Correlations-Adjusted Export Market Diversification

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This paper introduces new export market diversification indices incorporated with correlations of business cycles among export partners to identify the actual effects of export market diversification on export instability. Three existing export market diversification indices reflect the dispersion level in terms of the number of export partners and their export shares, without a clear control for correlations among export earnings from export partners. In addition, they are underestimated or overestimated in illuminating the negative relationship with export instability. Correlations-Adjusted export market diversification indices help their normalization. Their superiority is also proven through the regression analysis in investigating the effects of export market diversification on export instability.

Keywords: Correlations-Adjusted export market diversification, Export instability
JEL Classification: F13, E32, C82

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본 논문은 수출시장간 경기순환주기의 상관관계를 통합 반영하여 수출시장 다변화가 수출 불안정에 미치는 영향을 좀더 실질적으로 확인할 수 있도록 하는 새로운 수출시장 다변화 지수를 고안한다. 세 가지 기존 수출시장 다변화 지수들은 수출시장으로부터의 수익들간 상관관계를 명확하게 미통제한 채 수출시장의 수와 그들의 수출비중에 의한 분산수준을 반영한다. 또한 그들은 수출 불안정과의 음의 관계를 조명하는 데 과소 또는 과대 평가된다. 상관관계로 보정된 수출시장 다변화 지수는 이러한 기존 지수들의 문제점을 해소하여 정상화시키는데 일조한다. 상관관계로 보정된 수출시장 다변화 지수의 우월성은 수출시장 다변화가 수출 불안정에 미치는 영향을 연구하는 회귀분석을 통해서도 증명된다.

핵심용어: 상관관계로 보정된 수출시장 다변화, 수출 불안정
JEL 분류: F13, E32, C82
I. Introduction

Since the global financial crisis began in the U.S. in 2008, those countries heavily dependent on exports have received more criticism in that they are more vulnerable to external factors. Accordingly, the policy of export market diversification is attracting significant interest again from policymakers as a key solution for reducing export instability.

Most of all, the tools to measure the level of export market diversification by country are vital when choosing the policy. Therefore, the ‘Herfindahl Hirschman Index’, the ‘Gini Hirschman Index’, and the ‘entropy coefficient’ are commonly adopted for such purposes. However, those measurements for export market diversification do not clearly control the correlations among export earnings from export markets although they deal with a degree of diversification in the number of export partners and their export shares. Suppose that a country has an export structure in which the number of export partners is large and their export shares are distributed equally. In other words, the country has a high level of export market diversification in terms of the three existing indices. In such a case, if all export partners of the country had similar business cycles, it would be unacceptable to think that the level of its export market diversification is high.

Down (2007) also supports this view, as he argues that a country with an extensive array of trading partners and relatively low levels of trade concentration, should consider the correlations of export partners’ business cycles to reflect the actual diversification of export markets. Unfortunately, the empirical approach was not provided. Furthermore, there are no other efforts to incorporate the correlations among export earnings from export markets into the existing export market diversification indices.

Hence, the objective of this paper is to introduce new indices for export market diversification incorporated with the correlations of business cycles among export partners to take account of actual effects of export market diversification on export instability.
This paper reviews a theoretical framework in section II, and looks into the empirical evidence in section III. Finally, a brief conclusion is offered in section IV.

II. Theoretical Framework

There are two possible explanations for the effects of export market diversification. The first is its impact on export growth. Most economists do not demonstrate a high degree of interest in the relationship between export market diversification and export growth. More recently, however, several scholars have begun to investigate such issues. Evenett and Venables (2002) showed that an export expansion along the extensive margin plays a significant role for export growth in developing countries. They showed that about one third of the export growth of developing countries between 1970 and 1997 were due to exports of old goods to new markets. Shepherd (2008) reinforced the idea as stated, in that the trade growth of developing countries can take place through the creation of trading relationships with new partners.

The second one is its impact on export instability. In contrast with the first case, many scholars have made significant efforts regarding this issue. Massell (1964) came up with several interesting findings by concluding that there is a significant positive relationship between instability of export earnings and concentration of exports. His findings are based on the argument that the newly developing countries, in particular, many of whom are heavily dependent upon earnings from the sale of primary commodities, experience instability in their export proceeds. However, he could not illustrate a clear relationship between export market concentration and export instability. Another cross sectional analysis conducted by Soutar (1977) concluded that geographic concentration is one of the significant variables in explaining the instability in 48 Less Developed Countries (LDCs) from 1957 to 1969. He emphasized that the reason in which other works including the study by Massell (1964) failed to obtain a significant positive
relationship between geographic concentration and export instability, is that they
did not control for the correlation problems among export partners. As a systematic
approach, Love (1979) developed a model based on Markowitz’s portfolio model1) to
explain the relationship between a commodity concentration and export fluctua-
tions. Recently, Samen (2006) stated that countries specializing in a narrow group
of export products expose themselves to instability of export earnings.

This paper intends to focus on the second approach to introducing the new
export market diversification indices related to export instability. The approach
for devising the new indices is based on three existing concentration indices commonly
used for measuring a degree of a country’s export concentration. The first is the
‘Herfindahl Hirschman Index’2) or ‘Gini Hirschman Index’3). According to Low
et al. (1998), the Herfindahl Hirschman index is a flow-weighted concentration
index which implies that it can be decomposed according to the shares of total
flows of each group. Thus, the weight given to each group depends on the
trade share of each group. The formula is as follows:

\[
HHI_i = \sum_k \left( \frac{X_{ik}}{X_i} \right)^2
\]  

1) It is a theoretical framework for this paper and will be explained later.
2) See Hirschman (1964).
3) See Hirschman (1945).
GHI, is ‘Gini Hirschman Index’ of country i. It is the square root of HHI. Like HHI, its export market diversification index is made by taking it from 1.

The second is ‘entropy coefficient’ derived from the information theory. Hirsch and Lev (1971) used it to test that export diversification tends to stabilize the firm’s sales. Soutar (1977) introduced it to investigate the relationship between export instability and geographic concentration as well as commodity concentration in LDCs. Its formula is as follows:

\[
entropy_i = - \sum_k \left( \frac{X_{ik}}{X_i} \right) \ln \left( \frac{X_{ik}}{X_i} \right)
\]

(3)

It is an inverse measure of concentration in that it increases in value as concentration decreases. The maximum value of the entropy coefficient occurs when export share is spread evenly over all export commodities or export destinations. Also, its minimum value occurs when all exports are concentrated in one commodity or a single export destination.

However, those measurements for export market diversification do not clearly control the correlations among export earnings from export markets although they deal with a degree of diversification in the number of export partners and their export shares. Soutar (1977) supports this view. He argued that GHI is inadequate as a commodity concentration index or geographic one since it is calculated based on the assumption that each commodity or export partner is independent even though such assumption may not be valid. Love (1983) also shares this view. He emphasized that a positive covariance among export commodities is one of the causes for the absence of a significant relationship between commodity concentration and export instability. Meilak (2008) also added as well that export diversification can lower the earnings volatility if the country diversifies into products with price movements that are not strongly correlated with current exports.

4) Although Samen (2006) and Meilak (2008) suggested the other indices as well as the three existing ones, the measurements also did not control the correlations among export earnings from export markets.
‘Modern Portfolio Theory’ adopted by Markowitz (1952) offers the theoretical framework for introducing the new export market diversification indices which can control the correlation problems more strongly. It describes how to select a portfolio with the highest possible expected return, or explains how to select a portfolio with the lowest possible risk. It defines the risk as the variance or standard deviation of return. The formula of the variance is as follows:

\[ V(R) = \sum_{i=1}^{N} a_i^2 V(R_i) + 2 \sum_{i=1}^{N} \sum_{j=1}^{N} a_i a_j \sigma_{ij} \]  

(4)

\( V(R) \) is the variance for a weighted sum of returns on each asset \( R_1, R_2, \cdots, R_N \), which are random variables. \( a_i \) is the proportion of investments for asset i. \( \sigma_{ij} \) is the covariance between \( R_i \) and \( R_j \). Equation (4) can be transformed as follows, based on the fact that the variance of \( R_i \) is \( \sigma_{ii} \).

\[ V(R) = \sum_{i=1}^{N} \sum_{j=1}^{N} a_i a_j \sigma_{ij} \]  

(5)

If \( \sigma_{ij} \) is zero, Equation (4) becomes identical to Equation (1) from the side of export under the fact that \( V(R_i) \) is a random variable which an investor cannot control. Accordingly, it is reaffirmed that HHI is made under the assumption that each export partner is independent as stated by Soutar (1977).\(^5\)

However, since export partners are correlated with each other due to international trade, \( \sigma_{ij} \) cannot be zero. Baxter and Kouparitsas (2005) support this view. They demonstrated that the main determinant of business cycle co-movement between countries is bilateral trade. Hence, Equation (5) is appropriate for introducing the new export market diversification indices. Its main components are the export share of export partner i times that of export partner j and covariance between their respective export earnings. The former is quite similar to the

5) As GHI and entropy coefficient are devised similarly, this argument applies there as well.
component of the three existing indices in Equations (1)-(3). Therefore, it is convincing that the new indices are made by the incorporation of Equations (1)-(3) and the covariance. However, since the non-recorded data on export earnings from export partners prevail and the procedure of measurement is somewhat complex, this paper uses the correlation of business cycles among export partners as a proxy for the covariance. According to Danthine and Donaldson (1993) and Bagwell and Staiger (2003), trade volume over business cycle is procyclical. Especially, Danthine and Donaldson (1993) demonstrated that the import volume over business cycle is more strongly procyclical. Accordingly, the correlation of business cycles among export partners is appropriate as a proxy for the covariance among export earnings from them. Like the method introduced by Stock and Watson (2005), Shin and Wang (2003), and Baxter and Kouparitsas (2005), this paper adopts the correlation of time series in real GDP growth rates among export destinations as the proxy. After all, the measurement is as follows:

\[ BCCI_k = \sum_{m,m \neq k} Corr(rGDPG_k, rGDPG_m) \]  \hspace{1cm} (6)

\( BCCI_k \) is ‘Business Cycle Correlation Index’ of export destination k.

\( Corr(rGDPG_k, rGDPG_m) \) is the correlation coefficient between real GDP growth rate for export destination k and that of export destination m. Therefore, the index implies how similar a business cycle of an export destination is to others. The final step is to incorporate Equation (6) into Equations (1)-(3). Equations (7)-(8) show the results as follows:

\[ CAHDI_i = 1 - \sum_k BCCI_k \left( \frac{X_k}{X_i} \right)^2, \quad CAGDI_i = 1 - \sqrt{\sum_k BCCI_k \left( \frac{X_k}{X_i} \right)^2} \]  \hspace{1cm} (7)

6) The export data are HS 92 version downloaded from UNCOMTRADE.
7) More specifically, this paper uses the growth rate of real GDP in purchasing power parity.
8) It is revised to be applied in Equations (7)-(8). At first, it becomes a positive number by adding absolute value of its minimum and 1 to multiply it to existing indices. Subsequently, it is ranged from 0 to 1.
Correlations-Adjusted Export Market Diversification

\[ CA_{entropy}_i = -\sum_k (1 - BCCLI_k) \left( \frac{x_k}{X_i} \right) \ln \left( \frac{x_k}{X_i} \right) \]

(8)

\( CAHDI_i \) is ‘Correlations-Adjusted Herfindahl Diversification Index’ of country \( i \) and \( CAGDI_i \) is ‘Correlations-Adjusted Gini Diversification Index’ of country \( i \). \( CA_{entropy}_i \) is ‘Correlations-Adjusted entropy coefficient’ of country \( i \). While \( BCCLI_k \) is used in Equation (7) to reflect the similarity of business cycles among export destinations on existing export market diversification indices, \( 1 - BCCLI_k \) is employed in Equation (8) to do the heterogeneity in accordance with the property of entropy coefficient.

III. Empirical Analysis

This section measures a degree of export market diversification through the new Correlations-Adjusted export market diversification indices, and then compares them with the existing indices.

1. Correlations-Adjusted Export Market Diversification Index

Tables 1-2 show the calculation results of Equations (1)-(8). The export data are HS 92 version downloaded from UNCOMTRADE and real GDPs in Purchasing Power Parity for calculating business cycles of export destinations are obtained from the IMF. The value of exports is measured in current US dollars. In addition, the time series is from 1995 to 2008\(^{10} \) and divided into 9 periods; 1995-2000,

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9) ‘Herfindahl’ comes from ‘Herfindahl Hirschman Index’ and ‘Gini’ is from ‘Gini Hirschman Index.’

10) The reason why this paper selects the period is that it would like to use sufficient trade data which UNCOMTRADE dataset offers. Year 1995 is the time when world trade started to increase significantly due to the effectuation of the WTO agreement and Year 2008 is the latest one obtained from UNCOMTRADE dataset.
1996-2001, 1997-2002, 1998-2003, 1999-2004, 2000-2005, 2001-2006, 2002-2007, and 2003-2008\(^{11}\)). Therefore, each index is calculated based on a 6-year period and finally, each value in Tables 1-2 is an average of the 9 periods. In order to obtain the average values, current export values are transformed into constant export values. To do so, export price indices for each country are required. However, since it is difficult to obtain such data, this paper adopts the US import price index\(^{12}\) employed by Minondo (2010), which is a good proxy of the average evolution of export prices in the world.

In Tables 1-2, 6 out of the top 10 countries are replaced when using the business cycle correlation adjustment for \(Ave\textunderscore entropy\) whereas the country ranks for \(Ave\textunderscore HDI\) and \(Ave\textunderscore GDI\) change only slightly with business cycle correlation adjustment. Also, the correlation coefficient of \(Ave\textunderscore HDI\) and \(Ave\textunderscore entropy\) (0.917

### Table 1. Country rank by existing export market diversification indices

| Rank | a. Ave\textunderscore HDI | b. Ave\textunderscore GDI | c. Ave\textunderscore entropy |
|------|--------------------------|--------------------------|-------------------------------|
| 1    | Russian Federation       | Russian Federation       | Ukraine                       |
| 2    | Germany                  | Germany                  | Russian Federation            |
| 3    | South Africa             | South Africa             | India                         |
| 4    | Finland                  | Finland                  | Turkey                        |
| 5    | Lebanon                  | Lebanon                  | South Africa                  |
| 6    | Sweden                   | Sweden                   | Lebanon                       |
| 7    | Greece                   | Greece                   | Italy                         |
| 8    | Kuwait                   | Kuwait                   | Greece                        |
| 9    | Egypt                    | Egypt                    | Germany                       |
| 10   | India                    | India                    | Finland                       |
|      |                          |                          |                               |
| Country | 167                      | 167                      | 167                           |

**Correlation**

- a, b: 0.981***
- a, c: 0.917***

Note: *** is significance at 1%. The source is from the author’s own estimation based on figures from UNCOMTRADE and IMF.

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11) Subsequently, the applied period for constructing ’Business Cycle Correlation Index’ is 6 years.

12) The data are obtained from the Bureau of Labor Statistics.
at 1% significance level) decreases much more with business cycle correlation adjustment (0.875 at 1% significance level) while that of Ave_HDI and Ave_GDI (0.981 at 1% significance level) decreases only slightly with business cycle correlation adjustment (0.979 at 1% significance level)\(^{13}\). In brief, Ave_entropy is more sensitive than Ave_HDI and Ave_GDI with business cycle correlation adjustment.

2. Relationship with Export Instability

This subsection offers the opportunity to compare the new Correlations-Adjusted export market diversification indices with the existing ones by investigating their relationship with export instability. Massell (1970) argued that high geographic

\(^{13}\) Overall, the correlation coefficients among new Correlations-Adjusted export market diversification indices as well as among existing indices are quite similar. Hirsch and Lev (1971) who addressed that Herfindahl Hirschman Index and entropy coefficient offer the same results for their analysis, support it.
concentration is likely to imply a greater dependence on economic conditions in one or a few countries, and fluctuations in demand in any recipient country will then have a more pronounced effect on receipts of the exporting country than if receipts were diversified among recipients. This is consistent with the concept of ‘Modern Portfolio Theory’ introduced by Markowitz (1952) as mentioned in Section II. Therefore, the expected relationship between export instability and export market diversification index is negative.

Table 3 offers the correlation coefficients between export instability and the export market diversification indices over various periods, such as 3 year, 6 year, 9 year, and 12 year periods. The data sources for this analysis are the same as those of Tables 1-2. However, the constructions for each variable are slightly different. First, panel data is employed through the combination of countries and periods. In addition, each index is calculated based on each year period, and standard deviation of the growth rate in constant export values for each period is added to illustrate the relationship with the export market diversification indices.

Table 3. Correlation b.t. export instability & market diversification in various periods

|                  | lnSD_EXG |
|------------------|----------|
|                  | 3yr  | 6yr  | 9yr  | 12yr |
| lnHDI            | -0.091*** | -0.086*** | -0.092*** | -0.071*** |
|                  | (1623) | (1082) | (624) | (263) |
| lnCAHDI          | -0.105*** | -0.108*** | -0.142*** | -0.191*** |
|                  | (1623) | (1082) | (624) | (263) |
| lnGDI            | -0.128*** | -0.127*** | -0.140*** | -0.122*** |
|                  | (1623) | (1082) | (624) | (263) |
| lnCAGDI          | -0.142*** | -0.151*** | -0.196*** | -0.242*** |
|                  | (1623) | (1082) | (624) | (263) |
| lnentropy        | -0.207*** | -0.203*** | -0.225*** | -0.243*** |
|                  | (1623) | (1082) | (624) | (263) |
| lnCAentropy      | -0.128*** | -0.115*** | -0.148*** | -0.251*** |
|                  | (1623) | (1082) | (624) | (263) |

Note: ** is significance at 5% and *** is significance at 1%. ( ) is the number of observations. The source is from the author’s own estimation based on figures from UNCOMTRADE and IMF.
All variables take on the logarithm form.

Table 3 shows that both the existing and new indices have a negative relationship with $\ln SD\_EXG$ over various periods\textsuperscript{14). Its interesting feature is that $\ln CAHDI$ and $\ln CA\_GDI$ have stronger explanatory power than existing $\ln HDI$ and $\ln GDI$ in demonstrating the negative relationship with export instability while $\ln CA\_entropy$ has weaker explanatory power than $\ln entropy$ except for the 12 year period.

Figure 1 offers a clue for a reasonable explanation about the feature. It shows the change for the world average of three existing export market diversification indices from 1995 to 2008. The world average of entropy fluctuates significantly while there is almost no change in world averages of HDI and GDI. Furthermore, it is informative that a slight change for world average of HDI or GDI causes a dramatic change for that of entropy in the same direction.

According to Low \textit{et al.} (1998), entropy is more influenced by changes in the share of the group of countries which have a small share whereas HDI is more influenced by changes in the share of the group of countries which have a large

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\textbf{Figure 1. Trend for world average of HDI, GDI, and entropy}

Note: This paper takes 2 from original value of entropy for the comparison. 81 countries are used for the world average. The source is from the author’s own estimation based on the UNCOMTRADE dataset.

\textsuperscript{14) The negative relationship is consistent with the correlation coefficients shown by Lam (1980).}
share. In terms of $HDI$ being the most representative index, the world level of export market diversification during the period of 1995-2008 is over 85%. It means that export destinations which have a large export share are few during the period. Accordingly, the value of $\ln {	ext{entropy}}$ is overestimated while that of $\ln HDI$ or $\ln GDI$ is underestimated in illustrating the negative relationship with export instability. Consequently, the $\ln CAHDI$, $\ln CAGDI$, and $\ln CAentropy$ that are Correlations-Adjusted export market diversification indices, help their normalization as shown in Table 3.

3. Application to Export Diversification Regression Analysis

In order to apply the new Correlations-Adjusted export market diversification indices to investigating the factors affecting export instability, this paper introduces the following regression model based on the one suggested by Soutar (1977) which adopted a model to explain export instability in LDCs by using a sample of 48 LDCs between 1957 and 1969.

$$\ln SD\_EXG_{it} = \ln COM\_DI_{it} + \ln MAR\_DI_{it} + \ln imp\_Petroleum_{it}$$ (9)

$\ln COM\_DI_{it}$ is the logarithm of export commodity diversification index of LDC $i$ in $t$ time. $\ln MAR\_DI_{it}$ is the logarithm of export market diversification index of LDC $i$ in $t$ time. $\ln imp\_Petroleum_{it}$ is the importance of petroleum transformed by the logarithm for LDC $i$ in $t$ time. It implies the share of petroleum products (HS 92 version 27 code) in total exports. Its expected sign over export instability is negative since petroleum products act as stabilizing agents as stated by Soutar (1977).

Tables 4-6 show the regression results based on Equation (9)$^{16}$. Each variable

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15) The LDCs include low income and lower middle income countries according to the World Bank classification. World Bank divides all countries into low income ($\leq$995), lower middle income ($996$-$3,945$), upper middle income ($3,946$-$12,195$), and high income ($$12,196$ or more), based on 2009 GNI per capita.
is calculated based on a 6 year period. The data on $\ln MAR\_DI_t$ are the same as those of Table 3. For the data on $\ln COM\_DI_t$ and $\ln imp\_Petroleum_t$ HS 92 2-digit codes downloaded from UNCOMTRADE are employed.

Table 4 offers the regression results by ordinary least squares analysis. The coefficients of both the export commodity diversification indices and the market ones are positive at 1-5% significance level. The results are similar to those of Soutar (1977) who also adopted the regression equation based on the ordinary least squares. As for the importance of petroleum products, they are insignificant although the signs are consistent with the expectations.

Tables 5-6 show the results of panel analysis which can control the unobserved individual factors which ordinary least squares method can not do. The results are quite different from those of Table 4, especially for the variables of interest\(^{17}\). The coefficients of the new Correlations-Adjusted export market diversification indices are insignificant in both fixed and random effects whereas those of the existing ones are positively significant at 1-10% level in both of them. These findings are consistent with the results of Massell (1970) and Hamid (2010)\(^{18}\). Also, considering the argument of Soutar (1977) which suggested that the results can be different depending on the sample and the time period used, the results are plausible. Furthermore, they are estimated by fixed and random effects that could be different from the ordinary least squares used by Soutar (1977). However, the coefficients of the existing indices are somewhat inconsistent, taking into account that the effects of export market diversification on export instability are negative or insignificant in accordance with the findings made by Massell (1964, 1970), Soutar (1977), Love (1979), Samen (2006), and Hamid (2010).

\(^{16}\) Since there are no significant differences between the coefficients of GDI (or CAGDI) and of HDI (or CAHDI) as shown in Table 3, this paper excluded the former for the regression analysis.

\(^{17}\) In case of control variables, the coefficients for the export commodity diversification indices and the importance of petroleum products are similar to those in Table 4. However, those of the former are insignificant in fixed effects.

\(^{18}\) They investigated the effects of geographic and commodity concentration on export instability by using the data on 55 countries for 1950-66 and on Malaysia for 1970 to 2003, respectively.
Consequently, the existing indices without a clear control for the correlations among export earnings from export partners can be biased. Accordingly, they should be transformed as Equations (7)-(8) based on portfolio variance adopted by Markowitz (1952).

Table 4. OLS Analysis based on Equation (9)

| Dependent Variable | lnSD_\_EXG_{it} | Model 1 | Model 2 | Model 3 | Model 4 |
|--------------------|-----------------|---------|---------|---------|---------|
| lnCOM_\_HDI_{it}   | -0.468***       | -0.499*** |         |         |         |
|                    | (-6.18)         | (-5.69) |         |         |         |
| lnCOM_\_entropy_{it} | -0.461***     | -0.542*** |         |         |         |
|                    | (-5.77)         | (-6.26) |         |         |         |
| lnMAR_\_HDI_{it}   | -1.109***       |         |         |         |         |
|                    | (-3.32)         |         |         |         |         |
| lnMAR_\_entropy_{it} | -0.763***     |         |         |         |         |
|                    | (-4.31)         |         |         |         |         |
| lnMAR_\_CAHDI_{it} | -1.507**        |         |         |         |         |
|                    | (-2.37)         |         |         |         |         |
| lnMAR_\_CEntropy_{it} | -0.386***     |         |         |         |         |
|                    | (-2.99)         |         |         |         |         |
| lnimp_\_Petroleum_{it} | -0.017        | -0.013 | -0.001 | -0.004 |
|                    | (-0.92)         | (-0.68) | (-0.04) | (-0.23) |         |

Observation | 368 | 368 | 368 | 368 |
R² | 0.124 | 0.118 | 0.161 | 0.145 |

Note: * significance at 10%, ** significance at 5%, *** significance at 1%. ( ) is t-value based on robust standard error. In addition, the values for year dummy and constant do not appear in the tables although they are included in the analysis.

Table 5. Fixed Effects Analysis based on Equation (9)

| Dependent Variable | lnSD_\_EXG_{it} | Model 1 | Model 2 | Model 3 | Model 4 |
|--------------------|-----------------|---------|---------|---------|---------|
| lnCOM_\_HDI_{it}   | -0.446 (-1.38) | -0.027 (-0.07) |         |         |         |
| lnCOM_\_entropy_{it} | -0.541        | -0.090 (-1.46) | (-0.20) |         |         |
| lnMAR_\_HDI_{it}   | 3.022*** (4.59) |         |         |         |         |
Table 5. Continued

| Dependent Variable | \( \ln SD_{EXG_{it}} \) |
|--------------------|-------------------------|
| Model              | (1)                     | (2)                 | (3)                  | (4)                  |
| \( \ln MAR_{entropy_{it}} \) |                        | 2.310***              |                        |                        |
|                    |                         | (3.91)               |                        |                        |
| \( \ln MAR_{CAHDI_{it}} \) |                        | 0.474                |                        |                        |
|                    |                         | (0.82)               |                        |                        |
| \( \ln MAR_{CAentropy_{it}} \) |                        |                      | -0.018                | (-0.12)               |
|                    |                         |                      | (-0.12)               |                        |
| \( \ln imp_{Petroleum_{it}} \) | -0.044                | -0.037               | -0.040                | -0.031                |
|                    | (-1.09)                | (-0.90)              | (-1.01)               | (-0.81)               |
| Observation        | 368                    | 368                  | 368                   | 368                   |
| \( R^2 \) (within) | 0.162                  | 0.062                | 0.150                 | 0.059                 |

Note: * significance at 10%, ** significance at 5%, *** significance at 1%. ( ) is t-value based on robust standard error. In addition, the values for year dummy and constant do not appear in the tables although they are included in the analysis.

Table 6. Random Effects Analysis based on Equation (9)

| Dependent Variable | \( \ln SD_{EXG_{it}} \) |
|--------------------|-------------------------|
| Model              | (1)                     | (2)                 | (3)                  | (4)                  |
| \( \ln COM_{HDI_{it}} \) | -0.522***              | -0.386***            |                        |                        |
|                    | (-3.88)                | (-2.62)              |                        |                        |
| \( \ln COM_{entropy_{it}} \) |                        | -0.631***            | -0.472***             |                        |
|                    |                         | (-3.98)              | (-2.91)               |                        |
| \( \ln MAR_{HDI_{it}} \) | 1.327**                |                      | 0.693*                |                        |
|                    | (2.35)                 |                      | (1.82)                |                        |
| \( \ln MAR_{entropy_{it}} \) |                        | 0.090                | (0.21)                |                        |
| \( \ln MAR_{CAHDI_{it}} \) |                        | 0.090                | (0.21)                |                        |
| \( \ln MAR_{CAentropy_{it}} \) |                        |                      | -0.082                | (-0.61)               |
| \( \ln imp_{Petroleum_{it}} \) | -0.029                | -0.020               | -0.022                | -0.011                |
|                    | (-1.18)                | (-0.81)              | (-0.87)               | (-0.47)               |
| Observation        | 368                    | 368                  | 368                   | 368                   |
| \( R^2 \) (within) | 0.132                  | 0.055                | 0.103                 | 0.054                 |

Note: * significance at 10%, ** significance at 5%, *** significance at 1%. ( ) is z-value based on robust standard error. In addition, the values for year dummy and constant do not appear in the tables although they are included in the analysis.
IV. Conclusion

The most significant contribution of this paper is to offer the new correlations-adjusted export market diversification indices. The three existing export market diversification indices reflect the dispersion level in terms of the number of export partners and their export shares without a clear control for the correlations among export earnings from export partners. In addition, they keep their own bias in measuring a degree of export market diversification. In case that export destinations which have a large export share are few, the value of entropy is overestimated while that of HDI or GDI is underestimated in illustrating the negative relationship with export instability. The CAHDI, CAGDI, and CAentropy that are Correlations-Adjusted export market diversification indices, help their normalization.

The superiority of the new Correlations-Adjusted export market diversification indices versus the existing ones is also proven through the regression analysis in investigating the effects of export market diversification on export instability.

Consequently, since the new Correlations-Adjusted export market diversification indices have stronger explanatory power than the existing ones as export market diversification indices, they can be good tools for various analyses related to export market diversification.
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라정주(羅貞柱)

현재 국제통상금융센터에서 객원연구원으로 재직 중이다. 2009년 서울대학교 국제대학원에서 국제통상 석사학위를 취득하였다. 주요 연구분야는 국제무역과 무역 및 성장이며, 주요 논문으로는 “Effects of Food Import and Source Diversification on Food Security” (2009, 공저)가 있다.