food import, the more vulnerable it is with respect to exporter's uncertainties such as those related to reduction of production due to climate change or export ban derived from maintaining stability of domestic supply. In other words, food import may be unfavorable for price stability. <Table 1> shows the relationship between food trade and food security.

Another concept we want to adopt to analyze food security is 'Modern Portfolio Theory' adopted by Markowitz(1952).<sup>(8)</sup> Although the theory is related to financial issue, it can be useful to explain the relationship between diversification of food import source and stability of food import price. The theory models an asset's return as a random variable, and models a portfolio as a weighted combination of assets so that the return of a portfolio is the weighted combination of the assets' returns. Moreover, a portfolio's return is a random variable, and consequently has an expected value and a variance. Risk, in this model, is the standard deviation of return. A risk averse investor can reduce portfolio risk simply by holding combinations of instruments which are not perfectly positively correlated. In other words, investors can reduce their exposure to individual asset risk by holding a diversified portfolio of assets. Diversification will allow for the

**<Table 1> Relationship between food trade and food security**

	Food security		
	Availability	Accessibility	Stability
Food trade (Import)	Helpful	Helpful	Unfavorable

(8) see Markowitz(1952).

same portfolio return with reduced risk.

An analogy can be made with respect to food security. Food security means low risk or low standard deviation of import price. An import source is a risk asset supplying food at random price. The prices offered by different sources are not perfectly correlated. Importing country may enhance food security, that is, reduce the standard deviation of food import price, by diversifying the source of food imports. According to the theory, food import price of a country is more unstable if it relies on a single import source, and more stable as it diversifies into various import sources whose prices are not positively correlated. The assumption is that the foods supplied by various countries are not perfect substitutes due to distance and quality, and therefore, they are not perfect substitutes.

Furthermore, whether the sources of food imports are developed countries or developing ones, is a very important factor that determines the stability of food import price. High diversification of food sources is more important for stability of food import price when the exporters are developing countries. There are two reasons for this. First, since developing countries' infrastructure is less developed than that of developed countries, their production is less stable and more uncertain. That is, the risk is higher. Therefore, when a country imports food from developing countries, it should import from a larger number of countries to ensure the stability of food import price. Second, the supply prices of developed countries can have a higher positive correlation with each other than those of developing countries. This is because the arbitration is more efficient in developed countries and the food market is more integrated.

### 3. Empirical Analysis

To analyze the effect of food import and diversification of import source on the stability of import price, we employed the standard deviation of the rate of change of food import price as dependent variable. As independent variables, we adopted food import reliance (IMR) calculated as the share of imported food in domestic food supply, and Herfindahl Hirschman Index (HHI) as a proxy for diversification of food import source. The index is originally used as a measure of the size of firms in relationship to the industry and as an indicator of the amount of competition among them. In other words, it addresses the degree of market concentration. In terms of food import source, it means how concentrated is the import source of a food importer. After all, it

measures the degree of diversification of food import source. Accordingly, high value of the index means low diversification of food import source.

The standard deviation of the rate of change of food import price and import reliance (IMR) were calculated using data from FAOSTAT. HHI was calculated with data from UNCOMTRADE. It was based on the SITC 3 digits of Revision 3. Since the product code adopted by the FAOSTAT is quite different from that of UNCOMTRADE, we selected only those products whose codes in FAOSTAT can be easily matched with the food classification of UNCOMTRADE.

The period covered to calculate the dependent variable was from 2000 to 2005. For the independent variables, we used the data of the year 2000 in order to investigate how the level of food import reliance and diversification of food import source for a country in 2000 affected the dependent variable since then.

In the case of cereals, wheat, rice, barley, maize, oats, and rye were included in the analysis. In the results of <Table 2>, we reported only the regressions with one independent variable because of the problem of multicollinearity. In the regressions where IMR was used as independent variable, only maize was significant. If maize import reliance increases by 0.1, its standard

<Table 2> Cereals

product	Ind. Var.: IMR			Ind. Var.: HHI		
	coefficient	R <sup>2</sup>	# obs	coefficient	R <sup>2</sup>	# obs
Wheat	0.152 (0.762)	0.007	87	0.218 (0.726)	0.006	87
Rice	-0.186 (-0.372)	0.001	121	0.144 (0.164)	0.000	121
Barley	0.761 (1.752)	0.043	71	-0.594 (-0.894)	0.011	71
Maize	-0.471** (-3.138)	0.068	136	-0.064 (-0.254)	0.068	136
Oats	-0.233 (-1.192)	0.021	69	0.301 (0.899)	0.012	69
Rye	-0.015 (-0.043)	0.000	49	0.675 (1.114)	0.026	49

\*: significant < 0.05, \*\*: significant < 0.01.

deviation of the rate change of import price decreases by 0.0471. In other words, the more a country relies on maize import, the more stable its maize import price is. When HHI was included as independent variable, none of the cereals reported significant results. It means that diversification of cereal import source does not affect stability of cereal import price.

In the case of fruits, apple, grape, orange, banana, and pineapple were selected. <Table 3> shows the regression results for fruits, which are quite different from those of cereals. When we employed IMR as independent variable, the coefficients of banana and pineapple are significant with the expected sign. If import reliance of banana and pineapple increases by 0.1, the standard deviation of the rate of change of import price decreases by 0.0482 for banana and by 0.0342 for pineapple. In other words, the more a country relies on import of banana and pineapple, the more stable are their import prices. Using HHI as independent variable, the coefficients are significant for all the fruits. If Herfindahl Hirschman Index for apple, grape, orange, banana and pineapple increases by 0.1, the standard deviation of the rate of change of import price increases by 0.0252 for apple, by 0.0612 for grape, by 0.0424 for orange, by 0.038 for banana, and by 0.0435 for pineapple. It means that the more a country diversifies the import source, the more stable is its fruit import price.

For vegetables, we selected cabbage, potato, tomato, and leguminous plant. <Table 4> shows

<Table 3> Fruits

product	Ind. Var.: IMR			Ind. Var.: HHI		
	coefficient	R <sup>2</sup>	# obs	coefficient	R <sup>2</sup>	# obs
Apple	0.078 (1.507)	0.018	125	0.252** (3.185)	0.076	125
Grape	0.134 (1.162)	0.012	113	0.612** (2.933)	0.072	113
Orange	-0.124 (-1.385)	0.020	95	0.424** (3.044)	0.091	95
Banana	0.482** (-4.548)	0.250	64	0.380* (2.064)	0.064	64
Pineapple	-0.342** (-3.527)	0.147	74	0.435** (3.535)	0.148	74

\*: significant < 0.05, \*\*: significant < 0.01.

**<Table 4> Vegetables**

product	Ind. Var.: IMR			Ind. Var.: HHI		
	coefficient	R <sup>2</sup>	# obs	coefficient	R <sup>2</sup>	# obs
Cabbage	0.420* (2.304)	0.065	78	0.604* (2.391)	0.070	78
Potato	-0.144 (-0.584)	0.003	127	0.025 (0.066)	0.000	127
Tomato	-0.451** (-2.717)	0.078	89	0.614** (2.787)	0.082	89
Leguminous	0.326 (1.463)	0.046	46	0.472 (1.147)	0.029	46

\*: significant < 0.05, \*\*: significant < 0.01.

**<Table 5> Tropical products**

product	Ind. Var.: IMR			Ind. Var.: HHI		
	coefficient	R <sup>2</sup>	# obs	coefficient	R <sup>2</sup>	# obs
Coffee	-0.283 (-1.107)	0.009	137	0.750 (1.780)	0.023	137
Tea	-0.107 (-0.956)	0.007	139	0.353* (2.203)	0.034	139
Spice	-0.176* (-2.578)	0.078	81	0.390* (2.155)	0.056	81

\*: significant < 0.05, \*\*: significant < 0.01.

the regression results for vegetables. In the case of tomato, both import reliance and diversification of import source reduced the variability of tomato import price. However, in the case of cabbage, diversification of import source reduced the variability of import price, but import reliance didn't. In the case of potato and leguminous, import reliance or diversification of import source did not have any significant effect on the standard deviation of the rate of change of the import price.

As for tropical products, we chose coffee, tea, and spice. <Table 5> shows the regression results for tropical products. Even if import price variability of coffee did not react sensitively with respect to import reliance or diversification of import source, that of tea and spice did. As

expected, import price variability of tea and spice reduced with import reliance and diversification of import source.

In the case of meats, for which bovine meat, pig meat, and poultry meat were selected, most of the coefficients showed the expected sign, but only that of bovine meat with respect of IMR was statistically significant. As shown in <Table 6> the others were at best marginally significant.

In the regression of other products in <Table 7> like egg, wine, and tobacco, wine showed a marginally significant coefficient with a t-value of -1.905. Import price variability of tobacco did not reduce with import reliance but reduced with higher diversification of import source.

Overall, diversification of import source was not very useful to reduce the instability of import price for the case of cereals, but it was for the case of fruits. This is strange as the import price of cereals fluctuates more than that of fruits. As shown in <Table 8>, the standard deviation of the

<Table 6> Meats

product	Ind. Var.: IMR			Ind. Var.: HHI		
	coefficient	R <sup>2</sup>	# obs	coefficient	R <sup>2</sup>	# obs
Bovine meat	-0.461* (-2.138)	0.035	129	0.210 (0.846)	0.006	129
Pig meat	0.019 (0.129)	0.000	84	0.200 (1.839)	0.040	84
Poultry meat	-0.216 (-1.932)	0.029	127	0.233 (1.813)	0.026	127

\*: significant < 0.05, \*\*: significant < 0.01.

<Table 7> Others

product	Ind. Var.: IMR			Ind. Var.: HHI		
	coefficient	R <sup>2</sup>	# obs	coefficient	R <sup>2</sup>	# obs
Egg	-0.673 (-1.735)	0.026	117	-0.035 (0.000)	0.026	117
Wine	-0.138 (-1.905)	0.026	138	0.272 (1.879)	0.025	138
Tobacco	-0.370 (-1.703)	0.025	114	1.126** (3.786)	0.113	114

\*: significant < 0.05, \*\*: significant < 0.01.

**<Table 8> Average standard deviation of the rate of change of import price for cereals and fruits**

		Value
Cereals	Wheat	0.56
	Rice	0.87
	Barley	0.82
	Maize	0.55
	Oats	0.52
	Rye	0.73
Fruits	Apple	0.27
	Grape	0.34
	Orange	0.34
	Banana	0.34
	Pineapple	0.30

\* Source: own estimation from FAO data.

rate of change of import price of cereals is higher than that of fruits. As the import price fluctuates a lot, we would expect that the risk could be reduced by diversifying the import source. However, if the price change is correlated across import sources, this risk is a non-diversifiable risk.

It was shown that import price for 13 out of 24 foods could be made stable through diversification of food import source. Another question is whether the effect of diversification on the stability of import price varies depending on the exporting countries. The answer is that when a country is importing food from developing countries, it should diversify more its import sources in order to stabilize the import prices, whereas if the country is importing food from developed countries, it does not have to diversify so much. This may be because developed countries have much better infrastructure for agriculture than developing countries, and therefore they can maintain a more stable production and price.

In order to prove this argument, import sources were divided into developed countries and developing countries to investigate the distinct effects for them. For developed countries, the 32 countries were selected according to IMF classification while the rest of the countries were considered as developing countries. In <Table 9>, the dependent variable is the same as before: the standard deviation of the rate of change rate of import price. Independent variables are one Herfindahl Hirschman Index for developed countries and another for developing countries.

**<Table 9> Results for testing price stability according to kind of import source**

product	Ind. Var.: HHI(developed)			Ind. Var.: HHI(developing)		
	coefficient	R <sup>2</sup>	# obs	coefficient	R <sup>2</sup>	# obs
Banana	0.183 (1.312)	0.038	46	0.319 (1.817)	0.053	61
Cabbage	0.159 (0.722)	0.008	71	0.812** (2.859)	0.098	77
Tea	0.454** (2.769)	0.056	132	0.357* (2.189)	0.034	138
Poultry meat	0.045 (0.633)	0.004	113	0.290 (1.930)	0.031	120
Tobacco	0.132 (0.840)	0.007	103	0.574* (2.400)	0.050	112

\*: significant < 0.05, \*\*: significant < 0.01.

The products included in the regression were banana, cabbage, tea, poultry meat, and tobacco, which are representative products for each food category and selected among the 13 foods for which diversification of import source are significant for stability of import price. When we employ the HHI for developed countries, only tea shows a significant coefficient. It means that diversification of import sources among developed countries is helpful to reduce price variability only for tea and not for the other products. However, if we employ the HHI for developing countries, the coefficients of all the products were significant or at least marginally significant. This means that the diversification of import sources among developing countries is helpful to reduce the price variability. This may be either because the export price of developed countries is stable or because the export price of developed countries moves together, so the risk cannot be significantly reduced by diversification.

#### 4. Conclusion

Because of the recent increase in food price, many scholars emphasized the importance of food self-sufficiency or diversification of import source to enhance food security. However, there is no empirical study about how food self-sufficiency or diversification of import source

affects the stability of food price.

This study showed through an empirical test that high import reliance is helpful to reduce the price variability for banana, pineapple, tomato, spice, poultry meat, wine, maize, and bovine meat whereas there were some exceptions like cabbage. In other words, self-sufficiency for most of the foods is not good for the stability of price.

As for diversification of food import source, diversification is helpful to reduce the variability of import price for banana, pineapple, tomato, spice, poultry meat, wine, apple, grape, orange, tea, pig meat, tobacco, and cabbage. In addition, a country should diversify more its import source in order to stabilize import price when it is importing food from developing countries than when it is importing from developed ones. This is probably because developed countries, with better infrastructure for agriculture, can maintain more stable production and price.

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## References

- 이근태(2008) : “국제 농산물 가격 상승의 원인과 전망,” *LGERI report*.
- 이재욱(2000) : “21세기 세계식량수급의 전망과 과제,” 『농촌경제』, **32**, **9**.
- 이중용 · 성명환 · 이규천(2000) : “21세기 식량안보 확보방안,” Korea Rural Economic Institute.
- 최기현(2004) : “식량자급률 목표 설정 방안 연구: 추진방향과 과제를 중심으로,” Korea

- Rural Economic Institute.
- \_\_\_\_\_ (2008): “우리나라의 식량자급 실태와 자급률 제고방안,” 『농어촌과 환경』, **99**.
- Caribbean Food and Nutrition Institute, and Food and Agriculture Organization(2007): *Vulnerability and Food and Nutrition Security in the Caribbean*.
- Food and Agriculture Organization(1983): “World Food Security: A Reappraisal of the Concepts and Approaches,” *Director General’s Report*, Rome.
- \_\_\_\_\_ (2003): *Trade Reforms and Food Security*.
- Gollop, Frank M., and James L. Monahan(1991): “A Generalized Index of Diversification: Trends in U.S. Manufacturing,” *The Review of Economics and Statistics*, **73**, 318-330.
- Hirschman, Albert O.(1964): “The Paternity of an Index,” *The American Economic Review*, **54**, **5**, 761.
- Markowitz, Harry M.(1952): “Portfolio Selection,” *Journal of Finance*, **7**, **1**, 77-91.
- McCalla, A. F.(1996): “Agriculture and Food Needs to 2025: Why We Should Be Concerned,” Consultative Group on International Agricultural Research.
- Moore, Eric(2001): “Measuring Economic Diversification,” Oregon Employment Department, OLMIS.