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Analyzing Trade Integration in North African Markets: A Border Effect Approach

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Abstract

This paper uses the border effect estimate from a gravity model to analyze the level of market trade integration among Algeria, Egypt, Mauritania, Morocco, and Tunisia from 2005-2012. We analyze total trade as well as trade in agricultural and industrial products. The border effect estimates show that crossing a national border within these North African countries induces a trade-reduction effect. The highest effect is for Algeria, with total trade being reduced by a factor of 5 in 2011-2012, while the lowest effect is for Tunisia, with the total trade being reduced by a factor of 2 in 2011-2012. Our results also show that the border effect is stable over time. The mean value masks differences that are quite substantial in market integration when considering agricultural products or industrial products, the borders effects being lower for the latter. For industrial products in 2011-2012, the highest border effect is in Tunisia, with a factor of 3.3, and the lowest border effect is for Morocco with a factor of 1.9. For agricultural products in the same period, the highest border effect is in Algeria, with a factor of 5.9, and the lowest border effect is in Egypt, with a factor of 2.9. Finally, the equivalent tariffs implied by the estimated border effects are not implausible compared to the actual range of direct protection measures. Integration of the North African market should be pursued by improving structural policies to improve trade efficiency and reap the benefits of international trade.

Résumé

Cet article utilise un modèle de gravité pour estimer les effets frontières et analyser le niveau d'intégration commerciale en Afrique du Nord entre l'Algérie, l'Egypte, la Mauritanie, le Maroc et la Tunisie. Notre analyse couvre la période 2005 - 2012 et concerne aussi bien l'ensemble des échanges que les échanges des produits agricoles et industriels. Nos estimations confirment que les frontières réduisent le commerce en Afrique du Nord. L'effet frontière le plus élevé est observé pour le cas de l'Algérie (le commerce global est réduit par un facteur de 5 en 2011-2012) alors que l'effet le plus faible est observé pour le cas de la Tunisie (le commerce global étant réduit par un facteur de 2 pour la même période). Même si nos résultats empiriques font état d'une relative stabilité des effets frontières dans le temps au niveau du commerce global, ceux des échanges agricoles sont bien plus importants que ceux affectant les produits industriels en 2011-2012. En effet, pour les produits industriels (agricoles) en 2011-2012, l'effet de frontière le plus élevé est celui de la Tunisie (Algérie) avec un facteur de 3,3 (5,9) alors que l'effet frontière le plus faible est pour le Maroc (Egypte) avec un facteur de 1,9 (2,9). Enfin les équivalents tarifaires calculés suite à l'estimation des effets frontières ne contrastent pas avec le niveau actuel des mesures directes de protection. L'intégration en Afrique du Nord passerait par la mise en place de reformes structurelles pour accroître l'efficacité et faciliter le commerce afin de tirer pleinement profit des avantages du commerce international.

1. Introduction

North African countries: Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia represent about one-third of Africa's total GDP and a market of nearly 172 million people (AfDB, 2012). This region is viewed as a large regional trade market; however, intra- trade among the North Africa countries is among the lowest in the world (AfDB, 2012), even though these countries are involved in a variety of bilateral and regional trade agreements.

In 1997, the Arab League created the Greater Arab Free Trade Area (GAFTA) to facilitate and develop trade among the League members through a gradual elimination of trade barriers. Eighteen of the 22 Arab League states signed this agreement. In March 2001, it was decided to speed up the liberalization process, and on January 1, 2005, the elimination of most tariffs among the GAFTA members was enforced. With the exception of Mauritania, which is in the process of joining GAFTA, all North African countries are members of the group.

Recent events appear have worsened this pattern of low intra-regional trade. First, in 2007–2008, the food and financial crises affected global trade and may also have had an impact on intra-regional trade. Second, North African countries have been affected by revolution in some Arab countries, which caused the disruption of economic activity, a reduction in investments, a decrease in foreign direct investment inflows, and a reduction of tourism receipts. Finally, Morocco-Algeria relations have been tense due to several issues; the Morocco-Algeria border has been closed since 1994. This may have an impact on regional integration given the fact that these two countries are the region's largest.

In this paper, we use the gravity-border effect model to analyze the multiple factors that determine bilateral trade flows among North African countries. The underlying intuition of this approach initiated by McCallum (1995) is to compare countries' bilateral trade with respect to the trade flows taking place within those countries' own borders. The estimated border effect captures all trade impediments related to the existence of national borders. The gravity model adopted draws mainly on Anderson and van Wincoop (2003) and is in the spirit of recent applications (e.g. Olper and Raimondi, 2008; Anderson and Yotov, 2010; Fally, 2015). Our work is innovative in several ways. To the best of our knowledge, this is the first study that estimates the level of border effects in Mauritania, Tunisia, Morocco, Algeria, and Egypt and their evolution from 2005-2006 to 2011-2012. In this paper, we also compare the border effects between (aggregated) industrial products and (aggregated) agricultural products, taking into account the impact of several policy variables. Our quantified results provide relevant and useful information for policymakers addressing the issue of the cost of "non-North African regional integration."

The rest of the paper is structured as follows. Section 2 presents an overview of intra-regional trade, while section 3 is devoted to a brief review of the literature. Section 4 develops the empirical model and presents the data used; section 5 presents the results. Section 6 discusses the main implication for North African countries.

2. A Glance at North Africa's Intra-regional Trade

North African countries share similar trade structures. Egypt, Morocco, and Tunisia are labor-abundant countries, while Algeria and Libya produce natural gas in large amounts and are the largest suppliers of natural gas to the European Union. These latter countries also have also huge reserves of hydrocarbons. For Libya and Algeria, the majority of export revenues are linked to oil (i.e. with a dependency on hydrocarbon revenues that exceeded 80 percent of total revenues)[1]. The main manufacturing export sectors in Egypt, Tunisia, and Morocco are the clothing and textile industries, the electrical and mechanical industry, the agri-food industry, and the building materials industry. Mauritania is classified as a Least Developed Country (LDC); its economy suffers from continued trade deficits and fragile economic growth. Mauritania has limited agrarian resources but contains extensive mineral deposits. The country's main source of foreign revenue comes from exporting fish, iron ore, and gold[2].

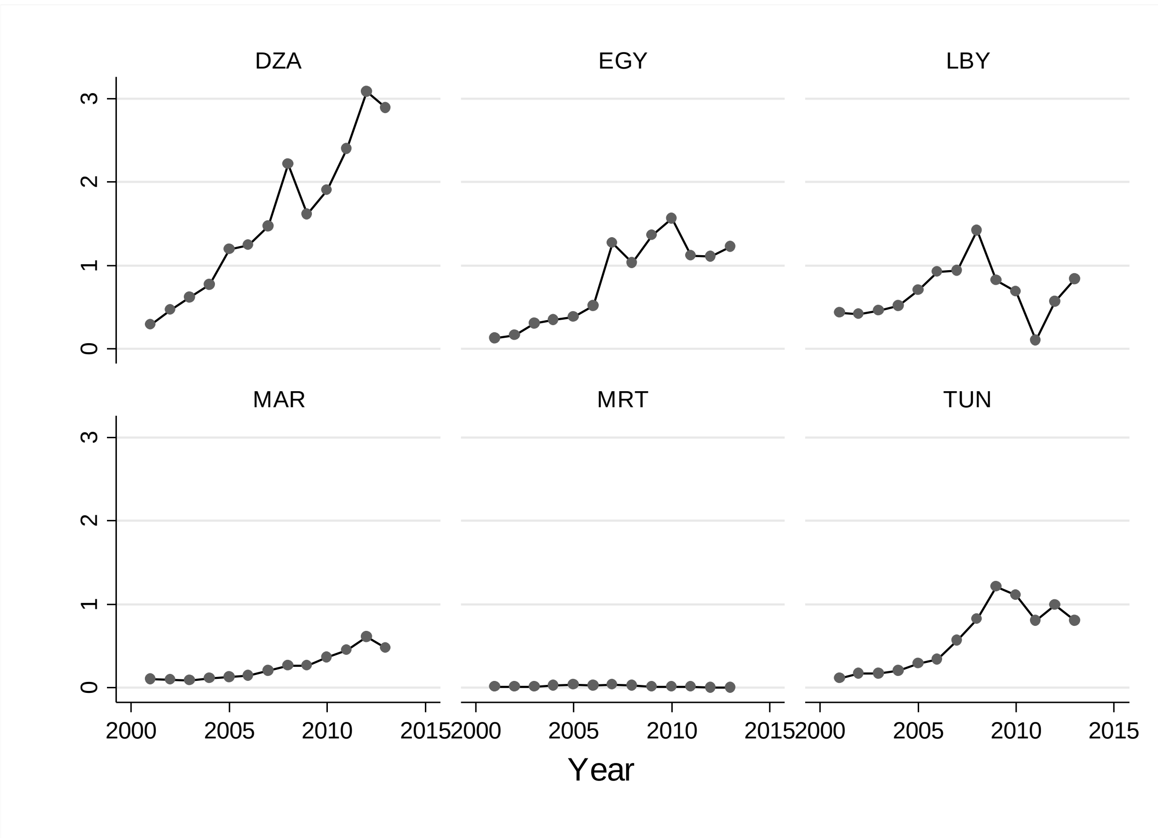
North Africa's total trade accounted for more than 90 percent of the region's GDP during the period 2011-2013[3]. Figures 1 and 2 present the value of exports and imports among North African countries. From 2001-2013, trade increased in all countries, with the exception of Libya and Mauritania, which experienced a decline in exports from 2008-2009. Algerian exports are the most important in the region and go mainly to Egypt, Morocco and Tunisia. The other North African countries receive a very small proportion of Algerian exports. A significant proportion of Morocco's exports went to neighboring Algeria, with the rest allocated among Tunisia, Egypt, and Mauritania. The main destination for Libyan exports is Tunisia, followed by Egypt and Morocco. Between 2008 and 2011, Libyan exports to Tunisia decreased considerably and then rising gradually through 2013. Tunisian exports grew considerably during the same period (2008-2011), with Libya, Algeria, Morocco, and Egypt making up the main destinations, in order of importance. However, Tunisia's exports to Mauritania were very low and stagnated during the study period. Egypt's exports to Mauritania are also low, but its exports to other countries increased from 2001-2013. Egypt's main export markets are Libya, Morocco, Algeria, and Tunisia, respectively. Mauritania has the lowest trade value in the region. Its major export partners are Egypt and Algeria, while its imports come mainly from Morocco.

The picture of exports (see figure 1) is close to that of imports when considering the growth of trade, as well as the low level of exports of Mauritania. The 2008-2009' crisis seems to have had an impact on imports

[1] Tunisia also has an oil sector, although its importance to the country's economy has decreased over time and currently constitutes less than one-third of the country's exports. Morocco is the world's largest exporter of phosphates.
[2] http://www.intracen.org/country/mauritania/ Accessed April 11, 2015.
[3] Mauritania, Libya, and Tunisia are the most open North African economies, with average trade volumes exceeding GDP during 2008–2013. However, for Egypt and Algeria, trade levels have decreased significantly between 2005-2007 and 2011-2013.

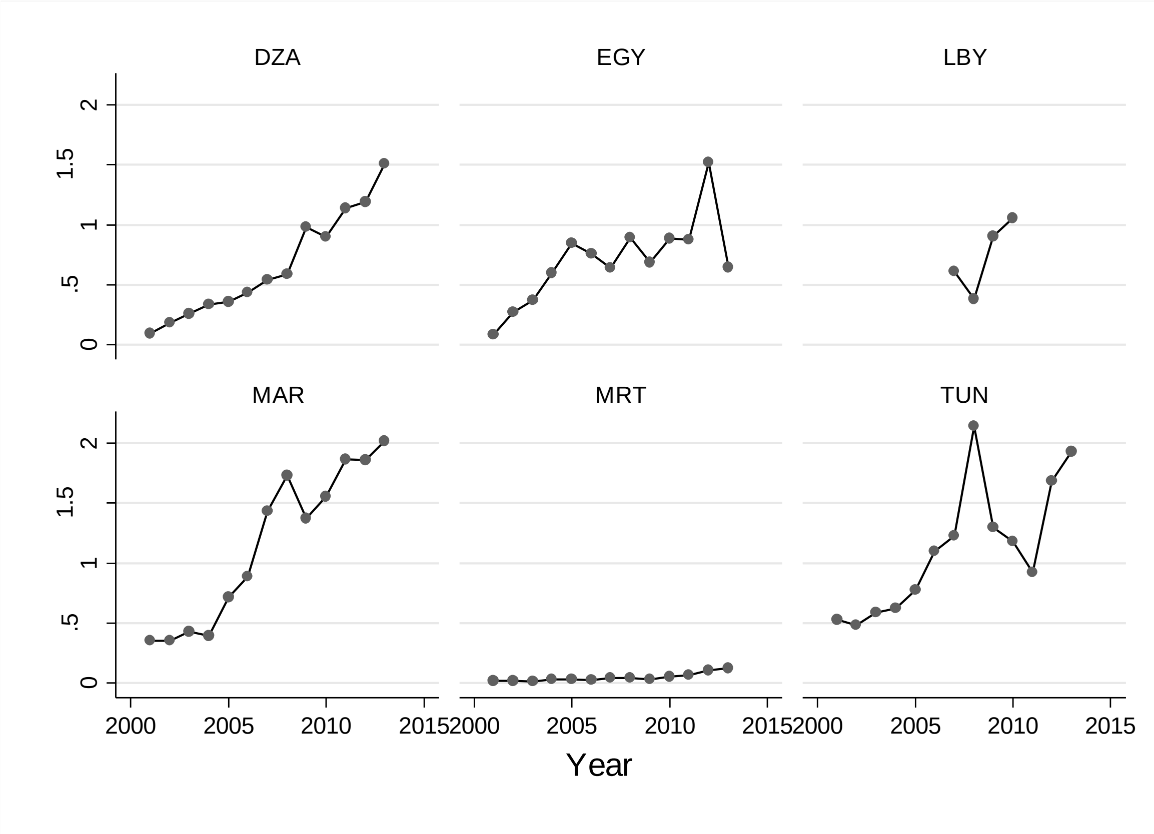
from Tunisia but not from Morocco (MAR). It is also worth noting that trade is more concentrated when considering exports, with exports being lower for Morocco, Mauritania, and Tunisia. Finally, the data indicates that the 2007-2008 crises do not have an impact on trade flows among North African countries, but there is an impact from the 2011 political crisis on exports from Egypt, Libya, and Tunisia.

Figure 1. Total value of exports (in 1000 USD) by destination to trading partners belonging in North Africa



Note: DZA: Algeria; EGY: Egypt; MAR: Morocco; MRT: Mauritania; TUN: Tunisia.
Source: Author's calculations based on UN Comtrade data.

Figure 2. Total value of imports (in 1000 USD) by destination to trading partners belonging in North Africa



Note: DZA: Algeria; EGY: Egypt; MAR: Morocco; MRT: Mauritania; TUN: Tunisia.
Source: Author's calculations based on UN Comtrade data.

3. Related Literature

Following the seminal contribution of McCallum (1995), a growing literature has documented the negative impact of national borders on trade. The border effect was re-estimated by Anderson and van Wincoop (2003) who, following the approach proposed by McCallum (1995), show that the border effect measure is subject to two distortions: an asymmetry effect and a misspecification of the traditional gravity equation. Among others, Raimondi and Olper (2008), Bergstrand, Larch, and Yotov (2015), Persyn and Torfs (2015) show that the theory-based gravity equation is a good approach to take when analyzing the border effect; however, some issues do emerge when using this approach. The first is the problem of taking into account unobservable multilateral resistance factors. Feenstra (2002) shows that using country-fixed effect leads to consistent estimates.

Second, the theory-based gravity approach implies that data on intra-national trade is available. Wei (1996) introduces an ingenious way to estimate border effects in the absence of detailed data on intra-national flow:

intra-national trade with itself is approximated as production minus exports to other countries. Wei (1996) introduces a dummy variable that takes the value of one for the observation of trade with itself and interprets this coefficient as the border effect. As indicated by Anderson and Yotov (2010), the gravity coefficients are unbiased by this practice because the fixed effects control for effect of the measurement error and omitted variables on the gravity equation.

Third, this approach implies the existence of a good measure of international and intra-national distances (Head and Mayer, 2010). Three approaches are commonly used in the literature:[4] (i) fractions of distances to the center of neighboring countries,[5] (ii) area-based measures to try to capture an average distance between producers and consumers,[6] and (iii) geometric approximation based on spatial distribution of economic activity.[7] Head and Mayer argue that the average distance is not the appropriate measure of distance between and within geographically dispersed countries and that a constant elasticity of substitution (CES) aggregation is better suited.

4. Empirical Trade Model and Data Description

4.1 Intensity of Trade

Following Anderson and Yotov (2010) and Fally (2015), we define the structural gravity equation to be estimated as:

$$M_{ij} = \frac{Y_i}{\Pi_i^{-\theta}} D_{ij}^{-\theta} \frac{E_j}{P_j^{-\theta}} \tag{1}$$

In equation (1), M_{ij} represents the value of trade, $P_j^{-\theta}$ $\Pi_i^{-\theta}$ are respectively inward and outward multilateral resistance indexes, Y_i refers to total output in country *i*, E_j refers to total expenditure in country *j*, D_{ij} capture trade costs from *i* to *j*, and the parameter θ reflects the elasticity of trade flows to trade costs.

The multilateral resistance indexes $P_j^{-\theta}$ and $\Pi_i^{-\theta}$ are defined by $P_j^{-\theta} = \sum_i \frac{Y_i D_{ij}^{-\theta}}{\Pi_i^{-\theta}}$ and $\Pi_i^{-\theta} = \sum_j \frac{E_j D_{ij}^{-\theta}}{P_j^{-\theta}}$

.

[4]See Head and Mayer (2010) for a detailed description.

[5]As mentioned by Head and Mayer (2010), Nitsch (2000) criticizes this approach and instead elaborates the average distances within a country as a function of country size.

[6]This approach requires an assumption about the shape of the country and the spatial distribution of buyers and sellers. (see e.g. Leamer, 1997; Heliwell and Verdier, 2001).

[7]Head and Mayer (2000) estimate the border effect in the European Union. They also consider the impact of the different internal measures on the value associated to the border effect. Their results cover a wide variation in the border effect across the industries. For the average industry in 1985, they find that European purchased trends 14 times more from the domestic country than from other European country, with equal size and distance. Head and Mayer (2002) demonstrate that the border effect is conditioned by the method used to measure the internal distance of a country. In this paper, they develop a correct measure of distance to inter-national and intra-national trade. They find the border effect and adjacency effects have been reduced, but they have not disappeared.

The log-linearization of equation (1) defines what Head and Mayer (2014) call the generalized gravity equation:

$$\log\left(\frac{M_{ij}}{Y_i E_j}\right) = \Gamma_j + \Gamma_i - \ln\left(D_{ij}^{-\theta}\right) \tag{2}$$

where $\Gamma_j \equiv \ln\left(P_j^{-\theta}\right)$ and $\Gamma_i \equiv \ln\left(\Pi_i^{-\theta}\right)$ are exporter and importer fixed effects respectively.

As indicated by Olivero and Yotov (2012), in estimating a size-adjusted gravity model, we deal, at least partially, with expenditure and production endogeneity as well as with the important issue of heteroscedasticity.[8] Also, by bringing output and expenditure shares on the left-hand side in our estimations, we impose unitary estimates of the coefficients of these variables, as suggested by the theory of gravity models (Anderson and van Wincoop, 2003). The estimations are done by OLS when analyzing total trade, whereas for industrial products and agricultural products, we use Heckman's two-stage procedure: the first stage probit model and second-stage OLS model. The rationale for using this estimation procedure lies in the fact that the scenario of zero trade flows in the dataset do not occur randomly, but are the outcome of a selection procedure.

4.2 Trade Costs

The trade costs include the effect of distance summarized by d_{ij} with $d_{ij} = d_{ji}$ and the effect of some factual factors of trade preference:

$$D_{ij}^{-\theta} = \exp\left(\begin{array}{l}\vartheta_1 CPIA_o + \vartheta_2 LPIO_o + \vartheta_3 \ln d_{ij} + \vartheta_4 Contiguity \\ + \sum_{c=1}^{5} \vartheta_{5,c}\delta_{ij} \cdot C_d \ln d_{ij} + \sum_{p=1}^{4} \vartheta_{6,p}\delta_{ij} \cdot P_p + \sum_{y=1}^{8} \vartheta_{7,y} \cdot Y_y\end{array}\right) \tag{3}$$

where the *CPIA* is the Country Policy and Institutional Assessment - Structural policies (1=low to 6=high) and *LPIO* is the Logistic performance index – Overall (1=low to 5=high).

We expect the two variables to have a positive impact on trade. $\ln d_{ij}$ is the log of weighted distance, while the variable $Contiguity$ takes the value of 1 if the two trading partners share a common border and 0 otherwise. We define δ_{ij} as an indicator variable taking the value of 0 if $i = j$ (intra-country "imports") and 1 otherwise (Feenstra, 2002; Olper and Raimondi, 2008). C_d is an indicator variable of the country of destination, while the variables P_y are indicator variables with P_1=2005-2006, P_2=2007-2008, P_3=2009-2010, and P_4=2011-2012. Including interaction variables between countries (periods)' indicator variables

[8]Santos Silva and Tenreyro (2006) show that heteroscedasticity renders log-linearized version of gravity estimates inconsistent.

and distance allows us to test the hypothesis that the impact of border effect varies with countries of destination (periods). Given the specification of the estimated model, for the destination country and taking the antilog of the estimated border coefficient $\left[\exp\left(-\vartheta_{c,p}\right)\right]$ with $\vartheta_{c,p} = \vartheta_{5,c} + \vartheta_{6,p}$, we have an estimate of the border effect: how much intra-country trade is above international trade, after catering for other factors that determine trade. Finally, we add year dummy variables $\left(Y_y\right)$ to control for the potential impact of global crises. We expect to see a significant negative impact from the 2007-2009 food and economic crises, as well as the political crises of 2011 and 2012.

As shown by Baldwin and Taglioni (2006) and many others, to properly identify the elasticity of a trade policy in a gravity panel setting, one needs to control for time-varying importers' and exporters' fixed effects. This is because multilateral resistances should not be time-invariant. However, in the study at hand and because of collinearity issues, we introduce 3-year time-varying importers' and exporters' fixed effects. Moreover, Baier and Bergstrand (2007) suggest that the best way to account for endogeneity, which is due to omitted variable bias (and other endogeneity issues), is to use time-invariant pair-fixed effects (see also Martínez-Zarzoso, Felicitas and Horsewood, 2009; Raimondi, Scoppola and Olper, 2012). Accordingly, our estimating equation includes a time-invariant country-pair effect Υ_{ij} with $\Upsilon_{ij} \neq \Upsilon_{ji}$.

4.3 Data Sources and Description

This study covers the period 2005-2012 in Algeria, Egypt, Mauritania, Morocco, and Tunisia. Libya is excluded because of a lack of data. Trade values were obtained from the United Nations Commodity Trade Statistics Database (UN Comtrade), with trade defined at the two-digit level using the harmonized system (HS2).[9] The selected groups of products are presented in Appendix A1.

Transport cost proxies are important variables in gravity models. Previous studies have found that trade elasticities with respect to transport cost and other transaction cost variables are sensitive to the method used to proxy transport cost (Head and Mayer, 2002). We use the measure suggested Head and Mayer (2002):

$$d_{ij} = \sum_{g \in i} \left(\sum_{h \in j} \varpi_h d_{gh} \right) \varpi_g \qquad (4)$$

[9] Data on trade were collected using the World Integrated Trade Solution (WITS), software developed by the World Bank in close collaboration and consultation with various International Organizations including United Nations Conference on Trade and Development (UNCTAD), International Trade Center (ITC), United Nations Statistical Division (UNSD) and World Trade Organization (WTO). See at http://wits.worldbank.org/wits/)

where d_{gh} is the distance between the two sub-regions $g \in i$ and $h \in j$ and ϖ_g and ϖ_h represent the economic activity share of the corresponding sub-region. The Centre d'Études Prospectives et d'Informations Internationales (CEPII) uses the above formula to create a dataset.[10]

Data on GDP, population, trade openness, and *LPIO* come from the World Development Indicators (WDI)[11], data on industrial production are from the United Nations Industrial Development Organization (UNIDO),[12] data on agricultural production are from the Food and Agriculture Organization of the United Nations (FAO),[13] and data on *CPIA* are from the African Development Bank (AfDB)[14]. Table 1 reports some descriptive statistics of the data used.

[10]We also tested the CES aggregation method where $d_{ij} = \left[\sum_{g \in i} \left(\sum_{h \in j} \varpi_h d_{gh} \right) \varpi_g \right]^{1/\theta}$ as suggested by Head and Mayer (2010) and found estimates that are very close.

[11] See http://data.worldbank.org/indicator.

[12] See at http://www.unido.org/en/resources/statistics/statistical-databases.html.

[13]See at http://faostat3.fao.org/home/E

[14]The CPIA is a rating system designed to capture the quality of countries' policies and institutional arrangements. In this paper, we use the CPIA-Structural Policies (Cluster B) that rates countries on a set of several criteria : Business Regulatory Environment; Infrastructure Development; Property Rights and Rule Based Governance; Quality of Public Administration; Transparency, Accountability, and Corruption in the Public Sector; Financial Sector Development; and Environmental Policies and Regulations. The AfDB published data for all African eligible countries up to, and including, 2011. For the year 2012, we use raw data of The Ibrahim Index of African Governance (The Mo Ibrahim Foundation) for Morocco, Algeria, Tunisia and Egypt.

Table 1. Summary statistics of data

Years	Variables	Mean	Standard deviation	Minimum	Maximum
2005	GDP (USD)	5.51E+10	3.46E+10	2.18E+09	1.03E+11
	Population	2.58E+07	2.40E+07	3.15E+06	7.18E+07
	GDP per capita (USD)	1.98E+03	1.40E+03	1.56E+02	4.82E+03
	Total trade (x1000USD)	9.88E+04	1.33E+05	1.06E+03	5.10E+05
	Agricultural products trade (x1000USD)	3.24E+03	6.90E+03	0.00E+00	2.79E+04
	Industrial products trade (x1000USD)	4.63E+04	1.04E+05	0.00E+00	5.06E+05
	CPIA (1=low ; 6=high)	3.633	0.271	3.167	4.000
	LPIO (1=low ; 5=high)	2.422	0.227	2.060	2.760
2010	GDP (USD)	9.89E+10	7.29E+10	3.53E+09	2.19E+11
	Population	2.78E+07	2.61E+07	3.61E+06	7.81E+07
	GDP per capita (USD)	1.98E+03	1.40E+03	1.56E+02	4.82E+03
	Total trade (x1000USD)	1.88E+05	2.29E+05	3.13E+00	8.38E+05
	Agricultural products trade (x1000USD)	2.04E+04	3.73E+04	0.00E+00	1.52E+05
	Industrial products trade (x1000USD)	1.35E+05	2.03E+05	0.00E+00	8.37E+05
	CPIA (1=low ; 6=high)	3.806	0.564	3.000	4.500
	LPIO (1=low ; 5=high)	2.595	0.266	2.330	3.030
2012	GDP (USD)	1.16E+11	9.12E+10	3.96E+09	2.63E+11
	Population	2.87E+07	2.70E+07	3.80E+06	8.07E+07
	GDP per capita (USD)	1.98E+03	1.40E+03	1.56E+02	4.82E+03
	Total trade (x1000USD)	2.54E+05	3.27E+05	8.29E+01	1.13E+06
	Agricultural products trade (x1000USD)	1.26E+04	2.42E+04	0.00E+00	9.47E+04
	Industrial products trade (x1000USD)	1.58E+05	2.87E+05	0.00E+00	1.12E+06
	CPIA (1=low ; 6=high)	3.422	0.838	1.889	4.361
	LPIO (1=low; 5=high)	2.712	0.360	2.280	3.170

5. Estimations Results

5.1 Gravity Model Estimates: Total Trade

Table 2 presents the estimated results of the stochastic frontier specification of the gravity model of imports between the North African countries estimated by maximum likelihood[15]. Column [1] presents the results

[15] In an earlier version of the paper, we estimate a model of trade while considering trade with the main European countries: Belgium, Germany, Spain, France, Italy, Portugal, and Greece. We test three specifications: (i) a model with only North African trading partners, (ii) a model including European trading partners, and (iii) a model including and interaction variable between distance and European countries. The "real" distance elasticity of North African countries is close when considering the values of specification (i) and (iii). We choose not to pursue estimating our model including trade with the main trading partners of European Union because of these results and the focus of our research paper. One should note that in estimating our gravity equation, we control for the Morocco status.

of the benchmark model. Distance is expected to have a significant negative value, and our results are close to those reported in the literature (Head and Mayer, 2013)[16]. The value of the coefficient of contiguity is also significant and negative, as expected. However, one should note that Algeria, one of the biggest economies of North Africa, is contiguous to all other countries except Egypt. The effect of Algeria's less important trade, *all things being equal*, is the effect that is captured by this variable.

As expected, the Country Policy and Institutional Assessment - Structural Policies and Logistics performance indices have a positive and significant sign, with logistics having a higher marginal impact. These results underline the importance of improving domestic policies to encourage entrepreneurial development and business facilities and confirm the need for the North African countries to improve their trade logistics at the national level to enhance trade efficiency and to implement trade facilitation reform programs.

Columns [2] to [3] present some robustness tests of the results. Our results indicate that overall, the estimated coefficients are stable in sign and magnitude. In specification [4], we estimate a model using a non-adjusted trade. The border effect coefficients are significant and have a positive sign, as does the coefficient of distance. Overall, our estimates of gravity model are robust to the specification.

[16] In Table 2, the coefficient of distance of our benchmark specification is -1.2. Head and Mayer (2014:30) reports a mean of 0.93 (-0.93) with a standard error of 0.4, Raimondi and Olper (2008:71) a coefficient of 1.14 (-1.14), Ravishankar and Stack (2014:691) a coefficient of 1.47 (-1.47) to 1.55 (-1.55).

Table 2. Estimated results of the gravity model – Total trade

		Adjusted Trade $\log\left(M_{ij}/Y_iE_j\right)$ **[1]**		**Adjusted Trade** $\log\left(M_{ij}/Y_iE_j\right)$ **[2]**		**Adjusted Trade** $\log\left(M_{ij}/Y_iE_j\right)$ **[3]**		**Non adjusted trade** $\log\left(M_{ij}\right)$ **[4]**	
Variables		**Coefficient**	**Standard error**	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**
GDP	Destination							0.907	0.917
	Origin							0.71	0.741
Country of origin	CPIA-B	0.787*	0.361	0.787*	0.361	0.808*	0.362	0.774*	0.365
	LPIO	1.607**	0.541	1.607**	0.541	1.563**	0.542	1.712**	0.609
Contiguity		-1.944***	0.411	-1.349***	0.285	-1.916***	0.412	2.817***	0.417
Log of distance		-1.218***	0.325	-1.638***	0.289	-1.219***	0.326	1.542***	0.301
Border (time	2005-2006	-0.438***	0.11	-0.318***	0.091			-1.622***	0.189
interaction)	2007-2008	-0.393***	0.108	-0.274**	0.088			-1.575***	0.183
	2009-2010	-0.502***	0.104	-0.383***	0.085			-1.683***	0.18
	2011-2012	-0.436***	0.104	-0.316***	0.085			-1.617***	0.18
Border (country interaction)	Mauritania	-0.174**	0.065			-0.620***	0.117	0.333	0.269
	Algeria					-0.451***	0.101		
	Tunisia	-0.210**	0.077			-0.653***	0.067	0.927***	0.168
	Egypt	0.12	0.08			-0.326**	0.098	0.665***	0.098
	Morocco	-0.092	0.096			-0.538***	0.134	0.167	0.17
Number of observations		175		175		175		175	
Adjusted R^2		0.924		0.921		0.920		0.935	

Note: ***, **, * indicate significance at 1%, 5% and 10% respectively. Estimates of fixed effects are omitted for brevity as are the years' dummy estimates.

5.2 Border Effects

5.2.1 Total Trade

We now analyze our results regarding the estimation of border effects within North Africa, using the benchmark specification of our gravity equation (Column [1] of Table 2). Overall, the results presented in Table 3 are reasonable when compared to those found in the literature (Feenstra, 2002; Olper and Raimondi, 2008).[17] At 5.038 in 2011-2012, Algeria has the highest border effect with a trade reduction of 503.8%. These results indicate that the Algerian market is the least integrated market in North Africa. Tunisia has the lowest trade reduction border effect, at 1.994. Our results also indicate that the border effect values are stable when considering the periods 2005-2006 and 2011-2012. For example, in Algeria, the decrease in border effect is from 506.3 percent in 2005-2006 to 503.8 percent in 2011-2012. These results indicates that the 2007-2008 and 2011 crises may have had an impact on North Africa's market integration. However, the results presented in Table 3 also indicate that trade reduction border effects were higher from 2009-2010 and lower from 2007-2008.

Following Olper and Raimondi (2008), we use the estimated border coefficients to compute an implied measure of ad valorem equivalent as:

$$AVE = \exp\left[\vartheta_{b,C_k^d} \big/ (1-\sigma)\right] - 1 \tag{5}$$

We use different values of elasticities of substitution of imports (σ). The results presented in Table 3 indicate that increasing the substitution elasticity between home and foreign goods significantly decreases the estimated AVE implied by border effects. As mentioned by Olper and Raimondi (2008: 173), this is due to "*the greater the elasticity, the smaller the necessary domestic-foreign price gaps, induced by protection, to have consumers switch to domestic products*". The elasticity of substitution varies by products, and each country pattern of production and imports has an impact on the estimated AVE.

[17]As an example, the border effect between Canada and US is about 5 (Feenstra, 2002).

Table 3. Border effect average by country and over time and for global trade

	2005-2006	2007-2008	2009-2010	2011-2012
Mauritania				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.289	-1.242	-1.350	-1.284
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	3.629	3.463	3.857	3.611
Algeria				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.622	-1.575	-1.683	-1.617
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	5.063	4.831	5.382	5.038
Tunisia				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-0.695	-0.648	-0.756	-0.690
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	2.004	1.912	2.130	1.994
Egypt				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-0.957	-0.910	-1.018	-0.952
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	2.604	2.484	2.768	2.591
Morocco				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.455	-1.408	-1.516	-1.450
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	4.284	4.088	4.554	4.263
Ad valorem equivalence				
Reference years	2011-2012			
Elasticity of substitution of imports (σ)	4	6	8	10
Mauritania	53.42%	29.28%	20.13%	15.33%
Algeria	71.43%	38.18%	25.99%	19.68%
Tunisia	25.86%	14.80%	10.36%	7.97%
Egypt	37.35%	20.97%	14.57%	11.16%
Morocco	62.15%	33.64%	23.02%	17.48%

5.2.2 Agricultural Products versus Industrial Products

Now we compare the results of the border effects for the aggregated industrial sector to those of the aggregated agricultural sector. The results of the border effects are presented in Tables 4 and 5. A higher border effect for agricultural product is expected because these products are characterized by high protection levels, complex tariff structures, low transportability, and strong "home bias" in preferences, all factors that could induce large border effects (Olper and Raimondi, 2010; Ghazalian, 2012). This expectation is confirmed by our results.

For example, while we find the highest border effect for industrial products in Tunisia, with a factor of 3.304, the highest border effect for agricultural products is 5.948 in Algeria. Because of lower elasticities of substitution between goods for agricultural products (Anderson and Yotov, 2010; Ghazalian, 2012), the estimated ad valorem equivalence of the border effect should be much higher in the agricultural sector. Our results also indicate that border effects increased from the period 2005-2006 to the period 2011-2012, especially when considering agricultural products.[18] For example, in Algeria, the increase was from 468.3 percent in 2005-2006 to 594.8 percent in 2011-2012 and in Egypt, the increase was from 225.5 percent to 286.3 percent. These results can be explained by the fact that following the 2007-2008 crisis, several countries adopted policies that disfavor international trade and market integration.[19]

For the industrial sector, the increase in border effect is less important. For example, in Tunisia, the increase is only from 291.2 percent to 330.4 percent, while in Morocco, it is only from 165.4 percent to 187.6 percent.

Finally, our results also indicate that countries' trade reduction border effects differ by goods. For industrial products, the highest border effect is seen in Tunisia while for agricultural products, it is in Algeria. At 187.6 percent, the lowest trade reduction border effect factor is in Morocco; for agricultural products it is in Egypt at 286.3 percent.

[18]Olper and Raimondi (2008) find that within the EU, market integration is slow for agricultural products.
[19]See e.g. Jones and Kwiecinski (2010) and http://www.fao.org/giews/food-prices/food-policies/en/ (Accessed January 29, 2016).

Table 4. Border effect average by country and over time and for agricultural products

	2005-2006	2007-2008	2009-2010	2011-2012
Mauritania				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.435	-1.537	-1.655	-1.674
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	4.200	4.651	5.233	5.333
Algeria				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.544	-1.646	-1.764	-1.783
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	4.683	5.186	5.836	5.948
Tunisia				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.067	-1.169	-1.287	-1.306
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	2.907	3.219	3.622	3.691
Egypt				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-0.813	-0.915	-1.033	-1.052
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	2.255	2.497	2.809	2.863
Morocco				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.156	-1.258	-1.376	-1.395
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	3.177	3.518	3.959	4.035
Ad valorem equivalence				
Reference years	2011-2012			
Elasticity of substitution of imports (σ)	4	6	8	10
Mauritania	74.72%	39.77%	27.02%	20.44%
Algeria	81.18%	42.85%	29.01%	21.91%
Tunisia	54.55%	29.85%	20.51%	15.62%
Egypt	42.00%	23.42%	16.22%	12.40%
Morocco	59.20%	32.18%	22.05%	16.77%

Table 5. Border effect average by country and over time and for industrial products

	2005-2006	2007-2008	2009-2010	2011-2012
Mauritania				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-0.732	-0.697	-0.877	-0.858
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	2.079	2.008	2.404	2.358
Algeria				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-0.826	-0.791	-0.971	-0.952
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	2.284	2.206	2.641	2.591
Tunisia				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-1.069	-1.034	-1.214	-1.195
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	2.912	2.812	3.367	3.304
Egypt				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-0.636	-0.601	-0.781	-0.762
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	1.889	1.824	2.184	2.143
Morocco				
Border coefficient $\left[\vartheta_{b,C_k^d}\right]$	-0.503	-0.468	-0.648	-0.629
Border effect $\left[=\exp\left(-\vartheta_{b,C_k^d}\right)\right]$	1.654	1.597	1.912	1.876
Ad valorem equivalence				
Reference years	2011-2012			
Elasticity of substitution of imports (σ)	4	6	8	10
Mauritania	33.11%	18.72%	13.04%	10.00%
Algeria	37.35%	20.97%	14.57%	11.16%
Tunisia	48.93%	27.00%	18.62%	14.20%
Egypt	28.92%	16.46%	11.50%	8.84%
Morocco	23.33%	13.41%	9.40%	7.24%

6. Concluding Remarks

In this paper, we use the gravity-border effect model to analyze factors that determine bilateral trading flows among Algeria, Egypt, Mauritania, and Tunisia. We analyze total trade as well as trade in agricultural and industrial products. The estimated border effect captures all trade impediments related to the existence of national borders.

Our results indicate that Tunisia has the highest distance elasticity when it is the country of origin; the distance elasticity is the highest for Egypt as a country of destination. The results show that the 2008-2009 economic crisis did not have an impact on the value of imports among North African countries. Thus, stronger regional integration could be a good way to surpass global economic crises.

The border effect estimates show that crossing a national border within North Africa induces a trade-reducing effect. Algeria is the country with the highest border effect, indicating that its market is the least integrated (i.e. the total trade being reduced by a factor of 5 in 2011-2012), while Tunisia has the lowest trade reduction border effect (i.e. the total trade being reduced by a factor of 2 in 2011-2012).

Our results also show that the border effect is stable over time when estimations are done using global trade. The pattern is different when analyses concern agricultural products; in this case, the border effect increased from the period 2005-2006 to the period 2011-2012. This result could be explained by the fact that following the 2007-2008 crisis, several countries adopted policies that disfavor international trade and market integration. In addition, we find that the trade reduction effect is higher in the agricultural sector and, because of lower elasticities of substitution between goods for agricultural products, the estimated ad valorem equivalence of border effect should be much higher in the agricultural sector. For industrial products in 2011-2012, the highest border effect is in Tunisia, with a factor of 3.3, and the lowest border effect is for Morocco with a factor of 1.9. For agricultural products in the same period, the highest border effect is in Algeria, with a factor of 5.9, and the lowest border effect is in Egypt, with a factor of 2.9. Finally, the equivalent tariffs implied by the estimated border effects are not implausible compared to the actual range of direct protection measures.

Our estimates indicate that trade-reducing effects do not decrease over time and that they experience an increase for agricultural products. Some of the underlying causes for this can be found in North Africa’s large share of traded goods subject to physical and documentary inspection at the borders; these inspections raise costs and delays. North African countries could gain from close customs cooperation and mutual recognition of regulations and procedures. The results underline the importance of improving domestic policies to encourage entrepreneurial development and business facilities and confirm the need for the North African countries to improve their trade logistics at the national level to enhance trade efficiency and to implement trade facilitation reform programs.

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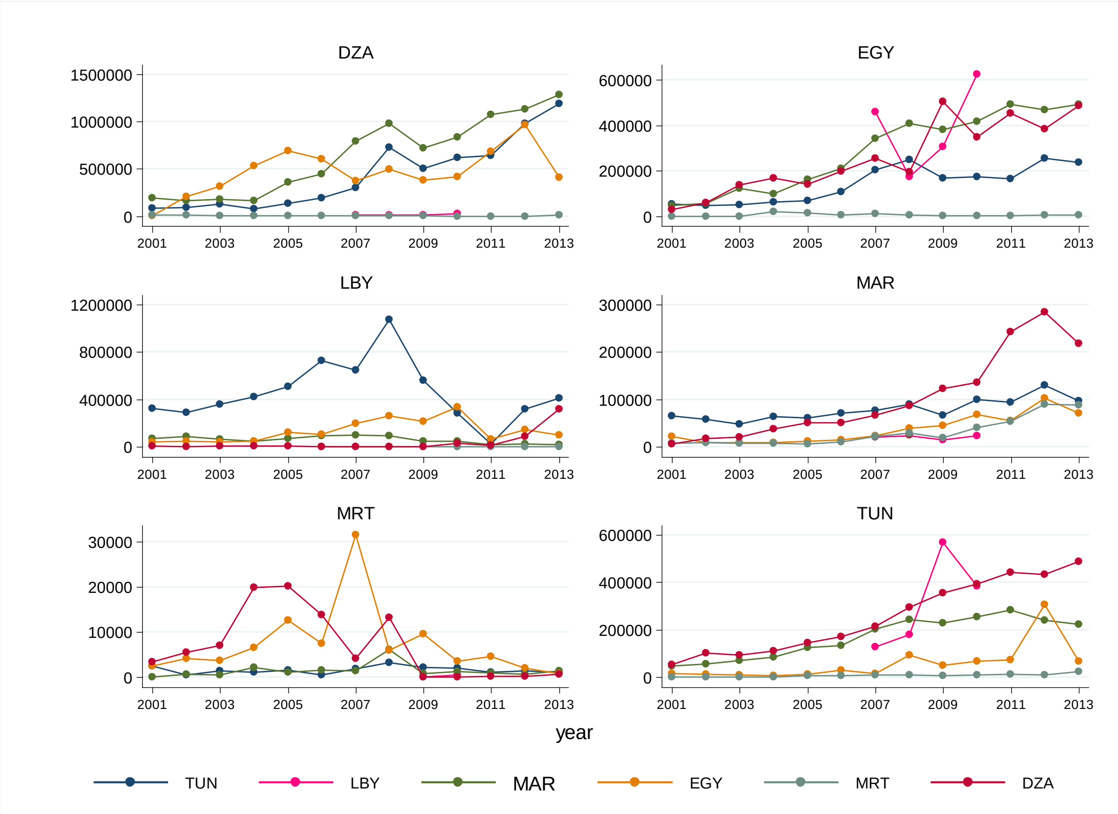
Appendix A1 - Selected groups of products

Product categories		**Section**	**HS range**	**Label**
Agricultural products		I	01 05	Live animals; animal products
		II	06 14	Vegetable Products
		III	15	Animal or vegetable fats and oils
		IV	16 24	Foodstuffs, beverages, tobacco
Industrial products	*Mineral Products*	V	25 27	Mineral products
	Chemicals & Allied Industries	VI	28 38	Products of the chemical or allied industries
	Plastics / Rubbers	VII	39 40	Plastics, rubber and articles thereof
	Raw Hides, Skins, Leather & Furs	VIII	41 43	Raw hides and skins, and saddlery
	Wood & Wood Products	IX	44 46	Wood, charcoal and cork and articles thereof
		X	47 49	Pulp of wood, paper and paperboard
	Textiles / Footwear/ Headgear	XI	50 63	Textiles and textile articles
		XII	64 67	Footwear, hats and other headgear
	Stone/ Glass/ Metal	XIII	68 70	Articles of stone, glass and ceramics
		XIV	71	Pearls, precious metals and articles thereof
		XV	72 83	Base metals and articles thereof
	Machinery/ Electrical/ Transportation	XVI	84 85	Machinery and appliances
		XVII	86 89	Transport equipment

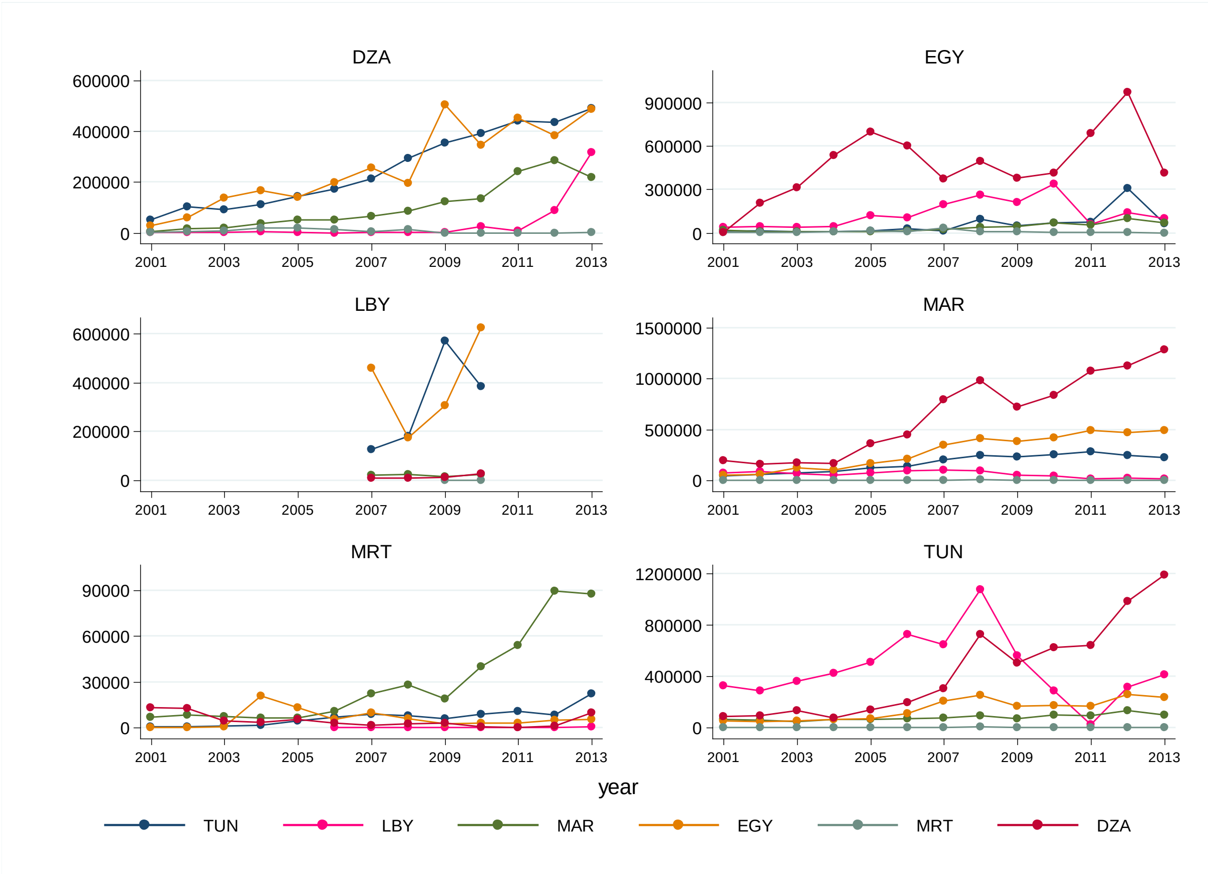
Source: UN International Trade Statistics

Appendix A2 Total value of exports (in 1000 USD) by destination to trading partners belonging in North Africa.



Note: DZA: Algeria; EGY: Egypt; MAR: Morocco; MRT: Mauritania; TUN: Tunisia.
Source: Author's calculations based on UN Comtrade data.

Appendix A3 – Total value of imports (in 1000 USD) by destination to trading partners belonging in North Africa.



Note: DZA: Algeria; EGY: Egypt; MAR: Morocco; MRT: Mauritania; TUN: Tunisia.
Source: Author's calculations based on UN Comtrade data.

Appendix A4 – Estimated results of the gravity model for agricultural and industrial products

Variables		Agricultural products		Industrial products	
		Coefficient	Standard errors	Coefficient	Standard errors
Origin	CPIA-B	1.531**	0.502	-0.636	0.717
	LPIO	1.750**	0.575	1.261	0.827
Contiguity		-0.669	0.668		
Log of distance		-1.645**	0.755	-3.144***	0.791
Border	2005-2008	-0.636***	0,106	-1.319*	0,495
	2007-2008	-0.601***	0,104	-1.548**	0,49
	2009-2010	-0.781***	0,101	-1.261*	0,487
	2011-2012	-0.762***	0,103	-1.424*	0,501
Border	Mauritania	-0,096	0,09	0,159	0,076
	Algeria	-0,19	0,128		
	Tunisia	-0.433***	0,09	0.478***	0,089
	Egypt			0.679***	0,09
	Morocco	0,133	0,149	0.360**	0,091
IMR				-1.265	1.060
Number of observations		175		127	
Adjusted R^2		0.897		0.781	

Note: ***, **, * indicate significance at 1%, 5% and 10% respectively. Estimates of fixed effects are omitted for brevity as are the years' dummy estimates.

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