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Do Productivity Differences between Countries Affect to the Factor Content of Trade Theory? Different Country Groups' Approach*

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Abstracts

Many trade economists assume that technologies between countries are equal in explaining the factor content of trade. This assumption is a very strong and unrealistic one. This paper extends the Heckscher-Ohlin-Vanek (HOV) model in a newly directed model by incorporating different technology consideration. This paper uses the pair-wise HOV model with different country groups: the intra-European trade and the trans-Atlantic trade with Canada and Australia. Modification of traditional HOV model is a contribution of this paper. When we compare test results of equation (9), which are the best results when we do the test using the trans-Atlantic countries' data with Canada and Australia, and test results of equation (10), which are the best results when we do the test using the intra-European countries' data, we can tell that test results of equation (10) are greater than those of equation (9). With this, our test results show that trade costs relatively do not play an important role in trade with consideration of productivity differences in calculating the factor content of trade.

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Keywords : Heckscher-Ohlin-Vanek(HOV), Factor Content of Trade, Productivity, Distance, The Trans-Atlantic Trade, The Intra-European Trade, Technology Differences

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Ⅰ. Introduction

Many trade economists have tried to twist and turn the original Heckscher-Ohlin-Vanek (HOV) model and the related data continuously to get better results in explaining the HOV model. Some trade economists use different country groups to get better explanations about the HOV model. Many previous papers could not prove empirically the HOV model although they do many efforts in modifying the original HOV model. Here, different country groups mean that trade economists change their group of countries such as ‘a trade between developed country’s groups’ which is a north-north trade, and ‘a trade between developing country’s groups’ which is a south-south country group. Additionally, some trade economists use different country groups with distance. Debaere (2003) explains the HOV model with different country groups. He proves that the south-north country pairs explain the HOV model better than the north-north country pairs. Well-known trade economists regarding the factor content of trade model, Donald Davis and David Weinstein extend upon the original HOV model in their paper of 2001 with some different approaches from the previous researches in proving the HOV model. One of the different approaches is that they use the original HOV model with the U.S. technology instead of using each country’s own technology. They also use the Hicks-neutral efficiency adjustment and Helpman no-factor price equalization model.

This paper’s first contribution is that we augment the factor content of trade model with the factor productivity adjustments. By this methodology, we modify Trefler’s (1995) factor content of trade model. Trefler (1995) explains that countries share identical production technologies at the productivity equivalent level. Unlike

Trefler's approach, we estimate the productivity parameters by running a regression, the unit factor requirements of the U.S. toward the other countries. This paper's second contribution is that we use the different country groups in testing the factor content of trade model with factor productivity adjustments. Previous researches regarding the HOV model concentrate on 'the north-north country pairs' or 'the north-south country pairs.' This paper constructs country groups by distances, the intra-European country group and the trans-Atlantic country group with Canada and Australia. This way, this paper ideally proves that the trans-Atlantic country group with Canada and Australia explains the model best using the factor productivity adjustments. The trans-Atlantic country group with Canada and Australia includes the idea of distance in the factor content of trade model.

Ⅱ. Methodologies and Models

The original Heckscher-Ohlin-Vanek (HOV) model has many strict assumptions to make the model simple. The strict assumptions are like followings: free trade, which means no trade cost, perfect competition, identical technologies across the countries, constant returns to scale, different factor endowment, preferences are identical and homothetic across the countries, factors are perfectly mobile in the long run across sectors, but perfectly immobile across countries, no measurement error. Among the above assumptions, this paper emphasizes on the identical technology across the countries in analyzing the HOV model. Many trade economists assume strongly that international technologies between countries are the same. This is a very strong and unrealistic assumption in explaining the world.

Trefler (1993) assumes that factor prices are different between countries and he incorporates this relaxed assumption in the standard HOV model. He is the first trade economist who incorporates this modified assumption i.e., factor prices are different, into the HOV model. This way, he tries to prove that the modified assumption explains the HOV model better. He introduces a simple Hicks-neutral productivity modification with individual factor level. He measures endowments of each country with the Hicks-neutral productivity modification. For example, to explain this, let's assume that there are two countries, country A and country B. And, country A and country B have the same labor supply, but workers of country A are twice more productive, in the perspective of labor skill, than those of country B. This means that country A have twice more labor than country B with productivity equalization units. In the perspectives of wages, wages of country A are twice higher than those of country B, because country A is more productive than country B. Trefler (1993) includes the idea of different productivity between countries in his model. Here, productivity is the similar concept to the technologies in Davis and Weinstein's (2001) paper. Trefler's (1995) assumption of 'modified factor price equalization' explains the factor content of trade better than the original HOV model with the strict factor price equalization.

Gabaix (1997) uses a modified factor content of trade model like Trefler's (1995) research. He uses the same data as Trefler's (1995) paper. He tries to find out if one country's endowment could be an appropriate predictor in measuring the factor content of trade. He uses the modified HOV model with the Hicks-neutral technological differences methodology. Though his efforts, his results could not explain the factor content of trade model quite well.

Davis and Weinstein (2001) analyze that Trefler's (1993) productivity modification is an imperfect one because Trefler does not explain a general differences in technologies between countries. They argue that prediction power will be enhanced when technologies of each country are modified by measures of factor abundance. Davis and Weinstein's (2001) research and Trefler's (1993) research are similar in that they concentrate on modifying unrealistic assumption of factor price equalization.

Maskus and Nishioka (2009) estimate factor specific productivities under the basis of constant return to scale (CRS) production function. They find out that their basic factor augmenting technology differences incorporating factor productivities enhance results of the sign test and the variance ratio test in explaining the HOV model. They also find out that estimated productivities are strongly correlated with total factor abundance. Maskus and Nishioka (2009) argue that the systemic productivity differences between factors make Trefler's (1993) paper successful, but the Hicks-neutral productivity cannot find out systemic productivity differences.

Maskus and Nishioka's (2009) paper and Davis and Weinstein's (2001) paper are similar in that they adjust country's technology with factor abundance in the targeted countries. Both two papers concentrate on the connections among the technologies, the productivities, and the factor abundances. Maskus and Nishioka (2009) focus on the factor-augmenting and industry-neutral productivity variation. And, we analyze that the modifications are more restrictive specifications.

The term V_f^c in equation (1) means the endowment of factor f and country c. Because we have only two factors, labor and capital, V_L^c is the labor endowment of country c and V_K^c is the capital endowment of country c. With coefficient (π_f^c), that is from the idea of Trefler (1993),[1)] we derive a new endowment vector V_f^{c*}, a factor endowment measured in productivity equivalent units,

$$V_f^{c*} = \pi_f^c V_f^c . \tag{1}$$

This means each country has its own unique productivity. The role of π_f^c in equation (1) is to adjust factor productivity. That means that π_f^c is a factor productivity adjustment. The term w_f^c is the price per unit of V_f^c and w_f^{c*} is the price per unit of V_f^{c*}. One unit of V_f^c provides π_f^c productivity equivalent unit of service. Therefore, $1/\pi_f^c$ units of V_f^c provide one productivity equivalent unit service priced at $w_f^{c*} = w_f^c/\pi_f^c$.[2)] With this, we derive equation (2) like following,

$$F_f^c = \pi_f^c V_f^c - s^c \Sigma_{g=1}^{G} \pi_f^g V_f^g . \tag{2}$$

Here, $\Sigma_{g=1}^{G} \pi_f^g V_f^g = V_f^{w*}$. Equation (2) is the HOV model with productivity equivalent factors.[3)]

$$w_f^c/\pi_f^c = w_f^{us}/\pi_f^{us} \tag{3}$$

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1) Trefler (1993), who indulges in the HOV model, introduces coefficient (π_f^c) in explaining the factor content of trade model. Here, π_L^c means a coefficient for the labor of each country c and π_K^c means the coefficient for capital of each country c in equation (1). Trefler (1993) wants to integrate factor productivity into the original HOV model.
2) Trefler (1993) assumes that technologies are identical at the productivity-equivalent level and normalized factor productivity of the U.S. is one.
3) The difference between basic Davis and Weinstein's equation (2001) and equation (2) in this paper is that equation (2) has factor productivity adjustment, π_f^c for country c and factor f and π_f^g for country g and factor f. And, equation (2) is an original or a strict HOV model.

Equation (3) means that factor price equalization holds when international factor productivities are adjusted with the factor productivity adjustments. This equation (3) is the same as $w_f^c/w_f^{us} = \pi_f^c/\pi_f^{us}$. And, if $\pi_f^{us} = 1$, then $w_f^c/w_f^{us} = \pi_f^c$. We derive equation (4) from equation (1),[4)]

$$F_f = X_f \Pi_f . \tag{4}$$

$$F_f = \begin{bmatrix} f_f^1 \\ f_f^2 \\ \vdots \\ f_f^c \end{bmatrix},$$

$$X_f = \begin{bmatrix} (1-s_1)V_f^1 & -s_1 V_f^2 & \cdots & -s_1 V_f^c \\ -s_2 V_f^1 & (1-s_2)V_f^2 & \cdots & -s_2 V_f^c \\ & \vdots & & \\ -s_c V_f^1 & -s_c V_f^2 & \cdots & -(1-s_c)V_f^c \end{bmatrix},$$

$$\Pi_f^c = \begin{bmatrix} \pi_f^1 \\ \pi_f^2 \\ \vdots \\ \pi_f^c \end{bmatrix}.$$

Equation (4) originally is modified and driven from Maskus and Nishioka's (2009) research. Here, Π_f^c for each factor f and for each country c are estimated by the ordinary least square (OLS) and we assume that $\pi_f^{us} = 1$.[5)]

$$a_{ij}^c = Z_{ij}^c / X_j^c \tag{5}$$

4) To estimate factor productivities (π_f^c), Trefler (1993) derives a factor productivity with equation (2) and (3). Trefler (1993) derives equation (4) from equation (1).

5) Trefler's (1993) contribution in his paper is that, at the production equivalent level, countries share identical production technologies and adjusted unit factor requirements are identical across countries.

In equation (5), a_{ij}^c are the unit factor requirements to produce one unit of gross output in each country. In other words, a_{ij}^c are the technical coefficients and ratios between the usage of each input and industry output. Here, Z_{ij}^c means the total value of industry i's output that goes into industry j. And, X_j^c are the outputs of country c and industry j. We assume that technology matrices (B^c) for each country c are different in two ways.[6] First, all factors in country c are shifted by an "efficiency" factor δ_c and technology matrix (B^c) will be measured with error. We follow Davis and Weinstein's (2001) methodology and run the logarithm of unit factor requirements on country fixed effects and common unit factor requirements:

$$\ln B_{fi}^c = \theta^c + \beta_{fi} + \epsilon_{fi}^c, \tag{6}$$

$$\ln B_{fi}^c = \theta^c + \ln \overline{B}_{fi} + \epsilon_{fi}^c. \tag{7}$$

In equation (6), $B_{fi}^c = e^{\theta^c} e^{\beta_{fi}} e^{\epsilon_{fi}^c}$ is the element of technology matrix (B^c).[7] Here, f stands for factor and i stands for goods. Davis and Weinstein (2001) use equation (6) to get the Hicks-neutral technology shift. In equation (6), θ^c and β_{fi} are parameters to be estimated and ϵ_{fi}^c is the measurement error. β_{fi} in equation (6) are the common factor input requirements for factor f in industry i and the industry fixed effects and θ^c is the country fixed effect. Maskus and Nishioka (2009) use $\ln \overline{B}_{fi}$, which has the similar role

6) This paper uses the idea of the Hicks-neutral technology shift like Trefler (1995) and Davis and Weinstein (2001) do in their paper.
7) Equation (6) originally follows from Davis and Weinstein's (2001) methodology and equation (7) originally follows from Maskus and Nishioka's (2009) methodology.

to β_{fi} in equation (6). $\ln\overline{B}_{fi}$ in equation (7) is the log of cross-country average unit factor requirements. In equation (7), θ^c is a vector of coefficients on country dummies. Here, $\exp(\theta^c) \equiv \delta_c$ explains the Hicks-neutral technology shift. We choose the omitted dummy to be the U.S. that is we normalize the technology shift of the U.S. to be one. Note that the larger δ_c means the higher the unit total factor requirements of the country. We interpret $\exp(\beta_{fi}) \equiv b_{fi}$ as the element of the international reference matrix, denoted by B. Thus the "true" elements of country c's matrix, that is, "absent error," are $\widetilde{B}^c_{fi} = \delta_c b_{fi}$, and they form a matrix that we call $\widetilde{B}^c (\equiv \delta_c B)$. Davis and Weinstein's (2001) paper weights all observations by $\overline{B}_{fi}\sqrt{\ln(VA^c_i)}/\overline{B}_f$ to correct for the heteroskedasticity. We also weight our model like Davis and Weinstein's (2001) research toward all observations in our paper.[8] Maskus and Nishioka (2009) study more general case of the factor-augmenting productivity adjustments. Their research allows one assumption that vectors of coefficients on country dummies for each factor are different, which means $\theta^c_f \neq \theta^c_{f'}$. $1/\exp(\theta^c_f)$ is the factor-augmenting productivity and in case of the U.S., $1/\exp(\theta^c_f)$ is one. We define that $\exp(\theta^c_f)$ is the same as λ^c. We know that c stands for

8) We need to consider two reasons why there exists heteroskedasticity in our model. First, we need to think about larger industries and smaller industries. When we see technology matrices of each country, we see that there are larger industries and smaller industries. Generally speaking, we know that larger industries are measured more accurately than smaller industries. When we have more and more output, we have more and more information about what the average unit input requirements are. Second, when we use more industry A than industry B, percentage errors are larger in industry B. To solve this heteroskedasticity problem, we need to weight all observations by $\overline{B}_{fi}\sqrt{\ln(VA^c_i)}/\overline{B}_f$. Here, $\overline{B}_f$ is the average of $\overline{B}_{fi}$ factor intensity across all industries. VA^c_i means value added for country c and industry i.

country c and f stands for factor f. Davis and Weinstein (2001) use equation (6) in their analysis. This paper uses both equation (6) and (7) and compares the results with our characteristic data. We consider distance using different country groups. Additionally, this paper uses the pair-wise HOV model which is a different approach from the previous researches. The pair-wise HOV model is proposed by Staiger et al. (1987) and Hakura (2001) with the following equation (8),

$$B^c T^c - s^{cm} B^m T^m = V^c - s^{cm} V^m . \quad (8)$$

Here, $s^{cm} = s^c / s^m = \frac{GDP^c / GDP^w}{GDP^m / GDP^w}$. In equation (8), T^c stands for a net trade vector for country c. If T^c is positive, it means exports. And, if T^c is negative, it means imports.

When we introduce the factor productivity adjustment in the pair-wise HOV model, we derive the following equation (9) like Maskus and Nishioka (2009),

$$B^c T^c - s^{cm} B^c T^c = \Gamma^c V^c - s^{cm} \Gamma^m V^m . \quad (9)$$

In equation (9), Γ^c and Γ^m are M×M matrices. Elements of Γ^c and Γ^m are productivity coefficients that we estimate from equation (6) and equation (7). B^c and B^m are the technology matrices after adjusting factor productivity and factor augmenting productivity,

$$B^c T^c - s^{cm} B^m T^m = V^c - s^{cm} V^m - (B^c - B^m) D^c . \quad (10)$$

When we assume that technology of country c and country m are the same with each other, we can derive the following equation (11),

$$B^c T^c - s^{cm} B^m T^m = V^c - s^{cm} V^m . \tag{11}$$

Ⅲ. Test Results

<Table 1> shows technological variations with the researches of Davis and Weinstein (2001) and Maskus and Nishioka (2009). We compare that Davis and Weinstein's (2001) Hicks-neutral technology differences and Maskus and Nishioka's (2009) factor-augmenting productivity. We reproduce Davis and Weinstein's

【Table 1】 Technological Variations

θ	Davis and Weinstein (2001)			Maskus and Nishioka (2009)	
	The Hicks-neutral technology differences	Implied Lamda (λ)	Reproduced Lamda (λ)	Labor productivity	Capital productivity
				Equation (8)	
Australia	0.531 (0.035)	1.7	1.349	0.719	0.852
Canada	0.381 (0.035)	1.5	1.340	0.812	0.925
Denmark	0.508 (0.036)	1.7	1.391	0.76	0.966
France	0.494 (0.034)	1.6	1.359	0.854	0.885
Germany	0.112 (0.034)	1.1	1.644	0.711	0.703
Italy	0.709 (0.034)	2	1.266	0.834	0.837
Netherlands	0.057 (0.035)	1.1	1.140	0.712	0.892
UK	0.520 (0.034)	1.7	1.440	0.706	1.039
USA	0	1	1	1	1

Notes: Standard errors are reported in the parenthesis. Davis and Weinstein's (2001) lamda (λ^c) is the same as $\exp(\theta_f^c)$.

(2001) lamda (λ^c), which is the same as $\exp(\theta_f^c)$ using our new and updated data from the OECD. In <Table 1>, 'reproducedλ^c' means that we get λ^c from new and the updated database from the OECD. And, this reproduced λ^c is different from the implied λ^c from Davis and Weinstein's (2001) data.

<Table 2> shows a factor-augmenting productivity in our model and Maskus and Nishioka's (2009) model. Again, we use our OECD data of year 2000 from the OECD input-output (IO) database and the STAN database. Maskus and Nishioka (2009) use their constructed data. They use around 1995 data from the OECD IO database and the statistical office of the European Communities (Eurostat).

【Table 2】 Factor-augmenting Productivity

Country codes	Theta(θ)		Country Name	Lamda(λ)		Lamda(λ) (Maskus and Nishioka (2009))	
	K	L		Capital Productivity	Labor Productivity	Capital Productivity	Labor Productivity
AUS	-0.04	-0.28	Australia	0.96	0.75	0.85	0.72
CAN	-0.01	-0.49	Canada	0.99	0.61	0.93	0.81
GBR	0.01	0.36	The U.K.	1.01	1.44	1.04	0.71
DEU	-0.05	-0.53	Germany	0.95	0.59	0.70	0.71
DNK	-0.04	-0.06	Denmark	0.96	0.94	0.97	0.76
FRA	0.11	-0.51	France	1.12	0.60	0.89	0.85
ITA	0.17	0.72	Italy	1.19	2.06	0.84	0.83
NLD	-0.08	1.02	Netherlands	0.92	2.76	0.89	0.71
USA	0.00	0.00	The U.S.	1.00	1.00	1.00	1.00
β						$\overline{B}$	
Weight to avoid heteroskedasticity							
Equation (6)						Equation (7)	

Notes: Here, K stands for capital and L stands for labor.

<Table 3> shows test results of equation (9), equation (10), and equation (11) respectively using the trans-Atlantic countries' data

with Canada and Australia. We prove that equation (9) has better results than equation (10) and equation (11) when we compare the results of the sign test, the slope test, and the variance ratio test. With this, we consider factor productivity adjustment in the pair-wise HOV model. The sign test compares the sign of the left hand side of the factor content of trade model, which is called the measured relative factor content of trade, with the sign of the right hand side of the factor content of trade, which is called the predicted relative factor content of trade. The slope test means the results of running the specification as a regression. When we do the slope test, we denote dependent variables as the measured relative factor content of trade, which is the left-hand side of the factor content of trade model. And, we denote independent variables as the predicted relative factor content of trade, which is the right-hand side of the factor content of trade model in this regression. The variance ratio test means that we test the variance ratio between the variance of measured relative factor content of trade, which is the left hand side of the factor content of trade, and the variance of predicted relative factor content of trade, which is the right hand side of the factor content of trade model.

【Table 3】 Test Results using the trans-Atlantic with Canada and Australia data

	The trans-Atlantic trade with Canada and Australia		
Assumptions	Equation 9	Equation 10	Equation 11
The Sign Test	0.65	0.63	0.43
The Slope Test	0.0079	-0.0036	0.002
Standard Error	0.029	0.028	0.029
R^2	0.001	0.0002	0.0001
The Variance Ratio Test	0.062	0.06	0.06
Dependent Variable	MRFCT	MRFCT	MRFCT

Notes: 〈Table 3〉 is the test result with λ using the OECD data. MRFCT means Measured Relative Factor Content of Trade which means the left hand side of the factor content of trade model.

<Table 4> shows test results to show if the models support the factor content of trade model using equation (9), equation (10), and equation (11) respectively. We use the intra-European countries' data for this test. When we compare the results of the sign test, we find that equation (9) has better result than equation (11). But, equation (10) shows the best result among three equations when we compare the results of the sign test. The slope test results show that equation (10) has better result than equation (9) and equation (11). When we compare the results of the variance ratio test, we see that equation (10) has the best results. And, equation (9) has a slightly better result than equation (11).

【Table 4】 Test Results using the intra-European Countries' data

	The intra-European countries' trade		
Assumptions	Equation 9	Equation 10	Equation 11
The Sign Test	0.63	0.73	0.2
The Slope Test	0.083	0.13	-0.081
Standard Error	0.035	0.04	0.03
R^2	0.16	0.26	0.15
The Variance Ratio Test	0.053	0.07	0.052
Dependent variable	MRFCT	MRFCT	MRFCT

Notes: 〈Table 4〉 shows test results with λ with the OECD data. MRFCT means measured relative factor content of trade which means the left hand side of the factor content of trade.

When we compare test results of equation (9), which is the best results when we do the test using the trans-Atlantic countries' data with Canada and Australia, in <Table 3> and test results of equation (10), which is the best results when we do the test using the intra-European countries' data, in <Table 4>, we can tell that test results of equation (10) in <Table 4> are greater than those of equation (9) in <Table 3>. <Table 3> shows test results using the trans-Atlantic with Canada and Australia. This means that we adopt the idea of trade costs. <Table 4> shows the test results using the intra-European countries' data. And, this means that we do not adopt the idea of trade costs. With this, our test results show that trade costs do not play an important role in explaining the factor content of trade model with consideration of productivity.

Ⅳ. Concluding Remarks

This paper shows the factor content of trade model using the factor productivity adjustments. By this methodology, we modify Trefler's (1995) factor content of trade model. Trefler (1995) explains countries share identical production technologies at the productivity equivalent level. Unlike Trefler's approach, we estimate the productivity parameters by running regressions, the unit factor requirements of the U.S. toward the other countries. This paper also uses different country groups to test the factor content of trade model. Previous researches regarding the factor content of trade concentrate on 'the north-north' country pairs or 'the north-south' country pairs. This paper constructs country groups by distances, the intra-European country group and the trans-Atlantic country group with Canada and Australia. This way, this paper proves that the trans-Atlantic country group with Canada and Australia explains the model best because the trans-Atlantic country group with Canada and Australia includes the idea of distance. This is a modification of the strict HOV model.

Our empirical tests use three test equations that are different from each other: equation (9), equation (10), and equation (11) respectively with the trans-Atlantic countries' data with Canada and Australia and the intra-European countries' data. We prove that equation (9) has better results than equation (10) and equation (11) when we compare the results of the sign test, the slope test, and the variance ratio test using the trans-Atlantic countries′ data with Canada and Australia. We do the test with equation (9), equation (10), and equation (11) using the intra-European countries′ data. However, when we use the intra-European countries′ data in analyzing the factor content of trade model, we could not get satisfactory results compared to the trans-Atlantic trade with Canada and Australia case. When we compare the results of the sign test, we prove that equation (9) has a better result than equation (11). And, equation (10) has a better result than equation (11) when we compare the results of the sign test. The slope test results show that equation (10) has a better result than equation (9) and equation (11). When we compare the results of the variance ratio test, we see that equation (10) has the best results. And, equation (9) has a better result than equation (11). When we compare test results of equation (9), which is the best results when we do the test using the trans-Atlantic countries′ data with Canada and Australia, and test results of equation (10), which is the best results when we do the test using the intra-European countries′ data, we can tell that test results of equation (10) are greater than those of equation (9). With this, our test results show that trade costs do not play an important role in explaining the factor content of trade model with consideration of productivity differences.

Although we get satisfactory results using the OECD data, we need more research in the future with the following perspectives. When we do correlation tests between industries of each country with the OECD data, we find out that there are relatively high correlations between industries of each country. The high correlations in the dependent variables, here, B_{fi}^{c}, imply that the error terms may be correlated with each other. So, we need to use a seemingly unrelated regression (SUR) estimator for these two models, equation (6) and equation (7). However, as Davis and Weinstein (2001) state that there are not enough degrees of freedom for the unrestricted SUR, they estimate the model as a system of equations with uncorrelated errors. But, they impose the additively constraints on the gamma parameters. We would like to estimate the model by using a software package like PROC SYSLIN in SAS or SUR in EVIEWS that allows us to estimate systems of linear equations and impose these cross-equation constraints. Also, note that we should weight the observations with the weight parameter in order to control the potential heteroskedasticity in the data. We leave the above researches for our future study to have more perfect results in explaining the factor content of trade model.

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Appendix

Equation (9), (10), and (11) show the pair-wise HOV model which are different from the original HOV model. A standard HOV model is $B^c T^c \equiv V^c - s^c V^W$. Here, s^c is a GDP of country c and V^W is the same as $\sum_{i=1}^{c} V^c$. V^W is an endowment of the world. This looks similar to the pair-wise HOV model. But, actually a standard or a strict HOV model and a pair-wise HOV model are different from each other. B^c stands for a technology matrix of country c and we get this data from the OECD input-output (IO) table. As we explain in equation (8), T^c stands for net trade vector for country c and this data comes from the OECD IO table. s^{cm} is calculated from GDP for country c over GDP for country m. V^c stands for endowment of country c and we get this data from the OECD structural analysis (STAN) database. Difference between our paper and Maskus and Nishioka's (2009) paper is that we use our data from the OECD. Maskus and Nishioka (2009) use 15 OECD countries. They use the OECD IO database and the statistical office of the European Communities (Eurostat) around 1995. We use the OECD IO table and the STAN database around 2000. We use the pair-wise HOV model; however Maskus and Nishioka (2009) use a strick HOV model. Maskus and Nishioka (2009) use 23 sectors and this paper use 46 sectors. Also, we group the data with two categories depending on distances as follows: the intra-European countries' data and the trans-Atlantic countries' data with Canada and Australia.

국가간 생산성 차이가 팩터컨텐트 이론에 영향을 미치는가? 상이한 국가그룹 접근*

김 연 준**

논문초록

많은 경제학자들은 무역에 있어서 팩터컨텐트 이론을 설명하는데 국가 간 기술력이 모두 동일하다고 가정한다. 이 가정은 매우 강한 가정이며 현실 설명력이 떨어지는 가정이다. 본 논문은 기존 HOV 모델에 더불어 상이한 기술이라는 가정을 포함시켜 생산성이 확장된 기술차이를 이용하여 팩터컨텐트 이론을 발전시키고 확장시킨다. 본 논문은 pair-wise HOV모델을 이용하고 상이한 국가군을 이용하여 분석한다. 여기서 상이한 국가군이라 함은 상대적으로 무역비용이 거의 없는 유럽 내 무역국가군과 거리차이 때문에 무역비용이 많이 드는 캐나다와 호주를 포함한 대서양 횡단 무역 국가군을 의미한다. 분석결과, 본 연구는 유럽 내 국가 간의 무역 데이터를 이용해 최적 결과를 얻은 방정식 (10)이 캐나다와 호주를 포함한 대서양 횡단 국가간의 무역 데이터를 이용해 최적 결과를 얻은 방정식 (9) 보다 팩터컨텐트 이론을 설명하는데 있어서 sign 테스트, slope 테스트, variance ratio 테스트 모두에서 좋은 결과를 얻었다. 이는 본 논문에서 국가간 생산성 차이를 인정한다는 전제 하에 상이한 국가 군을 이용해 무역비용이 존재하지 않는다는 것을 가정하는 오리지널 HOV 모델이 무역비용이 추가적으로 발생한다고 가정하는 HOV 모델 보다 약간 더 좋은 결론을 얻는다는 사실을 발견했다.

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