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ARTICLE

An Approach of Reducing Overall Level of Export Fluctuations of the Export-oriented Countries

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ABSTRACT

Overall level of export fluctuations of the export-oriented countries with rising export volume partly stem from the market failure caused by free choice of export enterprises, some government intervention thus may be necessary. To reduce the level of fluctuations of the export growth rates in these countries, this paper, taking the significant differences of the exports among various markets into account and thus using a new index named relative variance to measure the export volatility risks, proposes a model of merchandise market portfolio, a modified version of Markowitz model, available to provide explicit guidelines for the firms, the industries and even the whole country to optimize the structure of their export markets. An application of this model to the case of China's apple is then discussed. The results show that the market share of China's apple in 7 sub-markets should be redistributed drastically.

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1. Introduction

Many export-oriented countries such as Asian Tigers and China, in recent decades have experienced rapid economic growth, in which the export trade based on their comparative advantages played vital roles. With a rapid growth rate, however, the export trade of these countries undergone a high level of volatility, and further adversely affected the national income and employment. Take China as an example, its export enjoyed a high average yearly export growth rate, that is, 13.8% between 2001 and 2017, but the annual growth rates varied significantly. The highest annual growth rates were as high as 35.4% in 2004, while the lowest rates were -16% in 2009. Therefore, it is of great practical significance to reduce the export risks that the export-oriented countries face.

With the goal of reducing the level of export fluctuations, many earlier studies generally suggested to "enter new markets". But they did not recommend any practical solutions on how to open and assign the explicit export proportion in every market [1,5,12,21,23]. Geographic concentration is an important index to measure the degree of market diversification. The viewpoint that too high geographic concentration would cause export instability, has become an important basis of the export market diversification strategy made by many countries' policy makers [1,21]. However, the relation between geographic concentration and export stability is uncertain, theoretical-

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ly.① In fact, some empirical analyses showed that lower geographic concentration contributed to the stability of export earnings [6,10,19,20], while other studies demonstrated that the relation between them was not significant or even negative correlation [11,16,17,18,22].

Theoretically, the export growth rate of a product will be affected by many systematic and non-systematic factors. In terms of the non-systematic factors, Cai [4] found that due to incomplete information, externalities and high coordination costs, in the "free choice" of export destinations, export enterprises caused the market failure, which will aggravate the overall fluctuation level of the whole industry's exports. In other words, for an export-oriented country, the overall level of export fluctuations partly stem from separate and free choices made by export enterprises.

Hence, to reduce the overall level of export fluctuations, the government of the export-oriented country needs to optimize the structure of their export markets, namely, to determine the optimal export share of each market. This goal is quite similar to the one of stock investors who try to choose optimal portfolio that may minimize return volatility. Further, the modern portfolio theory developed by Markowitz [13,14] may provide a solution on this optimization, theoretically. The work by Hirsch and Lev [6], first linking Markowitz's theory to the question of export market diversification, just tested and supported the point that the diversification would be conducive to the stability of export earnings. Then, Board et al. [2,3], Kennedy [9], Jang and Chen [7] used different "return" variables such as the bed-night, the growth rate of tourism revenue and the number of tourists, to study Spain, Ireland and Taiwan's efficient portfolioes of tourist markets respectively. These earlier studies, ether didn't take the striking differences between "returns" from various tourist markets into account, resulting that the levels of fluctuations measured by variance are not comparable, or failed to classify various markets according to their fluctuation characteristics, resulting that risks in some markets are overestimated.②

This paper, taking the significant differences of exports among various markets into account and then using a new index named relative variance to measure export volatility risk, first proposes a merchandise market portfolio model, that is, a modified version of Markowitz model which has been published more than half a century, and been applied to so many fields except the diversification of merchandise export markets. This model is a practical tool to offer the policy makers of export-oriented countries explicit guidelines for risk management in the export trade. Moreover, we make a case study of China's apples. In detail, we divide all export markets of China's apples into 7 sub-markets, and explore the growth rates of export quantity in these markets during 2001-2017, then apply our model to estimate the efficient market portfolio. Each market portfolio is associated with a given expected export growth rate and a corresponding lowest level of instability.

This paper is organized in the following sections: The next section introduces a new index named relative variance measuring volatility risks in export markets, and proposes a model of export market portfolio aiming to stabilize the growth rate of export volume. Section 3 shows a process of empirical study about the optimal market structure of China's apple based on the model in the section 2. The final section concludes this study and offers some further discussion.

2. Relative Variance and a Model of Export Market Portfolio

As discussed in section 1, quite similar to choosing the optimal portfolio in finance investment is assigning the market share in each export market to minimize volatility risks. Thus, borrowing the modern portfolio theory for selecting the optimal export market portfolio is theoretically feasible.

If simply copying the approach of Markowitz - measuring volatility risks by variance, the following three problems would occur: Firstly, it is generally held that the concept of variance is not suitable to measure and compare the degree of volatility of data series with significant different levels. However, the mean values of export volume (or export growth rate) among export markets, often show significant differences. Hence, in order to correctly compare the degree of volatility of data series with significant different levels, the influences from the different levels of mean values should be eliminated. Secondly, the significant differences of exports among various markets, undoubtedly resulting in the significant differences of risks measured by the variance among export markets, are likely to lead to the variances of market portfolio trending upwards even unbounded, theoretically ;③ Thirdly, for

① If demand in each market remains fairly constant, even high geographic concentration would not cause significant fluctuations in export earnings. If demand in each market is so volatile and highly positive correlation with each other, even low geographic concentration would lead to significant export fluctuations.

② For Instance, in Jang and Chen's study, the number of tourist arrivals from some countries fluctuated around a certain mean value, while others had obvious increasing or decreasing trends. For the former kind of fluctuation, choosing the number of tourist arrivals as "return" variable as authors did is reasonable. But for the latter two kinds, if still choosing the same variable, export risks would be overestimated.

③ Markowitz (1959) suggested that, if variances of all securites are sorted according to their numeric values, the variance of the 100th kind security is not much larger than the 50th kind, and the 200th kind not than the 100th kind. Thus, it rarely happens that the security portfolio variance tends to rise even be unbounded.

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a certain stability goal associated with a given expected export volume (or export growth rate), the export market with larger variance will be assigned less market share, while the market with smaller variance more market share. However, the scale of market with smaller variance is often too small to import this share. Thus, it is not appropriate to use variance to measure the volatility risks faced by exporting country. To solve these problems mentioned above, we will propose a new index named relative variance, as an alternative to variance, to measure export risks.

2.1 The Relative Variance

Unlike the concept of variance that simply measures the degree of dispersal of a data series around its mean value, the coefficient of standard deviation, equal to the standard deviation divided by its mean value, measures relative dispersal of a data series around its mean value, and eliminates the influences from the different levels of mean values. Similar to the implication of coefficient of standard deviation, we define a new index, that is, relative variance as following:

$$S\ (r) = E(\frac{r-\bar{r}}{\bar{r}})^2,$$

Where $S(r)$ represents the relative variance of the data series r, $\bar{r}$ is the mean value of series r, and $\bar{r} \neq 0$. In the numerical aspect, relative variance is equal to the square of coefficient of standard deviation, avoiding the complex situation of comparing the degree of relative dispersal between series with two kinds of mean values: positive and negative. Clearly, greater relative variance means greater degree of relative dispersal. In addition, according to the definition of relative variance, we can get a proposition as following:

Proposition 1: *$\sum_{i=1}^{N} r_i X_i$ is the weighted sum of N data series, where r_i represents series i, X_i the weigh, let $S(\sum_{i=1}^{N} r_i X_i)$ and $V(\sum_{i=1}^{N} r_i X_i)$ denote relative variance and variance of this weighted sum, respectively. If $\sum_{i=1}^{N} X_i \bar{r}_i = A$, where A is a constant not equal to 0, then $S(\sum_{i=1}^{N} r_i X_i) = \frac{1}{A^2} V(\sum_{i=1}^{N} r_i X_i)$.*

This proposition, revealing the connection between relative variance and variance, is an important step towards proposing the following export market portfolio model. By the inductive method, a formal proof of this proposition is not complicated, so we ignore it.

The nature of relative variance, coupled with significant differences of exports among various markets, makes us view relative variance rather than variance as a more suitable index to measure the volatility risks. The reasons are as following: relative variance provides a more meaningful basis for comparison of risks through eliminating the influences from the different levels of mean values; the differences of risks measured by relative variance, on the other hand, will be lower than by variance, which theoretically reduces the likelihood that the variance of market portfolio tends to rise even be unbounded.

2.2 The Model of Export market Portfolio

With obvious rising tendency of the export volume, the risks facing the export-oriented countries mainly come from the fluctuations in the growth rate of exports rather than the fluctuations in the export earnings or the level of exports. Moreover, there often are significant differences of average yearly export growth rates among various markets. Therefore, different with the modern portfolio theory where Markowitz viewed return rate as expected return variable, here we view the growth rate of exports as expected variable,[①] and measure export risks by its relative variance.

According to Proposition 1, to minimize risks of fluctuations of expected export growth rate, the objective function of the export-oriented country and its constraint conditions can be expressed as:

$$Min\ \mathrm{M_p} = \frac{1}{R_p^{\ 2}}(\sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{k=1 \\ k \neq i}}^{N} X_i X_k \sigma_{ik})$$

$$s.t\ R_P = \sum_{i=1}^{N} X_i \overline{R_i}$$

$$\sum_{i=1}^{N} X_i = 1$$

$$b_i \geq X_i(1+\overline{R_i})/(1+R_p) \geq 0 \quad (i=1, 2, \ldots N)$$

Where M_P is the risk level of export market portfolio based on relative variance; X_i the share of market i in the portfolio when calculating the expected growth rate of ex-

① If we view the export volume with obvious tendency as expected variable, and measure the risks by its fluctuations, the outcome would be clearly overestimated.

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port market portfolio; σ_i^2 the variance of export growth rate in market i; σ_{ik} the covariance of growth rate between market i and market k; $\overline{R_i}$ the average growth rate in market i; R_p the expected growth rate of export market portfolio.

With X_i not involving export increment, the optimal share in market i needs to be computed. Suppose that B refers to all expected export volume, among which C is the expected incremental export volume. Then, the expected growth rate R_p can be expressed as C/(B-C), and the form of expected export volume in market i is $X_i(B\text{-}C) + X_i\overline{R_i}$ $(B\text{-}C)$. Hence, the optimal share in market i is $Y_i=X_i(1+\overline{R_i})/(1+R_p)$. Similar to the restriction on short selling in financial markets, we impose nonnegative condition on Y_i, meaning the situation that exporting country acts as trade intermediary has not been taken into account. Finally, b_i refers to the highest possible share in market i.

3. The Efficient Portfolio of China's Apple Export Markets

As the largest country of producing apple and one of main exporters all over the world, China has seen a rapid growth trend of its export volume since the 1990s. Total apple export quantity increased from 304 thousand tons in 2001 to 1,340 thousand tons in 2017, with an average growth rate of 9.7%. Across the world are the destinations of China's apple, the amount of which has been close to 100 countries (regions) in 2017. Nonetheless, a large market share of China's apple was still concentrated on a handful of destinations. For example, since 2001, the market share in 15 economies consisting of the 10 ASEAN countries, Japan, Korea, Macao, Hong Kong and Taiwan has long been more than 45%. On the other hand, the exports of China's apple have undergone a high level of volatility.

From the perspectives of both geography and trade relationship, all export markets of China's apple can be divided into 7 sub-markets, which include 15 Asian economies, Rest of Asia, the European Union (EU), Rest of Europe, Latin America, Africa, and Oceania plus North America. Among them, 15 Asian economies refer to the 10 ASEAN countries, Japan, Korea, Hong Kong, Taiwan and Macao, Rest of Asia other countries (regions) except this 15 economies in Asia, Rest of Europe other countries (regions) except the European Union in Europe. Given Oceania and North America, both consisting of few countries with similar level of economic development and both importing small quantity of China's apple, we combine them in the following analysis to calculate the optimal structure of the above 7sub- markets by using the model of export market portfolio.

To make sure the typical meaning of following analysis, we select the period from 2002 to 2017as the sample time, in which the growth rates in all sub-markets showed at least one complete cycle of fluctuations. Meanwhile, to make sure the practical sense of our results, it is reasonable to impose upper and lower limits on expected share in each sub-market. All lower constrains are the same as 0. Given both market maturity and past share of 15 Asian economies, Rest of Asia, EU and Rest of Europe, we set their upper constrains by the highest market share in the sample time times 1.5, that is, assuming 50% growth in their highest share. For other three sub-markets, based on their market scale and growth potential, we set their upper constrains by the highest market share in the sample time times 2. Obviously, these assumptions about constrains are subjective, so other researchers may reset the limits depending on their own judgment and prospects.

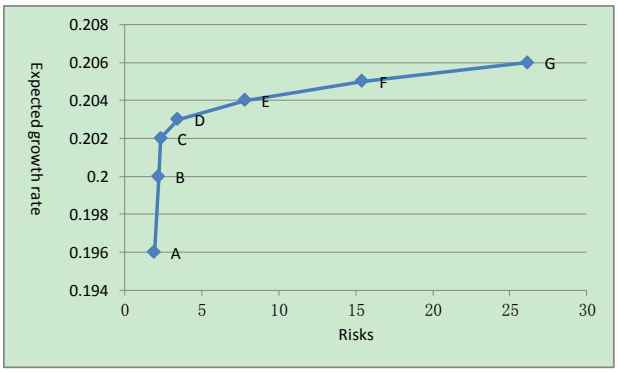

Figure 1. The efficient frontier for China's apple export markets

Figure 1. shows the efficient frontier of China's apple export markets. The shape of the frontier indicates that the risks level of the market portfolio will increase when expected growth rate rises, meaning that the higher expected growth rate, the more risks must be taken. Every point on the frontier, such as A, B, C, D, E, F and G, has the lowest relative variance for a specified level of expected growth rate, and represents an efficient market portfolio reported in Table 1.

Point A offers the minimum relative variance of 1.916 and an expected growth rate of 19.6%, the corresponding portfolio of which is composed mainly of two markets in Asia, these two markets accounting for 95% share of the overall markets due to their lowest relative variance and relatively low covariance with other markets (See Table 2). Compared with point A, in the corresponding portfolio of point G, the share of Rest of Europe rapidly becomes the second largest (30.9%), with a rapid drop to 4.1% for 15 Asian economies. The reason is that Rest of Europe, although with a higher relative variance, has a higher average yearly growth rate than 15 Asian economies and

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negative covariance with other four markets.

Interestingly, the optimal share of four markets including Rest of Asia, EU, Africa and Latin America remains the same. Due to a negative average yearly growth rate, the share of EU decreases down to its bottom constrain, that is 0. The share of other three markets is equal to their own upper constrains. The reason is that, with higher average yearly growth rates and smaller variance and covariance, these markets all are ideal export markets in 7 efficient portfolio, in other words, the more share, the better.

Further, to make the exports of China's apple stable, after comparing the actual portfolio in the sample time to the efficient portfolio, several important and clear policy implications can be found: Firstly, China's apple should completely withdraw from the EU markets; Secondly, the share in 15 Asian economies should be sharply reduced, the pace of reduction depending on the policy makers' preference on the efficient market portfolio; Thirdly, the share of exports going to Latin American, Rest of Asia, Africa, Oceania & North America should be increased. In addition, whether increasing or reducing the share in Rest of Europe will depend on the policy makers' attitude toward risks. For example, if the policy makers are extreme risk-averse, they will choose the market portfolio at point A, meaning that the share in Rest of Europe should be decreased. Conversely, if the policy makers are extreme risk-loving, they will choose the market portfolio at point G, meaning opposite implications.

4. Conclusions and further discussion

From the perspective of non-systematic risk, the overall fluctuation level of a country's exports is partly derived from the export enterprises' free choice of the export destinations. Therefore, the government can take necessary interventions to reduce these risks. For those export-oriented countries, the export stability is crucial to their national income and employment. Hence, the intervention of their governments is more urgent. On the optimal structure of merchandise export markets, earlier studies failed to provide quantitative solutions to minimize export instability. No less obvious is the fact that the goal of the modern portfolio theory developed by Markowitz is similar to the diversification of export markets. However, the significant differences of the mean values of the export growth rates among various export markets make the risks measured by variance not comparable. This paper, using a new index named relative variance to measure export volatility risks, proposes a modified version of Markowitz model to diversify the export markets of the export-oriented countries. In fact, our model can provide explicit guidelines for firms, industries other than the whole country to optimize their ex-

Table 1. The efficient portfolio of China's apple export markets

Point		A	B	C	D	E	F	G	The upper limit of share
The expected growth rate		0.196	0.200	0.202	0.203	0.204	0.205	0.206	
The relative variance		1.916	2.182	2.320	3.434	7.806	15.418	26.175	
Optimal share	15 Asian economies	0.348	0.338	0.333	0.272	0.195	0.118	0.041	0.951
	Rest of Asia	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
	EU	0	0	0	0	0	0	0	0.145
	Rest of Europe	0.014	0.016	0.017	0.078	0.155	0.232	0.309	0.394
	Africa	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
	Oceania & North America	0	0.008	0.012	0.012	0.012	0.012	0.012	0.012
	Latin America	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Note: Share for any given year do not sum to 100% because of rounding.

Table 2. The variance and covariance of the export growth rates from 7 sub-markets

Sub-market	15 Asian economies	Rest of Asia	EU	Rest of Europe	Africa	Oceania & North America	Latin America
15 Asian economies	0.025						
Rest of Asia	0.039	0.146					
EU	0.078	0.207	0.554				
Rest of Europe	0.137	-0.323	-0.290	10.125			
Africa	0.132	-0.006	0.136	1.310	1.641		
Oceania & North America	0.598	1.741	2.963	-1.959	0.204	28.162	
Latin America	0.176	0.225	0.408	-0.549	1.418	4.211	2.216

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port market structures. According to this model, the market share of China's apple in 7 sub-markets in the world should be redistributed drastically. The upper and low share limits imposed on each market are important assumptions in our model, but we cannot take for granted that the composition of any market portfolio would certainly rely heavily on those assumptions. In the case of China's apple, our results appear fairly robust, as other reasonable limits would not change outcomes significantly.

It is necessary to note that in practice, the classification of export markets will directly affect the specific composition of any efficient portfolio and the corresponding policy implications. Given high costs of market conversion, government should implement supportive polices to motivate those firms engaging in export businesses to enter new markets in efficient portfolio. Hence, we need to view efficient market portfolio as a long-term objective due to the low probability of instantly adjusting the share of all markets according to the efficient portfolio. Finally, if an exporting country causes serious trade friction with the certain country in the efficient portfolio, the share assigned to this country would not be achieved. But theoretically, we can find a group of markets to replace this country, maintaining the same risk level as well as expected growth rate.

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