Chapter 6

Factors Affecting Economic Growth in Developed Countries: A Copula Approach to Sample Selection with Panel Data

This work aims at determining the factors affecting economic output in developed countries. However, the definition of development depends on the criteria by which different principles provide different criteria of level of development. Therefore, there exists selective bias in classifying which countries are developed or developing, and if the selected samples are not representative of the underlying population of real developed countries. The ordinary least squares coefficients may be biased. This study examines the determinants of economic output in the panel data of 22 developed countries from 1996 to 2008 utilizing econometric techniques that take into account the selective nature of the samples. In general, there are two approaches to estimate the sample selection model, namely the maximum likelihood method and the method proposed by Heckman (1979). Moreover, these two approaches require that the joint distribution to be known. In general the multivariate normal distribution is assumed. However, this assumption can often be seen as excessively restrictive. Smith (2003) suggests applying the copula approach, especially the Archimedean copula to the sample selection model and the result also shows that the copula approach is well suited to apply to a model where the sample selection is biased, using cross-section data. In our work, we employ the copula approach to construct the sample selection model in the case of panel data, resulting in the identification of significant factors affecting economic output. This chapter is based on the paper that was presented at the 2012 the fifth International Conference of the Thailand Econometric Society, Chiang Mai, Thailand.

6.1. Introduction

"Which factors make countries experience different levels of economic growth and development?" is an important question that is often asked. However, the answers remain controversial.

In the recent global crisis, there are significant increases in volatility and uncertainty in the global economy, especially in developed countries like the U.S., Japan and European countries which have share of Gross Domestic Product (GDP) more than 50 percents of the world GDP. The uncertainties in identifying the main factors affecting their economic output impact not only their countries but also the rest of the world. Therefore, this study attempts to search for the factors that affect economic growth in developed countries and also provide some help for policy makers to create appropriate policies to resolve the crisis in developed countries. Moreover, to classify a country as a developed country, the important question will come up as to the most appropriate indicator to measure the country's developmental level. In traditional economic practice, income per capita was used to classify development. However, the term "development" has always meant – and continues to mean - different things to different people, hence the result from identifying development using a single indicator will lead to incomplete results. For example, even when a developing nation reaches its announced economic growth targets, the level of living of the people often remains low due to the unsolved problems of poverty, unemployment and/or inequality. In addition, one needs to focus on other indicators such as social, educational, health, cultural, and global indicators of development, and find appropriate indicators to capture the true breadth of possible improvements in human well-being associated with development. Therefore, the main goal of this work is trying to answer to previous question.

By the nature of our collected data, we face sample selection problem as often occurring in the fields of economics. However, several methods have been introduced but the debate is still open for researchers to find the best procedure which will obtain robust estimates from the sample selection model. In general, the two-step estimators proposed by Heckman (1979) and the maximum likelihood (ML) estimators are accepted as the most efficient estimators, as long as the underlying models are correctly specified. Moreover, these estimators can be derived only under a limited number of distributions and require specified joint distribution. The Heckman model and other empirical studies (e.g. Lee (1983), Vella and Verbeek (1999) Husted et.al (2001), and Dustmann and Rochina-Barrachina (2007)) impose bivariate normality on both margins, with each margin itself being normally distributed. However, this assumption can often be seen as unrealistic. To relax the normality assumption, a obvious trend of research has focused on semi-parametric or non-parametric methods (Wooldridge (1995), Kyriazidou(1997)) which does not require strict distribution assumptions. However, semi-parametric or non-parametric methods impose some costs, for example, the intercept of the outcome equation is not identified which, in an economic context, the intercept is important to identify the effect of policy implications. Another problem is estimation of the covariance matrix of the parameters is more demanding than in the parametric case (see Vella (1998)). Moreover, Smith (2003) suggested the copula approach to carry out sample selection and indicated a special case of copulas, namely the Archimedean copulas, which are easy to implement and quite flexible to fit in to a variety of distributional shapes. Genius and Strazzera (2008) also applied the copula approach to sample selection modeling. They showed the copula approach works when the assumption of normality of the joint distribution is patently violated.

Moreover, we use panel data which or longitudinal where each unit of individual is observed more than one time. The advantage of panel data across cross-sectional data is the presence of unobserved individual-specific effect in the equation of interest. Economic theory often suggests containing an unobserved heterogeneity which correlated with the model regressors. If unobserved individual specific effects affect the outcome variable, and are correlated with the model regressors, simple regression analysis does not identify the parameters of interest. The problem of unobserved individual-specific effects may be solved by using panel data or longitudinal where each unit of individual is observed more than one time. There are numerous of estimators which are available for estimating the parameters of panel data models providing a solution to this latter problem (see Hsiao (1986) and Baltagi (2008) for overviews).

Therefore, the objective of this chapter is to apply the copula approach to a sample selection modeling of panel data and to construct a model of economic output in developed countries for which there currently exists a sample selection bias, and to attempt to compare results of the Maximum Likelihood under the assumptions of normality and those obtained from the copula approach.

This chapter is organized as follows. Section 2 outlines our data. Section 3 is devoted to our main work, namely proposing the copula approach to our economic output model, from which results on the identification of factors affecting the economic output are obtained. Finally, section 4 concludes this chapter.

6.2. Data

The study is based on an unbalanced panel data set covering 22 developed countries over the period of 1996 to 2008. The countries are Australia, Austria, Canada, Cyprus, Czech Republic, Denmark, Finland, Hong Kong, Iceland, Israel, Japan, South Korea, Malta, New Zealand, Norway, Singapore, Slovak Republic, Slovenia, Sweden, Switzerland, United Kingdom and United States.

Table 6.1 gives the summary statistics for the data used in this analysis. We present three statistics which are calculated using the observations in the sample of 22 developed countries: Skewness, Kurtosis and Jarque-Bera. The value of Jarque-Bera test for GDP series accepts normality at 5 percent level significant. This implies that the GDP data are from a normal distribution.

Table 6.1 Descriptive Statistics

	Obs	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob
GDP (billion $ US)	286	983.086	14,369.080	3.635	2,424.344	0.111	2.876	0.772	0.680
Macroeconomic Indicator									
MONEY (billion $ US)	277	272.467	4,756.582	0.004	753.678	-0.612	2.983	17.295	0.000
INTEREST (percent per annum)	286	6.906	22.599	0.000	4.195	-0.307	3.341	5.881	0.053
EXCHANGE (per US Dollar)	286	71.118	1,401.440	0.187	233.397	1.020	3.162	49.911	0.000
INFLATION (percent per annum)	286	105.814	215.247	56.687	25.781	1.144	5.045	112.258	0.000
SAVE (percent)	286	23.810	55.699	5.198	8.049	-0.369	4.140	21.996	0.000
TRADE (percent)	286	108.268	438.092	18.969	86.893	0.240	3.603	7.067	0.029
EXPORTS/IMPORTS (percent)	286	1.039	1.648	0.644	0.156	-0.067	4.836	40.395	0.000
FDI_INFLOW (percent)	286	5.293	36.615	-10.140	6.329	-0.815	5.253	92.156	0.000
CAP (billion $ US)	286	193.926	2,295.612	0.705	460.011	0.154	2.936	1.175	0.556
LABOUR (million)	286	15.325	158.000	0.144	32.863	0.115	3.033	0.647	0.724
TOURISM (billion $ US)	286	14.143	117.969	0.180	22.028	-0.175	2.370	6.203	0.045
Social Indicator									
LIFE (years)	286	78.534	82.588	72.566	2.107	-0.681	3.254	22.864	0.000
SCHOOL (percent)	272	104.907	161.781	76.732	17.088	0.874	3.714	40.384	0.000
LACK_FREEDOM	126	37.643	40.000	17.000	4.874	-3.920	17.212	1383.101	0.000
TRANSPARENCY	264	7.780	10.000	3.500	1.744	-1.266	3.567	74.049	0.000
CRIME (per 100,000 population)	168	1.705	19.000	0.000	1.738	0.731	4.966	42.028	0.000
HDI	109	0.856	0.937	0.764	0.046	-0.180	2.699	1.000	0.606

6.3 Results

In this subsection, first the empirical results of the panel unit root test are presented and then if the evidence suggests that the variables do evolve as non-stationary processes, hence, it is necessary to turn to panel cointegration techniques in order to determine whether a long-run equilibrium relationship exists among the non-stationary variables in level form. The last subsection will provide the estimation results of standard macroeconomic model and sufficiency economic model with OLS and sample selection approach.

6.3.1 The empirical results of the panel unit root test

Tables 6.2 and 6.3 report the panel unit root tests on the relevant variables.

Most of the tests fail to reject the unit root null hypothesis for *ln GDP, ln money, ln interest, ln exchange, ln trade, ln labour, ln tourism, ln school, ln lack of freedom, ln transparency and ln life* at 5 percent significance, or better, in level form are in Table 6.2, but the tests that reject the null of a unit root at 5 percent significance or better in difference form are in Table 6.3. The table 6.2 and 6.3 further report the widely used Hadri-Z test statistic, which, as opposed to the aforementioned tests, uses a null hypothesis of no unit root.

However, for *ln inflation, ln save, ln Exports/imports, ln FDI inflow, ln cap,* and *ln crime* most of the tests rejected the null of a unit root in the level form, which implies that these six variables are stationary at this level. Moreover, *ln_HDI* can not be tested for stationary properties because of insufficient observation. Thus, the evidence suggests that the variables which are *ln GDP, ln money, ln interest, ln exchange, ln trade, ln labour,ln tourism, ln school, ln lack of freedom, ln transparency and ln life* do evolve as non-stationary processes and the application of OLS will result in biased and inconsistent estimates.

It is, therefore, necessary to turn to panel cointegration techniques in order to determine whether a long-run equilibrium relationship exists among the non-stationary variables in the level form.

Table 6.2: Results of Panel Unit root test base on 6 method test for all variables at level

	Null Hypothesis: Unit root (assumes common unit root process)		Null Hypothesis: Unit root (assumes individual unit root process)			Null Hypothesis: Stationary
	Levin,Lin and Chu	**Breitung**	**Im,Pesaran and Shin**	**Fisher-ADF**	**Fisher-PP**	**Hadri**
ln GDP	-5.055 (0.000)	3.096 (0.999)	0.320 (0.626)	45.094 (0.426)	53.807 (0.148)	8.709 (0.000)
ln money	-1.306 (0.096)	0.103 (0.541)	0.204 (0.581)	41.814 (0.566)	38.958 (0.687)	7.565 (0.000)
ln interest	-3.276 (0.001)	0.0326 (0.513)	-0.838 (0.201)	54.673 (0.129)	45.527 (0.408)	5.897 (0.000)
ln exchange	-4.619 (0.000)	5.410 (1.000)	0.496 (0.690)	39.078 (0.600)	47.955 (0.244)	8.456 (0.000)
ln inflation	-3.234 (0.000)	0.629 (0.735)	0.503 (0.692)	64.803 (0.022)	66.272 (0.017)	9.174 (0.000)
ln save	-5.838 (0.000)	1.103 (0.864)	-3.089 (0.001)	80.289 (0.001)	44.025 (0.471)	7.326 (0.000)
ln trade	-4.456 (0.000)	-0.862 (0.195)	-0.195 (0.422)	41.915 (0.561)	33.704 (0.869)	7.183 (0.000)
ln Exports /imports	-7.596 (0.000)	1.566 (0.941)	-2.023 (0.022)	71.459 (0.006)	44.563 (0.448)	7.355 (0.000)
ln FDI inflow	-9.329 (0.000)	-4.148 (0.000)	-4.848 (0.000)	95.768 (0.000)	98.315 (0.000)	4.969 (0.000)
ln Capital	-7.544 (0.000)	2.995 (0.999)	-2.296 (0.011)	65.219 (0.021)	68.828 (0.009)	7.299 (0.000)
ln Labour	-2.219 (0.013)	-1.270 (0.102)	1.330 (0.908)	31.557 (0.920)	25.013 (0.991)	6.769 (0.000)
ln Tourism	-4.462 (0.000)	3.396 (0.999)	-0.016 (0.494)	46.850 (0.356)	33.201 (0.883)	8.171 (0.000)
ln Life	-3.791 (0.000)	N/A	4.966 (1.000)	19.082 (0.999)	32.481 (0.900)	11.669 (0.000)
ln School	-4.652 (0.000)	-0.515 (0.303)	-0.955 (0.170)	54.971 (0.087)	51.429 (0.151)	6.544 (0.000)
ln Lack of Freedom	-7.475 (0.000)	-1.316 (0.094)	0.215 (0.585)	19.890 (0.590)	37.504 (0.021)	37.552 (0.000)
ln Transparency	-1.781 (0.038)	N/A	-0.191 (0.424)	45.473 (0.411)	50.576 (0.229)	5.589 (0.000)
ln Crime	-16.105 (0.000)	-2.822 (0.002)	-2.224 (0.013)	72.260 (0.000)	112.974 (0.000)	15.705 (0.000)
ln HDI	N/A	N/A	N/A	N/A	N/A	N/A

Note: An intercept and trend are included in the test equation. P-values are provided in parentheses. The lag length was selected by using the Akaike Information Criteria. N/A = inefficient observation.

Table 6.3 : Results of Panel Unit root test base on 6 method test for all variables at 1st difference.

	Null Hypothesis: Unit root (assumes common unit root process)		Null Hypothesis: Unit root (assumes individual unit root process)			Null Hypothesis: Stationary
	Levin,Lin and Chu	**Breitung**	**Im,Pesaran and Shin**	**Fisher-ADF**	**Fisher-PP**	**Hadri**
ln GDP	-10.051 (0.000)	-4.153 (0.000)	-2.487 (0.006)	69.879 (0.008)	69.711 (0.008)	9.992 (0.000)
ln money	-1.428 (0.077)	-2.095 (0.018)	-1.439 (0.075)	59.528 (0.039)	103.468 (0.000)	7.089 (0.000)
ln interest	-21.013 (0.0000)	-1.739 (0.041)	-5.411 (0.000)	84.458 (0.000)	130.478 (0.000)	6.722 (0.000)
ln exchange	-10.874 (0.000)	-2.980 (0.001)	-3.728 (0.000)	78.692 (0.000)	67.546 (0.008)	13.649 (0.000)
ln trade	-10.479 (0.000)	-5.043 (0.000)	-3.848 (0.000)	81.778 (0.001)	115.102 (0.000)	11.678 (0.000)
ln Labour	-10.645 (0.000)	-1.892 (0.029)	-4.907 (0.000)	102.769 (0.000)	137.209 (0.000)	8.181 (0.000)
ln Tourism	-8.799 (0.000)	-5.706 (0.000)	-2.670 (0.004)	67.030 (0.014)	78.295 (0.001)	8.691 (0.000)
ln Life	-6.842 (0.000)	N/A	-11.564 (0.000)	191.143 (0.000)	268.234 (0.000)	3.877 (0.000)
ln School	-11.700 (0.000)	-6.985 (0.000)	-4.815 (0.000)	95.333 (0.000)	124.210 (0.000)	6.372 (0.000)
ln Lack of Freedom	-27.480 (0.000)	-2.409 (0.008)	-2.417 (0.008)	40.171 (0.010)	68.467 (0.000)	13.641 (0.000)
ln Transparency	-12.394 (0.000)	N/A	-4.728 (0.000)	109.661 (0.000)	142.107 (0.000)	9.245 (0.000)

Note: An intercept and trend are included in the test equation. P-values are provided in parentheses. The lag length was selected by using the Akaike Information Criteria. N/A = inefficient observation.

6.3.2 The empirical results of panel cointegration test

This chapter applies the Koa (1999) test to test long-run relationship among economic output, macroeconomic, social and political variables are shown in Table 6.4.

Table 6.4 Kao (1999) for panel cointegration test

Test Statistic	T-Ratio	P-Value
Kao (1999) Test	-3.29***	0.00

Note: *** denote statistical significance at the 1 percent level.

The result suggests that *ln_GDP*, *ln_money*, *ln_interest*, *ln_exchange*, *ln_trade*, *ln_labour*,*ln_tourism*, *ln_school*, *ln_lack_freedom*, *ln_transparency and ln_life* are cointegrated at the 1 percent level.

The interpretation of above result is that the long-term economic output or GDP moves together with other variables towards equilibrium.

6.3.3 Estimation Results

1) OLS regression without controls for selection bias.

Before starting the sample selection model, this chapter provides the result of the OLS regressions, without controlling for sample selection bias (see Table 6.5). The model after the unit root test and cointegration test is as follows:

Standard Macroeconomic Model

$$\ln GDP_{i,t} = \alpha_i + \beta_{1i} \ln Money_{i,t} + \beta_{2i} \ln Interest_{i,t} + \beta_{3i} (\ln Interest_{i,t})^2 + \beta_{4i} \ln Exchange_{i,t} + \beta_{5i} \ln Trade_{i,t} + \beta_{6i} \ln labour + \beta_{7i} \ln tourism + \varepsilon_{i,t} \quad (6.1)$$

Sufficiency Economy Inspired Model

$$\ln GDP_{i,t} = \alpha_i + \beta_{1i} \ln money_{i,t} + \beta_{2i} \ln interest_{i,t} + \beta_{3i} (\ln interest_{i,t})^2$$

$$+ \beta_{4i} \ln exchange_{i,t} + \beta_{5i} \ln trade_{i,t} + \beta_{6i} \ln labour + \beta_{7i} \ln tourism$$
$$+ \beta_{8i} \ln life + \beta_{9i} \ln transparency + \beta_{10i} \ln lack\ of\ \ freedom + \beta_{11i} \ln school + \varepsilon_{i,t}$$

(6.2)

These are our benchmark regressions.

The result of the Hausman (1978) test suggests that Random Effect (RE) estimation is more suitable for estimating equation (6.1) or (6.2). Therefore, equation (6.1) or (6.2) is estimated by using random effect estimation and the result is shown in Table 6.5.

Table 6.5 compares the standard macroeconomic model with the sufficiency economy inspired model on the basis of the standard error of regression, adjusted R-Squared, and the Durbin-Watson (DW) statistic for autocorrelation. The standard error of regression in the Sufficiency Economy Inspired Model is smaller, signaling less spread of estimated values around the true values. An increase in the adjusted R-Squared can be noted despite the inclusion of more variables in the model. The result indicates that the sufficiency economy inspired model is suitable to construct the economic output model for the developed countries.

The results in Table 6.5 in column 2 or the sufficiency economy inspired model indicate that money supply, trade openness, school enrollment, transparency tourism expenditure and labour supply have a significantly positive impact on economic output , while a lack of freedom has a negative impact on economic output in a developed country. Comparing coefficients, the result shows that tourism expenditure has a greater impact on economic output than the money supply, the interest rate, the exchange rate, the trade openness, the labour supply, the life expectancy, the school enrollment, the transparency and the lack of freedom. Increasing 1 percent of tourism expenditure will lead to increase in economic output about 0.594 percent, at the 1 percent level of significance.

Table 6.5: OLS regression without controls for selection bias

Variable	Standard Macroeconomic Model	Sufficiency Economy Inspired Model
Constant	-7.467	-10.272 (-3.599)
Macroeconomic Variable		
ln Money	0.040*** (3.796)	0.001** (2.551)
ln Interest	0.164*** (2.942)	0.086 (1.135)
(ln Interest)^2	-0.071*** (-4.693)	-0.041 (-1.911)
ln Exchange	0.001 (-0.023)	0.002 (0.443)
ln Trade	-0.082* (-1.752)	0.394*** (16.841)
ln Labour	0.448*** (13.403)	0.479*** (21.627)
ln Tourism	0.680*** (29.441)	0.594*** (25.033)
Social and Political variable		
ln Life		1.135 (1.825)
ln School		0.001** (2.123)
ln Lack of Freedom		-0.001*** (-5.820)
ln Transparency		0.001*** (2.856)
Adjust R^2	0.934	0.991
SE of regression	0.175	0.172
D.W stat	1.408	1.863
F-Stat (Prob)	561.503 (0.000)	2,997.27 (0.000)

Note: The dependent variable is GDP. The t-statistic is in the parenthesis. A “*” indicate significance at 10 percent level, a “**” indicate significance at 5 percent level, and a “***” indicate significance at 1 percent level. The Hausman Test statistic (Prob) = 2.91 (0.89), indicate that the random effect model is appropriate.

2) Sample Selection Model with Copula Approach

In this section, we fit the Gaussian and Archimedean copulas discussed in chapter 3, to model the economic output and selection equation.

To test whether there exists sample selection bias, we use the unbalanced panel data from 22 developed countries and 95 developing countries in the analysis. As mentioned in the previous section, our model is composed of two different equations: the first equation is the development choice and the second equation is the factors determined economic output estimation, using a sample selection model with various covariate specifications.

We employ the sample selection with the bivariate normal assumption of the joint distribution and the five families of copula are estimated using ML estimation, the results are presented in Table 6.6. From the fitted normal marginals, we first need to check whether the margin of GDP has the uniform distribution by using the KS test. The result shows that the KS statistic is 0.0221 (p-value=0.4432) which accepts the null hypothesis implied that the margin of GDP is uniform, then we generate pseudo samples in the unit interval of [0,1].

From Table 6.6, first, this study consider the correlation coefficient or θ in all specification. The coefficient of θ is the relationship between the error term of the selection equation and the outcome equation. The result shows that θ are significantly different from zero which implied there is significantly relation between error term of the developed equation and the economic output equation or a selectively bias exists, and therefore coefficient from the OLS regression or Table 6.5 will features the potential source of a sample selection bias.

For the bivariate normality model (BVN) in column 1 of Table 6.6, the two equations (economic output equation and selection equation) show the coefficient of θ is significant indicating that selectivity bias is present under this specification. Moreover, compare the likelihood, AIC and SIC among the bivariate normality model and models that used Archimedean copulas which are shown in columns (2)-(6). The result shows the AMH model performs the worst for these data, because of maximize the likelihood and the lowest value of AIC and SIC. Moreover, Parameter estimates do not change dramatically across copulas and the coefficients are closely related to the benchmark model (BVN).

The interpretation of the AMH model is as follows. First we interest in the coefficient of θ, the result shows that θ is significantly different from zero which implied there a selectively bias exists, and therefore coefficient from the OLS regression will be biased and inconsistent. The Kendall'tau has the same sign as the linear correlations. The linear correlation (θ) is 0.646 and Kendall'tau is 0.175. The Kendall'tau take positive value indicates the ranks of error terms in both the selection and outcome equation increase together.

Next is interesting in the selection equation of the AMH model, table 5.6 shows the estimated coefficients of Gross National Income (GNI) per capita with a high export/import ratio, high in political and economic freedom level are significantly positive at a 1 percent level. The result indicates that being high in GNI per capita, export/import ratio and political and economic freedom level will lead to a country becoming a developed country.

Finally, this study interprets the results from the economic output equation (Table 6.6). The statistically significant coefficients of macroeconomic and socio-political variables support the idea that the macroeconomic and social indicators have significant effect a determining economic output in developed countries. Table 6.6 shows that money supply, labour supply, tourism expenditure and life expectancy have significantly positive impacts on the economic output at 10 percent level of significant or better. The money variable shows that if the developed countries increase the level of their money supply by 1 percent then the economic output will be increase by 0.007 percent. The coefficient of tourism expenditure is positive, meaning that increases in tourism expenditure will lead countries to increase in GDP, by about 0.578 percent. The coefficient of the labour supply is positive which is higher in labour force and will lead to higher in GDP and the coefficient is 0.315 implying an increase 1 percent of the labour force, and a GDP increase of 0.315 percent. The life expectancy had a significant positive effect on GDP at the 1 percent level. This shows that a 1 percent increase in life expectancy increases GDP by around 0.670 percent. Moreover, comparing coefficients, we observe that life expectancy has a greater impact on economic output than the money supply, labour supply, and tourism expenditure.

Table 6.6: Estimates of BVN and Archimedean Families of Copula

Varibles	BVN		Clayton		Gumbel	
	Coef	SE	Coef	Coef	SE	Coef
Outcome Equation						
Constant	-9.148	4.117	-20.006	21.161	0.223	0.770
ln Money	0.001	0.001	0.124	0.388	0.046	0.204
ln Interest	-0.071	0.069	-0.072	1.215	-0.034	0.639
(ln Interest)^2	0.010	0.020	-0.016	0.240	0.005	0.126
ln Exchange	-0.003	0.005	-0.094	0.360	-0.048	0.189
ln Trade	0.322***	0.050	0.808	1.410	0.369	0.741
ln Labour	0.537***	0.025	1.420***	0.565	0.054	0.297
ln Tourism	0.550***	0.025	0.455***	0.183	0.695***	0.096
ln Life	0.722	0.883	0.822	5.647	0.414	2.969
ln School	0.001***	0.000	0.009	0.553	0.002	0.291
ln Lack of Freedom	0.001**	0.000	-0.001	0.614	0.003	0.323
ln Transparency	0.001	-0.003	0.001	1.301	0.003	0.684
Selection Equation						
Constant	-11.593	16.729	-10.590	3.215	-8.450	1.047
HFREE	3.776	3.873	5.415***	1.607	0.107***	0.003
HEXPORT	-0.324	0.310	0.165	8.742	0.018	0.332
GNI	0.001***	0.000	1.455***	0.044	0.105	0.655
Health	0.616***	0.121	0.520	4.492	3.939***	0.645
θ	0.999***	0.053	0.519***	0.149	1.267***	0.107
K_τ	0.971		0.206		0.2110	
Log-Like	-1730.92		-2275.608		-1699.827	
AIC	3461.846		3448.902		3399.655	
SIC	3593.734		3580.790		3531.543	

Table 6.6 (Cont)

Varables	AMH		FRANK		JOE	
	Coef	**SE**	**Coef**	**Coeff**	**SE**	**Coef**
Outcome Equation						
Constant	0.034	4.867	0.275	3.593	2.469	3.596
ln Money	0.007*	0.004	0.009	0.201	0.004	0.100
ln Interest	-0.018	0.273	-0.023	0.628	-0.028	0.312
(ln Interest)^2	0.004	0.054	0.026	0.124	0.009	0.062
ln Exchange	0.008	0.081	-0.007	0.186	0.000	0.093
ln Trade	0.214	0.317	0.187	0.729	0.107	0.363
ln Labour	0.315**	0.127	0.436	0.292	0.280*	0.145
ln Tourism	0.578***	0.041	0.790***	0.095	0.404***	0.047
ln Life	0.670*	0.368	0.117	2.921	0.593	1.452
ln School	0.050	0.124	0.002	0.286	0.001	0.142
ln Lack of Freedom	0.086	0.138	0.001	0.318	0.005	0.158
ln Transparency	0.012	0.292	0.001	0.673	0.003	0.335
Selection Equation						
Constant	-6.754	1.086	-9.032	0.998	-2.737	1.660
HFREE	0.225*	0.124	0.084***	0.017	0.004	1.368
HEXPORT	0.453***	0.032	0.515	1.774	0.255	1.390
GNI	0.193***	0.064	0.117	3.450	0.039***	0.007
Health	0.045	0.631	0.491	3.500	2.086***	0.070
θ	0.646***	0.158	2.116***	0.165	2.801***	0.256
K_{τ}	0.175		0.225		0.450	
Log-Like	-1695.399		-1753.373		-2376.530	
AIC	3390.799		3506.747		4753.060	
SIC	3522.687		3638.635		4884.948	

Note: The dependence variable is GDP. A“*” indicate significance at 10 percent level, a “**” indicate significance at 5 percent level, and a “***” indicate significance at 1 percent level.

6.4. Conclusion

This chapter aims to search for the factors that can determine economic output in 22 developed countries for the period 1996-2008. Moreover, we apply the copula approach to construct a sample selection model which panel data. In general the assumption of dependence between the joint distribution of the error in the selection equation and outcome equation are bivariate normal. However, this assumption is excessively restrictive. Therefore, the copula approach is used in the specification the joint distribution which is non-normal. This involves specifying distributions for each of the margins, as well as selecting a copula function. Our discussion focuses on Archimedean copulas because of the ease of implication and the fact that it can handle high dimensional distributions.

With this sample selectivity model in hand, we first produce the OLS results then estimated the economic output equations using the sample selection approach. Our result confirms that there exists selection bias in our model which could lead to significant changes in the results of economic output analysis if we interest only the OLS results. Then, we provide sample selection approach with several specification of the joint distribution and the models are estimated by Maximum Likelihood approach. On the basis of two information criteria based on log likelihoods, it is conclude that the best fitting model is an AMH copula for the economic output model.

The chapter identifies the variables that influence whether a country be developed country or not. The results indicate that being high in GNI per capita, export/import ratio and high in political and economic freedom will lead to country to become a developed country.

Finally, the results of the economic output equation show that increases in money supply, labour supply, tourism expenditure and life expectancy can encourage economic output in developed countries, at a 10 percent level, or better, which implies that policy makers in developed countries should focus on money supply, labour supply, tourism expenditure and life expectancy.