DETERMINANTS OF NAMIBIAN EXPORTS: A GRAVITY MODEL APPROACH

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Abstract

Exports are the drivers of economic growth in Namibia. Given their importance in the economy, it is necessary to analyse factors that are determining export flows between Namibia and its trading partners. A gravity model is very important in the analysis of bilateral trade flows, and has proven to be a useful tool in determining trade or export potential of a country. The purpose of this study is to investigate factors that determine exports of Namibia using a gravity model approach. The analysis indicates that increases in importer's GDP and Namibia's GDP cause exports to increase, while distance and importer's GDP per capita are associated with a decrease in exports. Namibia's GDP per capita and real exchange rates do not have an impact on export. Namibia exports more to countries where it shares a common border and SADC as well as to the European Union. The study shows that there is unexploited export potential to among others, Australia, Belgium, Kenya, Mauritius, Netherlands, Portugal, South Africa, Switzerland and the United Kingdom. These results are important for trade policy formulation in order ensure that Namibia's export potential is exploited in order to enhance economic growth and generates employment.

JEL Classification: C01, C23, C33, F10, F14, F17.
Keywords: gravity model, Namibia, export potential, pooled, fixed effects, random effects.

1. Introduction

Exports are important for the process of growth. They generate scarce foreign exchange reserves that are necessary to finance imports of goods such as energy and investment goods. These goods are crucial for the formation of capital and economic growth. Exports ease the pressure on the balance of payments and create the much-needed employment opportunities (Jordaan and Eita, 2007). An export-led growth strategy provides incentives through various government policies to producers to rather export their products. This increases the capability of producing goods and services that can compete in the world market using advanced technology which will provide foreign exchange needed to import goods and services. Exports can also reduce the impact of external shocks on the domestic economy. The experience of Latin American and Asian economies provides good examples of the importance of exports to economic growth. The vital role of export as an engine of economic growth was also stressed Senhadji and Montenegro (1999).

At independence in 1990, the new government of Namibia recognised the role of export for the country to be competitive and have a sustainable level of growth. It adopted an export-led growth strategy through value addition. One such example is the Export Processing Zone (EPZ) established in 1995. The aim of the EPZ is to encourage export-oriented manufacturing in order to create employment, investment and transfer of technology to the rest of the economy (Jordaan and Eita, 2007). Various incentives were offered under the EPZ in order to encourage exports.

Although empirical research on the export of Namibia is limited, there is one notable study by Jordaan and Eita (2007). This study indicates that export is the key to economic growth in Namibia, and the country can expand its limited domestic market by exporting to the international markets. Given this importance and the role it plays in the Namibian economy, it is important to investigate the factors influencing exports and determine trade (export) potential to different countries. A useful tool in the determination of the export potential of a country is a gravity model. The model has its foundations in physical science and has become an important tool in the analysis of bilateral trade flows. Tinbergen (1962) and Poyhonen (1963) pioneered the idea of explaining trade flows in analogy to Newtons's law of gravity by the attraction of two countries' masses, weakened by distance between them and enforced by trade agreements they belong to. The masses of countries are measured by GDP or population, and transport costs are proxied by the distance between countries. As in physical science, the bigger and closer the units are to each other, the stronger the attraction. The analogy with gravity derives from GDP being a measure of economic mass and distance as a measure of resistance. The gravity model is used to investigate the relationship between the volume and the direction of international trade and the formation of regional trade blocks. The model is augmented with a number of variables to test whether they are relevant in explaining trade flows between countries. These variables include GDP, distance, infrastructure endowment, differences in per capita income and exchange rate (Eita and Jordaan, 2007).

In light of the above, the objective of this paper is to investigate factors determining Namibian exports for the period 1998 to 2006 using the gravity model. The paper then

investigates whether there is unexploited trade potential among Namibia's trading partners. There rest of the paper is organised as follows. Section 2 discusses the gravity model. Section 3 discusses the estimation procedure and Section 4 presents the univariate characteristics of the data. The estimation results and potential exports are presented in Sections 5 and 6. Section 7 concludes.

2. The gravity model

The gravity model was first applied to international trade in the early 1960s. Among others, Pöyhönen (1963) was the first to apply the gravity model to international trade. In the latter half of the twentieth century, the gravity model has been used to explain migration and other social flows in terms of gravitational forces of human interaction. Like in physical science, the bigger and closer the units are to each other, the stronger the attraction. The comparison with gravity derives from gross domestic product (GDP) being a proxy for economic mass and distance a proxy for resistance.

The gravity model performed well in analysing the international trade flows in the early 1960s but strong theoretical foundations were not produced until the end of the 1970s. This led to many studies to modify the original Newtonian gravity equation. From the works of Anderson (1979) and Bergstrand (1985, 1989) it became clear that the gravity equation is a good representation irrespective of the structure of product markets. Bergstrand (1985, 1989) included population size while Oguledo and Macphee (1994) included price variables.

Oguledo and Macphee (1994) derived the gravity equation from a linear expenditure system. This was in an attempt to answer criticism that the theoretical foundation of the gravity model is weak. The analysis assumes a weakly separable utility function from which a linear expenditure could be derived (Oguledo and Macphee, 1994).

In its general form, exports from country *i* to country *j* are explained by their economic sizes (GDP), population, geographical distance and a set of dummies incorporating some kind of institutional characteristics common to specific flows. The basic model is specified as (Martinez-Zarzoso and Nowak-Lehmann, 2003: 296; Jakab, Kovács and Oszlay, 2001: 280):

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} N_i^{\beta_3} N_j^{\beta_4} D_{ij}^{\beta_5} A_{ij}^{\beta_0} u_{ij} \qquad (1)$$

where X_{ij} is export of goods by country *i* to country *j* , Y_i and Y_j are the GDP of the exporter and importer, N_i and N_j are the populations of the exporter and importer, D_{ij} is the distance between the two countries, A_{ij} represents any other factors influencing trade between the countries and u_{ij} is the error term. For the purpose of estimation, the model in Equation (1) is expressed in log form as:

$$\ln X_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_i + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \ln \beta_6 \ln A_{ij} + u_{ij} \qquad (2)$$

An alternative form of Equation (1) uses per capita income instead of population and is represented as:

$$X_{ij} = \eta_0 Y_i^{\eta_1} Y_j^{\eta_2} (\frac{Y_i}{N_i})^{\eta_3} (\frac{Y_j}{N_j})^{\eta_4} D_{ij}^{\eta_5} A_{ij}^{\eta_0} u_{ij} \quad (3)$$

where $\frac{Y_i}{N_i}$ is the exporter's GDP per capita and $\frac{Y_j}{N_j}$ is the importer's GDP per capita. Equations (1) and (3) are equivalent. Expressing Equation (3) in log linear form yields:

$$\ln X_{ij} = \eta_0 + \eta_1 \ln Y_i + \eta_2 \ln Y_j + \eta_3 \ln \frac{Y_i}{N_i} + \eta_4 \ln \frac{Y_j}{N_j} + \eta_5 \ln D_{ij} + \ln \eta_6 \ln A_{ij} + u_{ij} \quad (4)$$

Equation (4) will be applied in this study. A high level of GDP indicates a high level of production in the exporting country which increases the availability of exports, and a high level of income in the importing country suggests high imports, hence β_1 and β_2 have positive signs. The same applies to η_1 and η_2 in Equation (4). The coefficient estimate for population of the exporting country (in this case Namibia) can be positive or negative depending on whether the country export more when it is large in economic terms or whether a large country export less than the smaller one. The population coefficient of the importing country can also be positive or negative for similar reasons (see Martinez-Marzoso and Nowak-Lehman, 2003). That means β_3 and β_4 have ambiguous signs. Similarly, in Equation (4), the population component of GDP per capita influence trade in two ways. A large population indicates a large domestic market, high level of self-sufficiency and less need to trade. Alternatively, a large population promotes division of labour and this means that there is economies of scale in production and opportunities as

well as desire to trade with greater variety of goods. Hence η_3 and η_4 are inderminate. This is also supported by Oguledo and MacPhee (1994) that the effect of the population variables (for importing and exporting country) on trade is indeterminate. Population size can be trade-enhancing as well as trade-inhibiting. A large population on one hand may indicate large resource endowment, self sufficiency and less reliance on international trade. It is possible on the other hand that a large domestic market or population promotes division of labour and thus creates opportunities for trade in a wide variety of goods, and in this case the coefficient of the population variables can be positive. The coefficient of distance is expected to be negative because it is a proxy for transport costs (β_5 and η_5 are is expected to be negative).

This study introduces the real exchange rate (*REAL)* as a proxy for relative prices and dummy variables to represent countries which are members of the Southern African Development Community (SADC) or part of the European Union (EU) in order to test the impact of regional agreements on bilateral exports. It also introduces the border dummy variables for countries that share borders with Namibia. Countries that are part of the EU or members of SADC as well as those that share borders with Namibia are coded one and zero otherwise. After introducing the dummy variables, Equation (4) is re-specified as:

$$\ln X_{ijt} = \alpha_{ij} + \eta_1 \ln Y_{it} + \eta_2 \ln Y_{jt} + \eta_3 \ln(\frac{Y}{N})_{it} + \eta_4 \ln(\frac{Y}{N})_{jt} + \eta_5 \ln D_{ij} + \eta_6 \ln REAL_{ij} + \eta_7 SADC + \eta_8 EU + \eta_9 BORDER + u_{ijt} \quad (5)$$

where α_{ij} represents individual effects, *SADC* is the dummy variable taking the value of one if the country is a member of SADC and zero otherwise, and *EU* is the dummy variable for countries that are part of the European Union and takes the value of one if part of EU or zero otherwise. *BORDER* is a dummy variable for countries that share borders with Namibia. It also takes the value of one and zero otherwise. According to Carrère (2006) membership of regional groupings can generate a significant increase in trade. The coefficient of the real exchange rate is expected to be negative, implying that an appreciation of the real exchange rate discourages exports, while those of dummy variables are expected to be positive. Regional trade agreements and sharing a common border promote exports between countries.

3. Estimation Procedure

There are three models that can be estimated in panel data estimation. These models are pooled, fixed effects and random effects. Since individual effects are included in the regressions a decision should be made whether they are treated as random or fixed. A random effects model can be more appropriate when estimating the flows of trade between a randomly drawn sample of trading partners from a large population. A fixed effects model would be a better model when estimating the flows of trade between an ex ante predetermined selection of countries (see Egger, 2000; Eita and Jordaan, 2007). Since this study deals with the flows of trade between Namibia and its 38 main trading partners, the fixed effect will be a more appropriate model than the random effect specification. The top 38 trading partners were selected based on trade statistics for the period 1998 to 2006. Furthermore, the study also applies the Hausman test to check whether the fixed effects model is more efficient than the random effects model. This will be true if the null hypothesis of no correlation between the individual effects and the regressors is rejected.

The main problem with a fixed effects model is that variables that do not change over time cannot be estimated directly because the inherent transformation wipes out such variables. These variables as Martinez-Zarzoso and Nowak-Lehman (2001) stated can be estimated in a second step by running another regression with the individual effects as the dependent variable and distance and dummies as explanatory variables. This is estimated as:

$$FE_{ij} = \alpha_0 + \alpha_1 D_{ij} + \alpha_2 BORDER + \alpha_3 SADC + \alpha_4 EU + \mu_i \quad (6)$$

where FE_{ij} denotes individual effects, and other variables are as defined before.

4. Univariate Characteristics of the Data

Data sources and countries included in the estimation are presented in the Appendix. Before estimating Equation (5), the study analysed the univariate characteristics of the data which entails panel unit root tests. Unit root test is the first step in determining a potentially cointegrated relationship between the variables. If all variables are stationary, then the traditional estimation methods can be used to estimate the relationship between the variables. If the variables are nonstationary a test for cointegration is required. There are different types of panel unit roots tests. The first test is the one of Levin, Lin and Chu (2002) and the second is that of Hadri (2000). The two tests of panel unit roots assume that the autoregressive parameters are common across countries. Levin, Lin and Chu (2002) which is also referred to as LLC uses a null hypothesis of a unit root, while that of Hadri (2000) uses a null of no unit root.

A third test is referred to as the IPS test developed by Im, Pesaran and Shin (2003). It allows the autoregressive parameters to vary across countries and also for individual unit root processes. It is

computed by combining individual countries' unit root tests in order to come up with a result that is specific to a panel. It has more power than the single-equation Augmented Dickey Fuller (ADF) by averaging N independent ADF regressions (Straus and Yigit, 2003: 309). The ADF tests specification may include an intercept but no trend or may include an intercept and time trend. The null hypothesis is that all series contain a unit root and the alternative is that at least one series in the panel contain a unit root. IPS is a one-tailed or lower tailed test based on the N(0,1) distribution. The IPS and LLC are applied in this study and test results are presented in Table A1 in the Appendix. The IPS test results show that only importer's GDP per capita and real exchange rate are stationary. The other variables are non-stationary. The LLC test results indicate that all variables are stationary (null of unit root is rejected). The study uses rejection of unit root by at least one test to assume a verdict of stationarity. This implies that cointegration test is not required and ordinary least squares method can be used to estimate Equation (5).

5. Estimation Results

The estimation results are presented in Table 1. The results of the pooled model are in the second column, while those of fixed effects and random effects models are in third and fourth columns. The main problem of the pooled model is that it does not allow for heterogeneity of countries. It does not estimate country specific effects and assumes that all countries are homogenous. It is a restricted model.

Fixed effects model introduces heterogeneity by estimating country specific effects. It is an unrestricted model as it allows the intercept and other parameters to vary across trading partners. The F-test statistic was performed to test whether countries are poolable and the results indicates that the null hypothesis of equality of individual effects is rejected. This means that a model with individual effects must be selected.

Like the fixed effects, the random effects model also acknowledges heterogeneity in the cross-section. However, it differs from the fixed effects model in the sense that the effects are generated by a specific distribution. Although it assumes that there is heterogeneity in the cross-section, it does not model each effect explicitly. This prevents the loss of degrees of freedom which happens in fixed effects model. The LM test was performed and the null hypothesis of equality of the individual effects is rejected in favour of random effect specification.

The Hausman statistic is used to test the null hypothesis that the regressors and individual effects are not correlated in order to distinguish between fixed effects model and random effects model. Failure to reject the null hypothesis implies that the random effects model will be preferred. If the null hypothesis is rejected, the fixed effects model will be appropriate. The Hausman test statistic shows that the null hypothesis is rejected and this indicates that country specific effects are correlated with regressors. This suggests that the fixed effects model is appropriate, and the random effects estimates are not consistent. Since the fixed effects model is the appropriate one, interpretation of the results will focus on the fixed effects model.

Table 1. Estimation Results

Dependent variable: Export

Variables	**Pooled model**	**Fixed Effects**	**Random Effects Model**
Constant	29.080 (2.154)**	32.634 (3.192)***	26.339 (2.563)**
Importer's GDP	0.622 (8.470)***	0.776 (1.829)*	0.558 (3.377)***
Namibia's GDP	2.470 (1.285)	3.44 (2.549)**	2.714 (2.066)**
Importer's GDP per capita	0.387 (4.588)***	-1.220 (-2.463)**	0.1254 (0.658)
Namibia's GDP per capita	-2.259 (-0.679)	-2.749 (1.216)	-2.387 (-1.059)
Real exchange rate	1.476 (0.538)	1.088 (0.584)	1.396 (0.751)
Distance	-1.634 (-5.203)***		-0.922 (1.288)
Border	0.947 (1.914)*		1.793 (1.524)
EU	1.584 (5.627)***		1.994 (2.946)***
SADC	0.788 (2.409)**		0.612 (0.761)
Adjusted R-squared	0.509	0.774	0.577
F-test		23.063***	
LM test			363.634***
Hausman test		255.009***	

Notes. ***/**/* significant at 1%/5%/10% level.
t-statistics are in parentheses.

The results show that an increase in increase in the importer's GDP and Namibia's GDP causes an increase in Namibia's exports. The coefficients for the two variables are positive and statistically significant. They are consistent with theoretical expectation. Although the coefficient of importer's GDP per capita is positive in the pooled and random effects model, it is negative in the fixed effects model. This indicates that an increase in the GDP per capita of the importing country causes Namibian exports to decrease. Increase in Namibia's GDP per capita also causes exports to decrease, but the coefficient is not statistically significant. This suggests Namibia's GDP per capita has no significant impact on exports. Namibia's real exchange rate has an insignificant coefficient, implying that it does not have an impact on exports.

Country specific effects estimates are presented in Table A2 of the Appendix. The country specific effects show the effects or factors which are unique to each country but not included in the estimation of the gravity model. They emphasise that the bilateral trade between Namibia and its trading partners is different from country to country, and each country is unique. Table A2 shows that there are unique characteristics in some countries which promote Namibia's exports to Angola, Australia, Belgium, Botswana, Canada, Congo, France, Germany, Iceland, Israel, Italy, Japan, Netherlands, Portugal, Singapore, South Africa, Spain, Switzerland, United Arab Emirates, United Kingdom, USA and Zimbabwe (countries with positive effects). Table A2 also shows that there are characteristics that not observable and discourages Namibia's exports to Brazil, Cameroon, China, Democratic Republic of Congo, Ghana, India, Kenya, Malawi, Malaysia, Mauritius, Mozambique, Nigeria, Russia, South Korea, Tanzania and Zambia (countries with negative effects). This suggests the importance of investigating factors which hinder Namibian exports to countries with negative effects in Table A2. This could help in the formulation of Namibia's trade policy.

As explained in Equation (6), some factors which have the potential to explain the fixed effects in Table A2 are determined in the second stage regression. The second stage regression results are presented in Table 2. Distance has a negative coefficient and this is consistent with *a priori* expectation. Namibia exports more to countries that members of the EU and SADC as well as countries where it shares a common border. This suggests that promotion of regional trade agreements encourages Namibian exports.

Table 2. Second stage regression results

Dependent variable: individual effects

Explanatory variables	Coefficient (t-statistics)
Border	3.224 (16.448)***
Distance	-0.140 (-40.240)***
EU	3.896 (122.851)***
SADC	0.814 (2.75)**
Adjusted R-squared	0.988

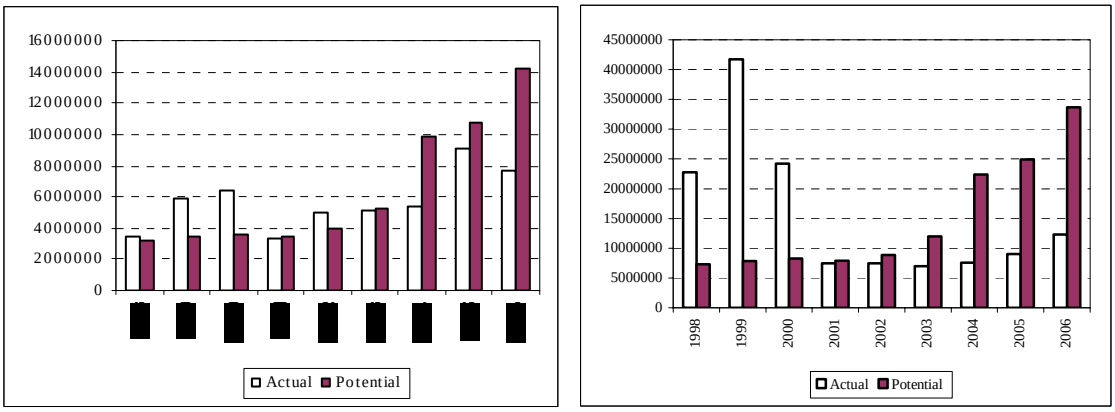
***/** Significant at 1%/5% level.

6. Potential Exports

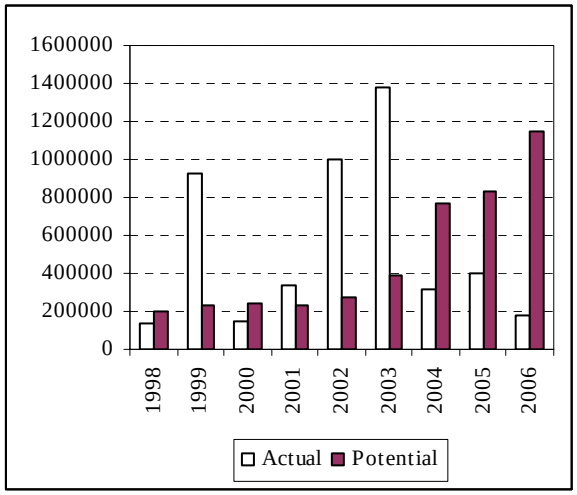
The estimated fixed effects model of Equation (5) is solved in order to determine the within sample potential exports of Namibia (see Eita and Jordaan, 2007). Potential exports are compared to actual exports in to determine if there is unexploited export potential. Figure 1 presents potential and actual exports. There is unexploited export potential to among others, Australia, Belgium, Kenya, Mauritius, Netherlands, Portugal, South Africa, Switzerland and the United Kingdom.

Figure 1. Trade Potential (in USA dollars)

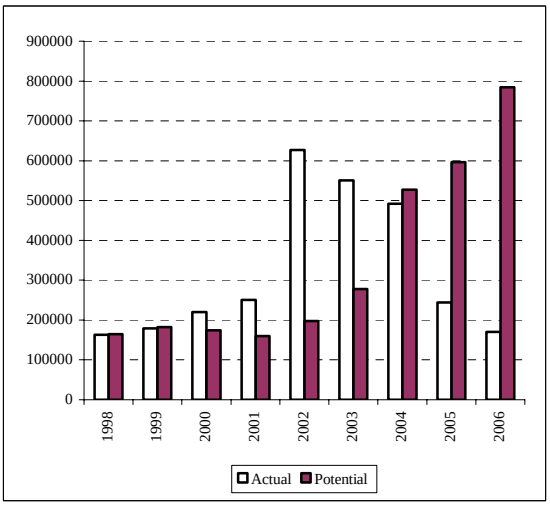
Australia **Belgium**



Kenya

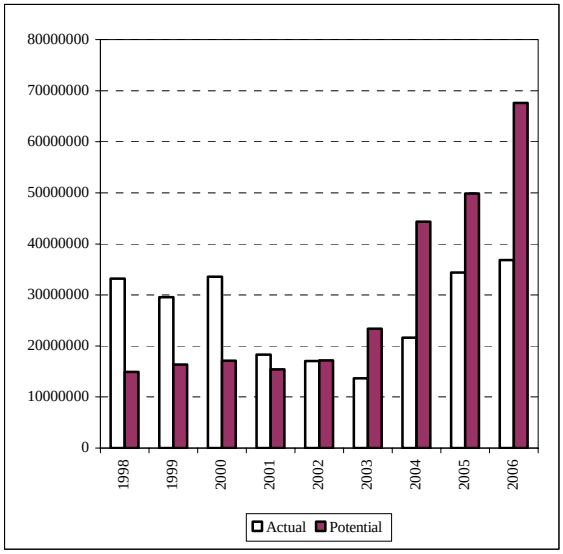


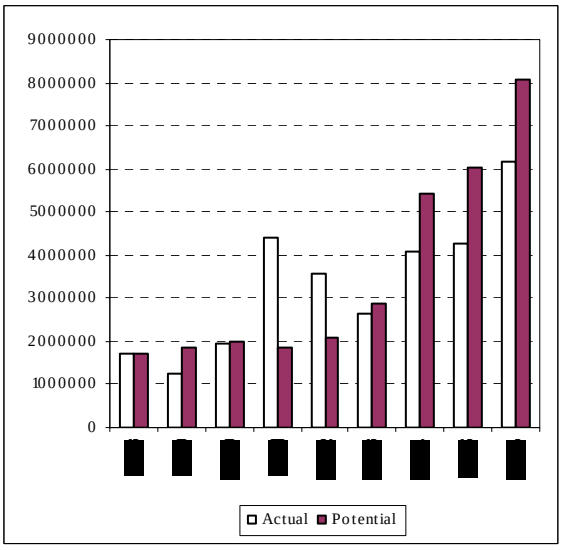
Mauritius



Netherlands

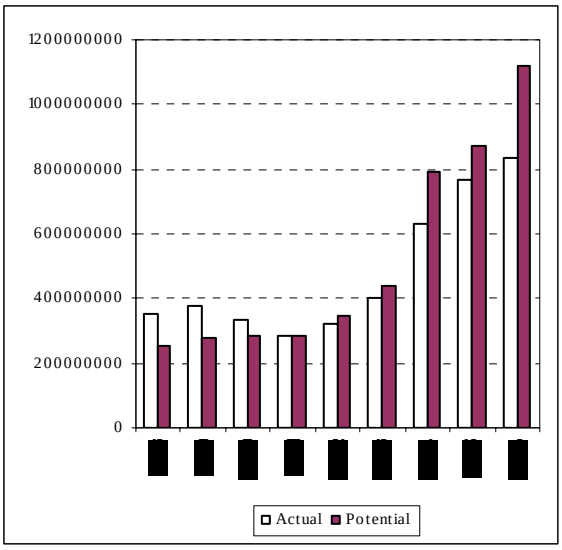
Portugal

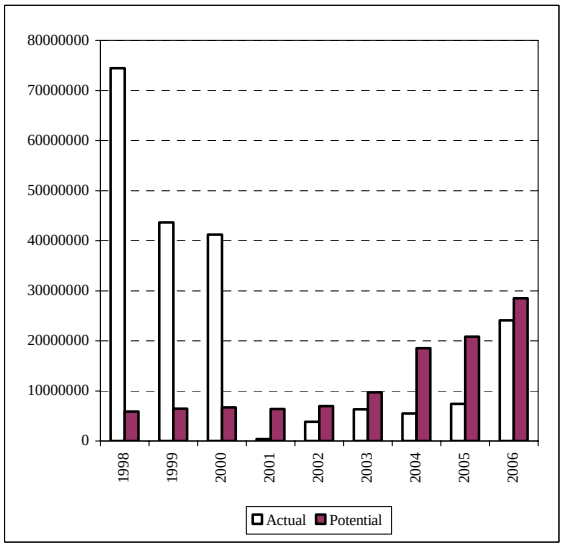




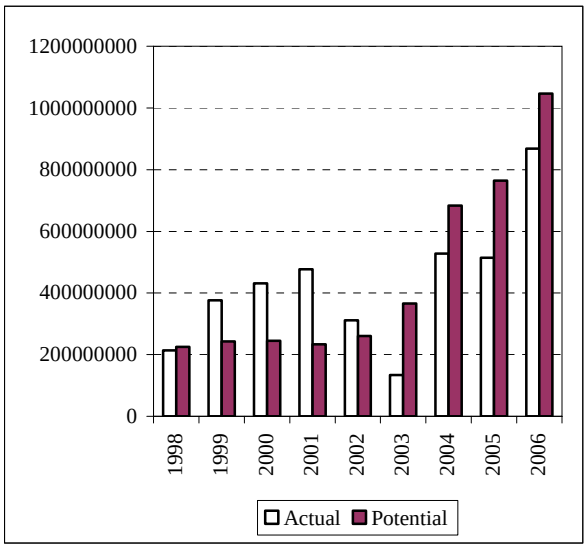
South Africa

Switzerland





United Kingdom



7. Conclusion

This paper applies the gravity model to Namibian exports covering the period 1998 to 2006 in order to investigate the factors that determine export flows between Namibia and its 38 main trading partners. The model was estimated in order to determine whether there is unexploited export potential among Namibia's main trading partners. The results showed that an increase in importer's GDP and Namibian GDP is associated with an increase in Namibian exports. Importer's GDP per capita has a negative impact on export, while Namibia's GDP per capita does not have significant impact on exports. The real exchange rate also does not have an impact on Namibian exports.

As per the theoretical expectations, distance is associated with a decrease in exports. The farther the country is from Namibia, the lower the export. Membership of SADC, EU and sharing a border with Namibia causes an increase in exports. This suggests that regional trade agreements be promoted in order to encourage exports.

The estimated model was solved to determine whether there is potential export that is not exploited. Determining export potential is important especially when the market is not known. The results indicates that among others, Australia, Belgium, Kenya, Mauritius, Netherlands, Portugal, South Africa, Switzerland and the United Kingdom have unexploited export potential. These results are important for trade policy in order to ensure that Namibia's export potential is fully exploited. This will accelerate economic and helps in generating the much-needed employment.

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Appendix

Data

Annual data are used in the estimation and covers the period 1998 to 2006. Thirty eight countries are included in the estimation. Data for exports in USA dollars are sourced from http://www.tips.org.za. Data for GDP and GDP per capita also in USA dollars are obtained from the IMF's World Economic Outlook 2008 at http://www.imf.org. Distance data are taken from http://www.timeanddate.com, while real exchange rate are sourced from various issues of Annual Report of the Bank of Namibia.

Table A1. Panel Unit root test

Variable	**IPS test statistic Null: all series in panel contain unit root**	**LLC test statistic Null: unit root (common unit root process)**
Export	-0.635 (0.263)	-6.679 (0.000)***
Importer's GDP	-0.929 (0.176)	-17.100 (0.00)***
Namibia's GDP	2.094 (0.984)	-6.905 (0.000)***
Importer's GDP per capita	-2.620 (0.004)***	-25.151 (0.000)***
Namibia's GDP per capita	1.438 (0.925)	-8.362 (0.000)***
Real exchange rate	-4.065 (0.000)***	-33.831 (0.000)***

Notes: ***/**/* rejection of the null at 1%/5%/10%.
Probabilities are in parentheses

Table A2.

Fixed Effects (Cross)	
ANGOLA	3.169716
AUSTRALIA	1.239255
BELGIUM	2.632636
BOTSWANA	2.630649
BRAZIL	-6.089036
CAMEROON	-2.305946
CANADA	1.961383
CHINA	-3.282336
CONGO	1.741620
DEMOCRATIC REPUBLIC OF CONGO	-3.224409
FRANCE	2.174326
GERMANY	1.632005
GHANA	-2.058526
ICELAND	2.619695
INDIA	-6.854696
ISRAEL	0.398793
ITALY	2.171727
JAPAN	0.925649
KENYA	-3.504723
MALAWI	-0.634745
MALAYSIA	-4.641938
MAURITIUS	-0.303541
MOZAMBIQUE	-1.077375
NETHERLANDS	3.024368
NIGERIA	-4.121744
PORTUGAL	0.840747
RUSSIA	-1.876658
SINGAPORE	0.593865
SOUTH AFRICA	4.151039
SOUTH KOREA	-0.747960
SPAIN	4.026809
SWITZERLAND	2.894770
TANZANIA	-3.776021
UNITED ARAB EMIRATES	0.270172
UNITED KINGDOM	4.714555
UNITED STATE OF AMERICA	1.816665
ZAMBIA	-1.549596
ZIMBABWE	0.418806