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A PANEL DATA ANALYSIS OF ALGERIAN FOOD EXPORTS: A GRAVITY MODEL APPROACH

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Abstract

In this paper, a gravity model approach was employed to analyze the major factors that influence Algerian food exports to the entire trading partners (98 countries) for the period 2001-2017. In accordance with the panel data analysis with WLS regression method, more consistent results were obtained. The results indicate that there is an increased propensity for food exports. Besides, the main factors to Algerian food exports are partner countries' growth, domestic demand and the common culture and border. All these factors affect the country's exports positively. Transportation costs, proxied by distance, have negative andsignificant effect on Algerian food exports. Results allow us to reveal the countryspecific effects through a ranking and shows that neighboring countries are in the top 10 list. Nevertheless, the existence of trade agreement has a significant negative effectwhich reflects the fact that trade gains from the trade agreements have been minimal for Algerian food exports.
Keywords: Food Exports, Gravity Model, Data Panel, Regression, Algeria.

1. Introduction

The food trade exchange of Algeria with other countries do not show any hopeful sign providing a significant contribution to the country's economic development. This is mainly due to low export trade of Algeria compared to its import trade. Therefore, it is essential to find out the determining factors of Algeria's food exports in order to help agricultural policy makers and planners to undertake appropriate measures to improve trade performance with special reference to food safety.

However, the overall performance of Algeria's agricultural exports since the 1970s has been extremely problematic. One of the main characteristics of Algerian exports structure is that food (and agricultural products) exports is strictly less than 1% since 1980 until now (with an average of 0.39%). In 2017, Algerian food exports are in absolute value about 349 million US$, which represents a share of 0.99% in the total exports!Nevertheless, we perceive a clear increasing (positive) trend in this share last decade shifting from 0.13% in 2006 to 0.99% in 2017.

In this challenge in exports structure, it is important to enhance the Algerian's export potential at global level in general and regional level in particular. Thus, this study aims to apply gravity model analysis for this purpose. This study is predominantly concerned with exploring and describing food exports for Algeria by revealing its main determinants and its basic characteristics. These will be derived using panel regression analysis from the overall importing partners (98 countries) over a period of 17 years(2001-2017).

Indeed, the gravity model has been used extensively during the last five decades, since the pioneering work of Tinbergen (1962), in explaining bilateral and multilateral trade flows.Literature review on theoretical and empirical developments of gravity modeling approach of trade are abundant and the main references are Anderson (1979), Bergstrand (1985, 1989) and more recent comprehensive review is Head and Mayer's (2014) chapter.

The rest of the paper is organized as follows: section 2 presents a brief overview of Algerian exports sector, section 3 describes the research methodology (including modeling approach, hypotheses and data used), section 4 is about results and discussion and section 5 concludes the paper.

2. Overview Algerian Food Exports

In this section, we briefly investigate the performance of Algerian food exports over the period 1974-2017 from CNIS (2018) data. In general, Algerian economy is characterized by the lack of economic diversification as a direct result of Dutch Disease (Ainas et al., 2012; Hausmann et al. 2010), and by its export market (Ainas et al., 2012) and alsoby weakly integrated into the global economy (Hausmann et al. 2010; Lakhdari et al., 2015). According to Teulon (2014), Algeria may be considered as a quasi-rentier country since its income is not based only on oil and gas extraction revenues but because it does not systematically have a surplus balance of trade.

Therefore, Algerian export is a key factor for both the domestic economic growth of Algeria and export generating sectors provide vital inputs for the growth of Algeria (Samad, 2011). Figure 1 shows the evolutionofAlgerian food exports, which climbed from 73 million dollars in 1982 to about 350million dollars in 2017.This corresponds to an average yearly growth of 16.07 percent during the period 1982-2017. Despite the increasing trend in food export values, it interesting to reexamine the facts in terms of the percentages of food exports in total Algerian exports. Figure 2 displays the percentage evolution of this share index over the period 1974-2017 (CNIS, 2018).

In comparing the share of Algerian food exports with total exports, Figure 2 clarifies that Algerian food exports a decreased trend over 1974-2017 with an average of 0.87%. This share has also fluctuated over the studied period and ranged from high values in 70s (about 3%) to its worst by tending to zero since 90s.

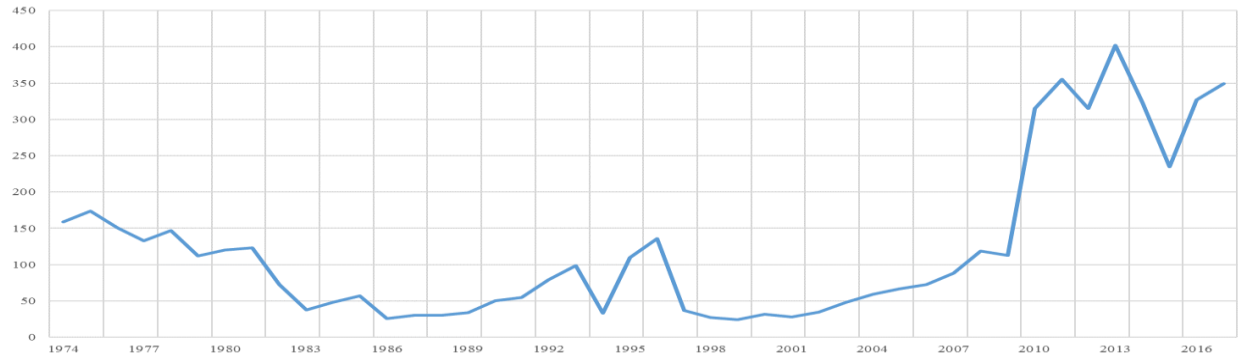

Figure 1. The Evolution of Algerian Food Exports (in Million US$)

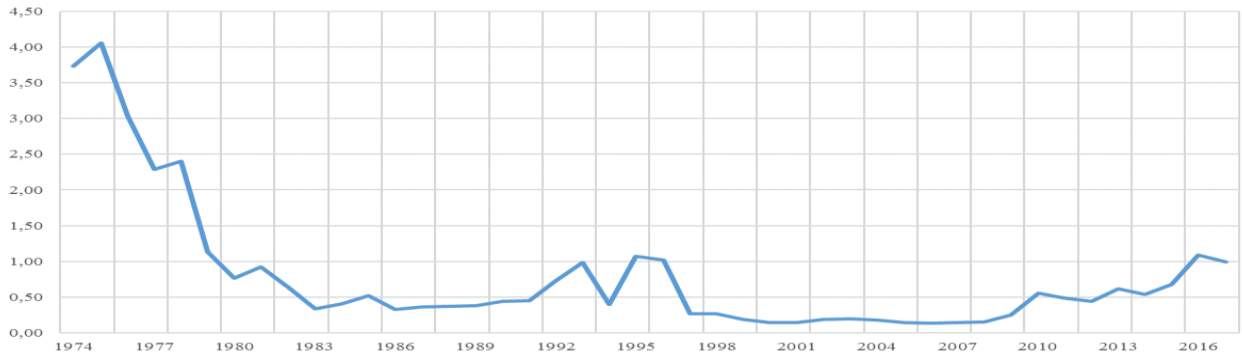

Figure 2. The Algerian Food Exports Shares in Total Exports

It should be noticed that the continued declines in shares since the last three decades may be explained by the increase of total exports, especially petroleum and otheroilexports in recent years.Nevertheless, we can perceive a slight increase in the last decade (since 2010). This could be explained by more expanding on investment promotion for export-oriented policy. The economic reasoning for this policy is based on the export-led growth hypothesis, which suggests that exports

contribute to economic growth, and hence, can be an effective mechanism to expand output, employment, and income and foreign exchange earnings.

3. Research Methodology

3.1 Modeling Approach

According to Newton's Law of universal gravitation, the standard gravity model describes that the force between two physical bodies is determined positively by each body mass, and negatively by the distance between them. This formulation can be generalized in terms of trade between countries as follows: the trade between the two countries is determined positively by each country's sizes, and negatively by the distance between them, by the following formula:

$$X_{ijt} = g \cdot Y_i^{\alpha} \cdot Y_j^{\beta} \cdot D_{ij}^{\delta} \quad (1)$$

where X_{ijt} is the flow of exports into country j from country i, Y_i and Y_j are country i's and country j's sizes, D_{ij} is the geographical distance between the countries and g is the gravity constant.

The generalized gravity model of trade states that the volume of exports between pairs of countries, X_{ij} is a function of their sizes(in terms of incomes – or/and populations – as standard measures), their distance (as a proxy of transportation costs) and a set of dummy variables either facilitating or restricting trade between them. However, additional variables might be added to improve the basic formulation of the selected gravity equation (Cortes, 2007).

In order to elaborate suitable explanatory variables in our model, we use the countries' GDP (**y**) and population (**p**) as measures of countries' size, and for the spatial dimension, we use the distance (**d**) between countries (in Kilometers) and a dummy variable for the existence of common border (**b**). We also add two dummy variables to reflect factors that influence trade namely: a dummy variable (**C**) for the common culture (with reference to the Arabic language and the Islam religion) and a dummy variable (Z) for the existence of trade agreement between Algeria and the importing country by using the multiplicative error term. Therefore, the simple empirical expression of our model is:

$$X_{ijt} = g \cdot y_{it}^{\alpha} \cdot y_{jt}^{\beta} \cdot d_{ij}^{\delta} \cdot e^{\mu} \quad (2)$$

and the secondempirical expression of our model is:

$$X_{ijt} = g' \cdot y_{it}^{\alpha_1} \cdot y_{jt}^{\alpha_2} \cdot p_{it}^{\beta_1} \cdot p_{jt}^{\beta_2} \cdot d_{ij}^{\delta_1} \cdot b_{ij}^{\delta_2} \cdot C_{ij}^{\omega_1} \cdot Z_{ij}^{\omega_2} \cdot e^{\mu} \quad (3)$$

which omits the cross-sectional unit-time effects. The third empirical expression of our model is:

$$X_{ijt} = g' \cdot y_{it}^{\alpha_1} \cdot y_{jt}^{\alpha_2} \cdot d_{ij}^{\delta_1} \cdot b_{ij}^{\delta_2} \cdot C_{ij}^{\omega_1} \cdot Z_{ij}^{\omega_2} \cdot e^{\mu} \quad (4)$$

considered as a full empirical expression omitting the population variables and re-including the cross-sectional unit-time effects.The modeling of Algerian food exports flow will be based on the log-linear form of thesetwo equations.In our estimation, we have used balanced panel data, and time and individual effects are included in the regressions. From the initial regression results, it has been suggested that weighted least-squares (WLS) of panel estimation is the appropriate model for our study.

Our methodology and hypotheses follow the main empirical studies on gravity model applied to exports, namely: Abu Hatab et al. (2010) and Elshehawy et al. (2014) for Egypt, Özer and Koksal (2016) for Turkey, Sevela (2002) for Czech, Butt (2008) and Abbas and Waheed (2015) for Pakistan, Rahman (2003, 2010) for Bangladesh, Boughanmi (2008) for EAU, Batra, (2006) for India, Abidin and Sahlan (2013) for Malaysia.

3.2 Hypotheses

In this study, the gravity modeling of Algerian food exports will exhibit the factors that determine Algeria's food exportation and they are expected to help us understand Algerian trade patterns through the WLS panel regression, which ignores certain problems experienced with panel data analysis. In this strategy, knowing the determinants of export markets will certainly help food exports. Thus, this study will evaluate the six hypotheses below: Hypothesis 1 about thefood exports propensity: We expect positive propensity of food exports. Hypothesis 2 on the size effects: We expect positive signs for α, α_1, α_2, β, β_1 and β_2. Hypothesis 3 on the distance effects: We expect negative signs for δ and δ_1.

Hypothesis 4 on the common border effect: We expect positive sign for δ_2. Hypothesis 5 on the common culture effect: We expect positive sign for ω_1. And finally, the Hypothesis 6 about the presence of trade agreement: We expect positive sign for ω_2.

3.3 Data

In this study, an export-gravity model is presented using total food exports from Algeria to the worldwide. The panel covers the whole 98 importing countries. The data collected for the period of 2001 to 2017 (17 years). We cannot go beyond this period because data are not available.

The data regarding food exports were obtained from the National Center of Information and Statistics (CNIS, 2018) database in current US$.The variables of Gross Domestic Product (GDP) and the population data between 2001-2017 are obtained from the statistics reports of the World Bank (2018).The distance between the importer country and Algeria is from the official website of distancefromto.net, and for the existence of trade agreements between the importer country and Algeria, the data was obtained from the report of the Head Department of Investment Promotion (DGPI, 2018) of the Algerian Ministry of Industry and Mines.

4. Results and Discussion

The collected data were inserted and processed by Gretl© v.3.2017, where the appropriate function of their logarithm was applied. The main descriptive statistics (mean, standard deviation, maximum and minimum values) are shown in Table 1.

Table 1. Descriptive Statistics of Variables Used in the Model

Variable	Mean	S.D.	Min	Max
log_food_export	10.320	8.529	0.000	22.530
log_gdp_dz	25.600	0.440	24.730	26.090
log_gdp	24.830	2.288	18.090	30.600
log_pop_dz	17.390	0.084	17.270	17.540
log_pop	16.290	1.778	11.300	21.050
log_dist	8.270	0.661	6.850	9.820
border	0.060	0.239	0.000	1.00
culture	0.265	0.441	0.000	1.00
agree	0.469	0.499	0.000	1.00

The independent variable (*log_food_export*) seems to have a mean of 10.32 having a null minimum value, to the extent that there is zero exports for some countries in time interval (2000-2017) with a maximum of 22.53 (values in logarithms).

The GDPs values (variables *log_gdp_dz* for Algeria and *log_gdp* for importer countries) have respectively 25.6 and 24.83 with lower variance for the first proper the exporter country. Populations (variables *log_pop_dz* and *log_pop)* also in the same manner having 17.39 and 16.29 respectively with lower variance for the first. On the other hand, dummy variables reflect the proportions of each one. For the common border dummy (i.e. variable *border*), it seems that 6% of the total countries are effective importers noting that Algeria, according to the data used, exports food for all neighboring countries. Concerning the common culture (language and religion), i.e. the variable *culture*, it seems that 26.5% of all importers shares the same culture is a significant percentage. The existence of trade agreement (i.e. the variable *agree*) presents a value of 0.469, which means that roughly 47% of countries importing food from Algeria do have different trade agreements.

In order to confirm the fact that there is an increasing trend for Algeria's food exports, not in terms of exports absolute values, but in terms of export propensity through time, we proceed to reveal the estimated coefficients for pooled OLS regression and plotting them. It should be noticed that seventeen estimated coefficients are statistically significant (with Fisher's Statistics F(16, 1649) = 20.23(0.0000)). The plot of all 17 values are shown in Figure 3.

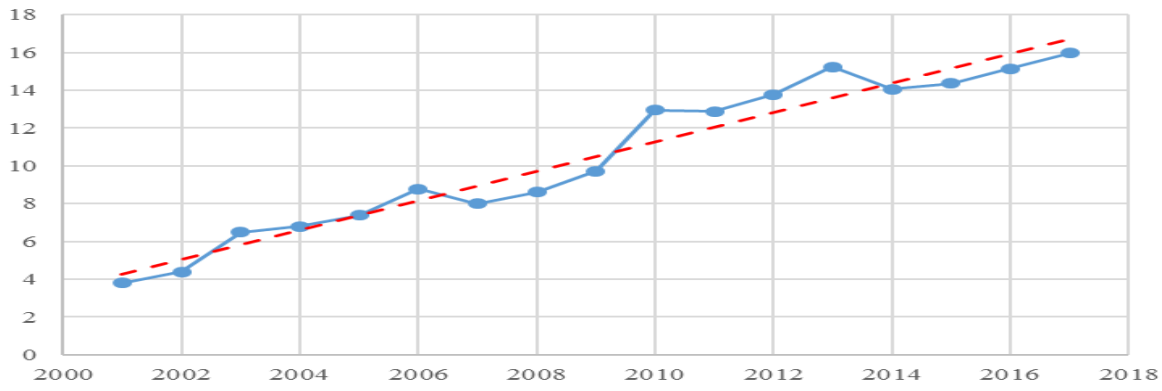

Figure 3. The Trend of the Propensity of Algeria's Food Exports

Each value in Figure 3 reflects the food exports propensity per year. However, the evolution of this index shows a positive slope (about 0.77), which highlights the fact of increasing trend for food exports of Algeria.

The estimation results of the gravity model are presented in Table 3. The simple model equation results are in the second column, where the second model without Country-Time effects is in the third column, and the third model with Country-Time effects without population measures is in the last column. We notice that the weights are based on per-unit error variances. The model has good fitness parameters. It shows values of 0.5 for the correlation (R^2), and overall significance through the F(8, 1641) with much lower p-values, which means that the models are relatively good for interpretation.

From the Table 2, the estimated coefficient of GDP (*log_gdp*) is positive and highly significant in the three models as expected. This implies that Algeria tends to export more towards larger economies. Algeria's exports with country *j* increases by roughly 1% as the product of Algeria's GDP and country *j*'s GDP increases by 1%.

Table 2. Panel Regression Results Using WLS for Algerian Food ExportsGravity Model

	Simple Model			**Model without CT effects**			**Model with CT effects**		
Variables	**Coeff.**	**t-ratio**		**Coeff.**	**t-ratio**		**Coeff.**	**t-ratio**	
const.	27.419	2.23	**	−368.567	−12.07	***	23.161	1.92	*
log_gdp_dz	−0.489	−0.99		−0.125	−0.29		−0.521	−1.08	
log_gdp	1.022	22.16	***	1.311	18.25	***	1.064	21.25	***
log_pop_dz				22.162	9.91	***			
log_pop				−0.449	−4.68	***			
log_dist	−4.420	−29.98	***	−3.848	−20.22	***	−3.977	−21.06	***
border				1.825	4.15	***	1.549	3.41	***
culture				2.042	7.31	***	2.105	7.49	***
Agree				0.298	1.10		−0.176	−0.69	
country	0.008	2.17	**				0.004	1.10	
year	0.422	9.58	***				0.423	9.81	
observations	1650			1650			1650		
R-squared	0.512			0.561			0.555		
Overall F-test	346.015			262.607			256.320		
Log-likelihood	−2317.250			−2318.096			−2321.274		
P-value(F)	0.0000			0.0000			0.0000		

In addition, the country *j*'s population variable indicates that Algeria tends to export more with smaller economies. A 1% increase in the population of food-importing countries (*log_pop)* had been calculated to decrease Algeria's food export by 0.3% (by having high statistical significance for the

last two models). Besides, Algerian population variable seems to have very high estimate with no statistical significance (with reference to the second model).

The distance variable (*log_dist*) is significant and has anticipated negative sign in the three models which indicates that Algeria tends to export more to closer countries. The coefficient value is roughly about 4 which indicates that when distance between Algeria and country *j* increases by 1%, the exports towards this country decreases by 4%. Border dummy (*border*) is found to be highly significant with a positive sign as expected (about 1.6 as average for last two models). Therefore, this evidence could suggest that Algeria should make more efforts to reduce transaction costs of trade with neighboring countries, such as Arab Maghreb Union, COMESA and southern EU countries, to achieve a deeper economic integration.

Common culture also shows a positive effect with high statistical significance. Countries with the same culture (Arabic as the official language and Islamic religious majority) are associated with an increase (about 2%) of Algerian food exports. The presence of trade agreement variable seems to have no significant statistical effect with unanticipated negative sign. This implies that trade gains from the trade agreements have been minimal for Algerian food exports.

With regard to the country specific effects, results are shown in Table 3 (Appendix). The model has R2 = 0.79, and F(97, 1568) = 62.64(0.000). Also there is no multicollinearity problem among the variables. The magnitude of the coefficients reflects the export propensity in our case.We observe that these effects are highly significant for all countries. The propensities are ranged from the highest to the lowest values in the table. Of these effects for example, France, Spain, Libya, Tunisia, Italy, Netherland, Belgium, Morocco, Canada and Mauritania appear to be the top 10 highest propensity to trade with Algeria, and so on to the countries with lower propensities [see Table 3 in Appendix]. It is obvious from the top 10 list, import countries are neighbors except for Netherland and Belgium (less closer) and Canada (extremely far).

5. Conclusions

Recognizing the increased trend in food exports last decade, our study attempted to analyze Algeria's trade pattern empirically and to identify the factors influencing Algerian food exports. We employed the gravity model, which is largely used in explaining bilateral trade, on Algerian food exports covering the period 2001 to 2017 in order to investigate the factors that determine food export flows from Algeria to its 98 trading partners. A panel data analysis with WLS regression method was used to perform the estimation.

According to our results in this study, Algerian food exports follow the basic gravity model, implying that food export flows will increase in proportion to the trading partner's GDP and decrease in proportion to the distance involved.The variable of distance indicates that if distance between Algeria and its importing markets were reduced, the expected change in food export value would be positive. Thus, logistics are important in the export process, which could be increased by improved connections such as infrastructure, direct air travel and improved maritime transportation between Algeria and its trading partners. Results also imply that Algerian food exports tend to increase into countries having the same culture (Arabic language and Islamic religion), which suggests that sharing the same culture promotes exports. This raises the importance ofAlgeria to expand and promote its food exports to those countries. The presence of trade agreements does not encourage Algerian food exports which means that trade gains from the trade agreements have been minimal for Algerian food exports.

This research is of academic value and of value to agricultural trade policy makers and practitioners in the Algerian trade. Hence, there should be some methodological improvements to assess the impact of Algerian food exports in the context of trade costs so that untapped trade potential among trade partners can be evaluated. Furthermore, it would be fortunate to improve the modeling approach so that dynamics considerations in the panel data method can be applied (to the extent that time trend shows significant effects) and thereby projections made based on more statistically significant explanatory variables (e.g. to the extent that population measures are without significant effects). These topics are left for future research.

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Appendix. Table 3

#	Countries	*Coefficient*	*t-ratio*		#	Countries	*Coefficient*	*t-ratio*	
1	france	21.35	277.80	***	50	guinee_equatorial	9.51	4.75	***
2	spain	20.87	183.50	***	51	sao_principe	9.18	4.76	***
3	libya	20.14	68.54	***	52	burkina_faso	8.85	5.89	***
4	tunisia	20.04	73.81	***	53	rep_coree	8.57	4.22	***
5	italy	19.94	64.96	***	54	india	8.39	4.03	***
6	pays_bas	19.49	83.55	***	55	albania	8.38	3.34	***
7	belgique	18.74	91.19	***	56	danemark	8.31	4.71	***
8	maroc	18.58	110.40	***	57	chypre	8.26	3.76	***
9	canada	18.49	111.80	***	58	vietnam	8.25	4.21	***
10	mauritania	18.40	30.24	***	59	thailand	7.53	3.32	***
11	emirats_eau	18.35	40.61	***	60	hongkong	7.31	3.73	***
12	uk	18.34	50.00	***	61	pologne	7.29	3.68	***
13	russia	18.04	47.51	***	62	angola	7.11	3.70	***
14	usa	17.60	66.93	***	63	bulgaria	6.84	3.29	***
15	koweit	17.53	39.42	***	64	south_africa	6.65	3.72	***
16	germany	17.22	30.29	***	65	australia	6.59	3.76	***
17	turquie	16.99	13.97	***	66	seychelles	5.94	3.32	***
18	arabia_saoudia	16.98	21.34	***	67	bangladesh	5.91	2.93	***
19	niger	16.72	13.52	***	68	tanzania	5.62	2.57	**
20	syria	16.46	9.86	***	69	japon	5.59	3.25	***
21	suisse	16.30	65.42	***	70	nigeria	5.55	2.93	***
22	liban	16.01	11.35	***	71	guatemala	5.54	2.95	***
23	guinee	15.94	8.42	***	72	cambodge	5.41	2.95	***
24	jordanie	15.69	9.90	***	73	cuba	5.34	3.68	***
25	suede	15.53	93.49	***	74	uruguay	5.25	2.95	***
26	ghana	15.32	8.43	***	75	gabon	5.22	3.27	***
27	senegal	15.30	10.54	***	76	kenya	5.08	2.56	**
28	qatar	15.25	10.33	***	77	togo	5.08	2.55	**
29	mali	14.57	40.40	***	78	tadjikistan	4.64	2.57	**
30	croatia	14.54	9.89	***	79	oman	4.48	2.56	**
31	cap_vert	14.22	10.61	***	80	djibouti	4.47	2.54	**
32	grece	13.96	7.05	***	81	roumania	4.27	2.51	**
33	gambie	13.39	7.09	***	82	georgia	4.17	2.21	**
34	sierra_leone	13.10	6.17	***	83	tcheque	4.13	2.54	**
35	benin	12.94	7.00	***	84	norvege	4.11	2.57	**
36	liberia	12.74	6.16	***	85	congo	3.87	2.56	**
37	soudan	12.27	5.75	***	86	new_zeland	3.68	2.20	**
38	portugal	11.59	6.03	***	87	yemen	3.67	2.21	**
39	indonesia	11.56	7.13	***	88	autriche	3.54	2.52	**
40	malte	11.41	6.06	***	89	pakistan	3.30	2.13	**
41	egypt	11.34	5.98	***	90	lituanie	3.30	2.14	**
42	cameroun	11.25	7.01	***	91	mexique	3.23	2.21	**
43	bahrein	10.98	7.06	***	92	tchad	3.20	2.20	**
44	china	10.90	5.98	***	93	azerbaidjan	2.89	1.85	*
45	malaisia	10.85	6.10	***	94	luxembourg	2.38	1.84	*
46	ukraine	10.69	6.04	***	95	panama	2.36	1.83	*
47	irak	10.44	4.18	***	96	maurice	1.75	1.46	
48	yougoslavie	10.04	5.09	***	97	estonie	1.61	1.43	
49	cote_divoire	9.59	4.67	***	98	Maldives	1.51	1.45	