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Short Paper

Gravity Model for Trade between Singapore and Malaysia using Employment

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Abstract

This paper uses GDP and employment data based on the Gravity Model to account for the trade volume between Singapore and Malaysia. There are two ways to operationalize this gravity model. One is based on GDP which is the current practice in the literature. But in this paper, we also use employment data. It is found that, to account for trade volume between Singapore and Malaysia, employment data performs better than the GDP data. Employment performs better than GDP because GDP is the result of trade but employment is an input to create trade volume.

Keywords

gravity model, trade, employment, labor force, GDP

1. A Selective Literature Review

As the economy of Singapore and Malaysia is growing through these decades, trade volume between the two Southeast Asian countries grows, some fluctuations happen though. When economic crises or depression hurts their economy, the bilateral trade volume will also decrease. This proves that the size of their economies is related to their bilateral trade volume.

The Gravity Model is often used to measure or predict international trade between the two countries. We use Equations for our analysis:

$$T_{ij} = A \times Y_i \times Y_j / D_{ij} \quad (1)$$

Where T_{ij} = Value of trade between country i and country j

Y_i = GDP/Labor Force of country i

Y_j = GDP/Labor Force of country j

D_{ij} = Distance between the two countries (i and j)

The variables of the equation arouse many discussions. The study of Leamer and Levinsohn (1994) proves that distance has an impact on bilateral trade by providing empirical evidences. Hummels (n.d.) argued that shipping costs including freight charges and marine insurance) can explain why distance matters. However, shipping cost is not important for bilateral trade between Malaysia and Singapore. Anderson (1979) puts forward some limitations of the equation when it comes to the additional variables of policy considerations. Enhanced Gravity Model (EGM) is put forward as the simplest model that combines the GM with the network approach within a maximum-entropy framework (Almog et al., 2015). Hassan Khayat (2019) admits the significant effects of GDP per capita and

population on trade between GCC and destination countries while eradicating the effects of trade barriers by analysing GCC's trade patterns based on the Gravity Model. Another research uses the gravity model to measure the potential of Indonesian fruit trade with variables such as free trade agreements, population, GNP of countries, distance and share of trade (Sinaga et al., 2019). It should be noticed that many authors estimate the equations of the Gravity Model with the log of per-capita incomes (ln M/POP) of the export and import countries as well as the log of aggregate incomes (ln M). However, this paper uses employment data for the Gravity Model, which is different from the previous studies.

This paper makes contributions to current literature on the Gravity Model. First, recent research on bilateral trade between Malaysia and Singapore by the Gravity Model cannot be found. This essay uses bilateral trade between Malaysia and Singapore as a case study for the Gravity Model. Second, this paper's replacing GDP with employment data to measure the economic size of countries is new to research on the Gravity Model. Previously, GDP is often considered as the best index to evaluate a country's economic size. However, this paper provides another way to do it: employment data (labor forces of countries).

2. Methodology and Hypotheses

The Gravity Model is an empirical tool that can help understand trade between any two countries. The model is based on a strong empirical relationship that exists between the trade volume and the economic size of the two countries as well as the distance. The size of a country's economy is represented by its Gross Domestic Product (GDP). The model's name is originated from the analogy to Newton's law of gravity. Krugman et al. (2012) stated the analogy:

"Just as the gravitational attraction between any two objects is proportional to the product of their masses and diminishes with distance, the trade between any two countries is, other things equal, proportional to the product of their GDPs and diminishes with distance" (pp. 12-13)

There are two ways to operationalize this gravity model. One is based on GDP which is the current practice in the literature. But in this paper, we also use employment data. The Gravity Model will be applied to the analysis of trade between Singapore and Malaysia with the bilateral trade figures from 1989 to 2018. GDP and labor force data are respectively used as data with regard to economic sizes to run the gravity model. The results then will be compared and a discrepancy is expected. It is expected that this essay can contribute to research on the Gravity Model and trade between Singapore and Malaysia.

3. Gravity Model based on GDP and Labor Force

We will make an attempt to see whether the GDP or the labour force perform better based on Gravity model.

3.1 GDP as Y

The statistics with regard to GDP and trade volume between Malaysia and Singapore from 1989 to 2018 originate from the World Bank and the World Integrated Trade Solution (WITS). Distance between Malaysia and Singapore (D) is defined as 369.45 km. These statistics are used for building Equation 1*. For Equation 1*, *A* is equal to *0.351091982442652*.

$$T_{sm} = 0.351091982442652 \times Y_s \times Y_m / 369.45 \quad (1^*)$$

3.2 Labor Force as Y

Labor force statistics can also be used to evaluate the economic size of both countries. It is expected that the equation result is different because of different statistical characteristics between two GDPs and two labor forces.

Pearson's coefficient is used to measure the statistical characteristics of two GDPs and two labor forces. According to the definition of Pearson's coefficient: (a) A correlation coefficient of 1 means that for every positive increase in one variable, there is a positive increase of a fixed proportion in the other; b) A correlation coefficient of -1 means that for every positive increase in one variable, there is a negative decrease of a fixed proportion in the other; (c) Zero means that for every increase, there isn't a positive or negative increase and the two just aren't related. For two GDPs, the simple correlation coefficient (Pearson's correlation) is 0.991728. For two labor forces, the simple correlation coefficient is 0.990618. Thus, both of them have a strong positive relation. But GDPs have stronger one. The statistical differences will lead to different equation results.

If we use labor force to measure the economic size, the coefficients of Equation 1 are different, we name it as Equation 1**. Because the labor force statistics in 1989 are unavailable, GDP statistics in 1989 will be removed later when comparison is needed.

Regression analysis of labor force based on Equation 1 is:

$$T\ [Million\ USD] = 0.69 * Y1 * Y2/D \qquad (1^{**})$$

3.3 Comparison between GDP and Labor Force as Y

As shown in Figure 1, disparities exist between the actual trade volume and Equation 1*/1**. However, Equation 1* predicts better with narrower disparity. Specific data can be seen in Table 1.

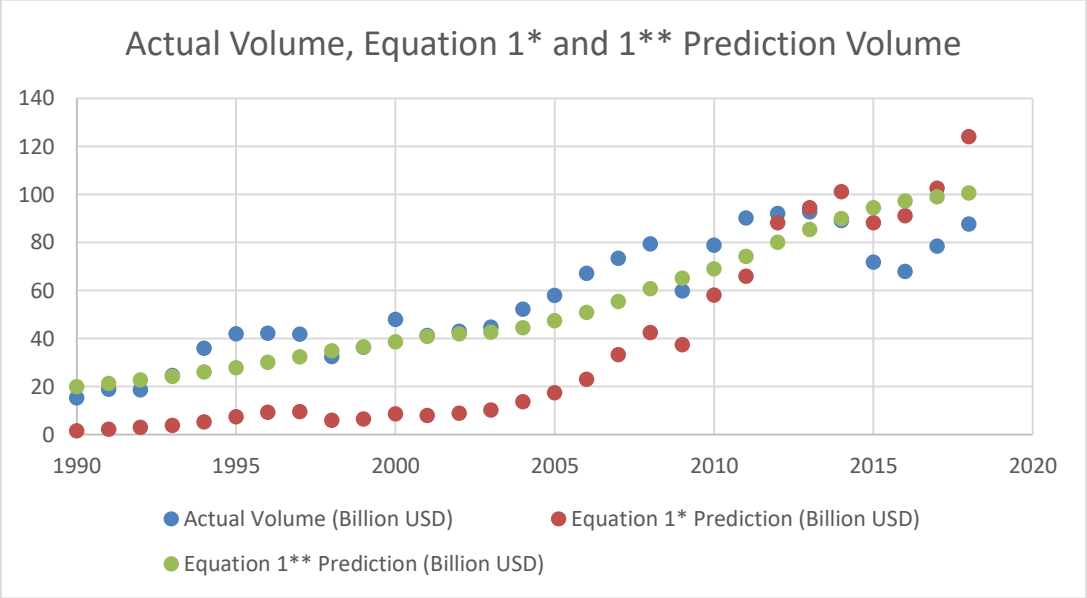

Figure 1. Actual Trade Volume between Malaysia and Singapore from 1990 to 2018

Note. Equation 1* prediction volume (GDP as Y) and Equation 1** prediction volume (Labor Force as Y).

Table 1. Disparity between Equation 1* & Equation 1 Prediction Trade Volume and Actual Trade Volume**

Year	Actual Volume (Billion USD)	Equation 1* Prediction (Billion USD)	Disparity between Actual and Equation 1*	Equation 1** Prediction (Billion USD)	Disparity between Actual and Equation 1**
1990	15.17857177	1.511831631	13.66674014	19.87365724	4.695085465
1991	18.87869235	2.123368388	16.75532396	21.29387516	2.415182813
1992	18.55408589	2.931261307	15.62282458	22.76091311	4.206827216
1993	24.53593396	3.817787616	20.71814634	24.22622179	0.309712168
1994	35.92359629	5.215710355	30.70788594	25.98607106	9.937525229
1995	41.94751898	7.402557637	34.54496134	27.82602334	14.12149564
1996	42.23542477	9.23384743	33.00157734	30.06560045	12.16982432
1997	41.72574515	9.512601825	32.21314332	32.35438394	9.371361208
1998	32.46808167	5.879694619	26.58838705	34.84092042	2.372838751
1999	36.27082957	6.489725039	29.78110453	36.47662637	0.205796802
2000	47.8578666	8.562677113	39.29518949	38.5516309	9.306235704
2001	41.21383459	7.916761851	33.29707274	40.86689409	0.346940499
2002	43.01898805	8.864520902	34.15446715	41.93416606	1.084821989
2003	44.6558065	10.22631305	34.42949345	42.59767199	2.058134508
2004	52.24061927	13.62791873	38.61270054	44.49071683	7.749902439
2005	57.90427156	17.42801785	40.47625371	47.3722248	10.53204676
2006	67.07743242	22.97585086	44.10158156	50.88050671	16.19692571
2007	73.33768758	33.26478933	40.07289825	55.32639102	18.01129656
2008	79.32771214	42.462582	36.86513014	60.7743236	18.55338854
2009	59.72026784	37.33450086	22.38576698	65.12703184	5.406764
2010	78.79887515	58.1104984	20.68837675	69.01019445	9.788680702
2011	90.18368127	65.98086974	24.20281153	74.17938926	16.00429201
2012	92.0500067	88.16921781	3.880788891	80.07354743	11.97645927

2013	92.77132024	94.50554193	1.734221688	85.39933055	7.371989693
2014	89.17984072	101.1772969	11.9974562	89.94747543	0.767634713
2015	71.74128376	88.21840585	16.47712209	94.42631658	22.68503282
2016	67.8692437	91.08105279	23.21180909	97.20767515	29.33843145
2017	78.43934213	102.5855706	24.1462285	98.95032148	20.51097935
2018	87.66565072	124.112484	36.4468333	100.6042002	12.93854952
Average			26.89918264		9.670143305
Standard deviation			10.91791165		7.452661096

If we take statistics from 1990 to 2018, we can get different results of Equation 1 based on GDP and Labor Force. For Equation 1* (GDP), the average disparity is 26.90 and the standard deviation is 10.92. For Equation 1** (Labor Force), the average disparity is 9.67 and the standard deviation is 7.45. Consequently, the calculation based on labor force statistics approaches more to the actual volume with lower average disparity and lower standard deviation. In other words, employment data predicts better than GDP for the Gravity Model based on Equation 1 (Note 1).

4. Conclusion

This paper studies the Gravity model by using GDP and labor force to evaluate the economic sizes (Y) of Malaysia and Singapore. It is found that, instead of GDP, when labor force represents the economic size based on Equation 1, the result approaches more to the real data. In conclusion, the employment data can be a second choice for measuring the economic size when it comes to the Gravity Model, and it is possible that the employment data predicts better than GDP.

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Note

Note 1. Gravity model can be represented by $T_{ij} = A \times Y_i^a \times Y_j^b / D_{ij}^c$, where a, b and c are the respective coefficient. Based on regression analyses, when GDP represents Y, Equation 2* predicts better than Equation 1** with narrower average disparity 7.58 and lower standard deviation 6.24. But, when labor force represents Y, the above equation cannot be produced due to a multicollinearity problem because the correlation coefficient between Singapore employment and Malaysian employment exceeds 0.9.