Options to improve food security in North Africa:
CGE modelling of deeper trade and investment integration with the European Union

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This paper presents some macro and food security impacts of deeper economic integration between the European Union and three North African countries, namely Egypt, Morocco and Tunisia. It conducts a quantitative impact assessment of increase in trade and investment flows using the Modular Applied General Equilibrium Tool (MAGNET). Trade liberalization enhances food security by counteracting the rise in food prices, fostered by growing demand for agricultural products in North Africa. Investments either on the whole economy or targeted to cutting down losses (waste) in food production are modelled. Results suggest that economic growth is stimulated mostly by widespread productivity gains (not restricted to agri-food sector) and boosted by trade integration through removal of non-tariff measures.

1. Introduction

The South Mediterranean region experiences a political turmoil where most of the countries, especially in North-Africa, are engaged in an ardent process of political and economic reforms. At hand improving food security appears crucial not only for economic development but also for ensuring a peaceful transition (Maystadt et al., 2014). Next to the Arab awakening, the European Union foreign affairs council provides the European Commission with a mandate to negotiate deep and comprehensive free trade areas (DCFTAs) with Egypt, Morocco, Tunisia (and Jordan). Compared to an existing FTA established by the Euro-Mediterranean Association Agreements, a DCFTA goes well beyond removing tariffs to cover a range of regulatory issues such as technical barriers (TBT), sanitary and phytosanitary (SPS) measures, investment protection, public procurement, competition policy, etc. It is thus expected that DCFTAs will increase foreign direct investments (FDIs) and capital flows among partners. For the EU, these DCFTAs are an invaluable tool for influence and stability. Whether through full membership in the EU or the conclusion of a DCFTA, the EU trade policy for a "near circle" (southern and eastern neighbors) is dominated by a goal of political stability (Boulanger and Messerlin, 2014).

For North Africa, further economic opening and interconnections with the EU ensure important implications for economic and social policies. Egypt, Morocco and Tunisia, despite national specificities, are characterized by a significant contribution of the agri-food sector in main economic aggregates such as GDP or employment (Table 1). Consumption is driven by a growing and young population (e.g. in 2050 the population of Egypt will represent more than one fifth of the EU population) and production faces many constraints (e.g. water scarcity or weak institutions). GDP per capita is much lower than in the EU, and experienced recent decrease in Tunisia or inertia in Egypt. In 2011, GDP per capita in EU is 23,372 euros,

i.e. 19 times, 12 times, 8 times the GDP per capita in Egypt, Morocco and Tunisia, respectively (Global Insight, 2013).

The EU is by far the main trading partner of NAF countries. Thiis relationship is not reciprocal. Taking the example of Morocco, the EU is the destination of about 60% of its exports (65% for food and animal products) and the most important source of its imports. By contrast, about 1% of EU exports are destined to Morocco, and EU imports from Morocco represent about 0.5% of European total imports.

<div align="center">(Table 1 here)</div>

NAF countries already benefit from significant trade preferences when exporting to the EU market (Emlinger et al., 2010). In view with existing trade commitments, price and seasonal duties remain a key topic to be addressed. Indeed the EU entry prices system (EPS) applies on 28 tariff lines at the 8-digit level, including tomatoes, cucumbers, courgettes, citrus fruits, grapes, apricots, and plums (WTO, 2013). Goetza and Grethe (2009) find that the EPS is of high relevance for North African exports, especially Moroccan exports of courgettes, cucumbers and tomatoes. For Emlinger et al. (2008), assessing effects of trade liberalization within the Mediterranean area must be discussed country by country and on a product-by-product basis. However the aim of our paper is to provide an overall assessment of potential increases in trade and investments in North Africa, going beyond specific sectors or sensitive products.

We use a computable general equilibrium (CGE) model to simulate the macroeconomic effects of economic integration between the EU and most of the NAF countries – namely Egypt, Morocco and Tunisia. We apply the MAGNET (Modular Applied General Equilibrium Tool; Woltjer and Kuiper, 2014) model that builds upon the well know GTAP (Global Trade Analysis Project; Hertel, 1997) model. We concentrate on the agri-food sector

and report on the regional effects with special attention to the impacts on growth, jobs and food security. Indeed economic integration through trade and investment flows generates changes in market prices and eventually in factor returns and household incomes (Rutten et al., 2013). Food security is thus impacted by price movements that a CGE model is able to quantitatively capture.

We model a set of four policy options, i.e (i) Trade liberalization scenario which shows the potential impacts of agri-food trade liberalization between NAF and EU countries in the context of DCFTAs negotiations; (ii) Extended trade liberalization scenario which pays special attention in removing non-tariff measures (NTMs) – such as SPS measures or TBT – which put productivity gains at risk; (iii) Broad public and private investment scenario which captures the effects of an increase in total factor productivity (TFP). This scenario sheds some light on the effects of FDIs and capital flow increase in NAF countries; (iv) Targeted food waste scenario which focuses on the improvement of food chain efficiency. This scenario assumes a TFP increase aiming to reduce losses (waste) in NAF countries' agricultural production, post-harvest handling and storage. Inclusive investment would also address related productivity challenges, e.g. addressing expected negative impacts of climate change on crop yields. Crop modelling results indicate that Middle East and North Africa will face yield declines of about 20% for wheat or 30% for rice in 2050 (IFPRI, 2009).

The paper is set out as follows. Section two develops the CGE modeling strategy, including data and scenarios. Section three is dedicated to the presentation and interpretation of the results. Section four concludes.

2. Modelling approach and simulations

MAGNET is a general equilibrium model built upon the GTAP model. It adopts a modular approach whereby the standard GTAP-based core can be augmented with modules depending on the purpose of the study.

In the general equilibrium modelling framework, demand for and supply of commodities and endowments meet in markets, which are perfectly competitive and which clear via price adjustments. Natural resources and land are assumed to adjust sluggishly between sectors. Based on respective assumptions regarding labor, land and capital markets, MAGNET features extend the standard GTAP model as follows: more sophisticated production structure (to account for inherent differences in the degree of substitutability between land and non-land factors), a consumption structure that reflects changes in taste over time (towards meats, dairy, fish, fruit and vegetables, and away from staple foods), segmented (agri-non, agri) factor markets and endogenous land supply (whereby land supplied to agriculture may respond to changes in the land rental rate). Each of these extensions is explained in more detail in Kavallari et al. (2013). This extension makes the MAGNET model suitable for carrying out trade and agricultural policy changes with a focus on food and agriculture.

2.1. Data and aggregation

The MAGNET model is calibrated using the GTAP v8 database with base year 2007 (Narayanan et al., 2012). For our modelling approach, the 129 countries and/or regions and 57 sectors available in the GTAP database are respectively aggregated to 21 regions and 29 sectors (Table 2, first column). The three countries of interest abbreviated as NAF countries, namely Egypt (egy), Morocco (mor) and Tunisia (tun) are separated from the rest of the Middle East and North Africa (MENA) region. Turkey as a major trade actor in the Mediterranean area is treated separately. The EU is divided into southern countries of Spain,

France, Greece, Italy and Portugal, as they are more closely integrated with NAF countries, as well as the small island states of Cyprus and Malta. The other EU Member States are aggregated as the rest of the EU. Since the time of analysis, Croatia accessed the EU, however EU aggregate includes 27 member states. Croatia and European Free Trade Area (EFTA) countries are distinguished from the rest of Europe. The remaining regions are summarized as geographical regional categories.

(Table 2 here)

Given the focus of this paper on agri-food products, primary (agricultural) and (processed) food products that are important in trade between Egypt, Morocco, Tunisia, and the EU are most disaggregated for the model simulations (Table 2, second column). Other food products are included in an aggregate of food, beverages and tobacco. For products other than agri-food products, we distinguish forestry and fishing as related primary sectors, textiles and clothing, an important export product of NAF countries, natural resource sectors (coal, oil, gas and derived petroleum and coal products), other manufacturing and services. Note that we differentiate between trade and transport as one specific category of services and other services.

With regard to factors of production, we retain the standard GTAP categories of five production factors, which include skilled and unskilled labor, capital, land and natural resources (Table 2, last column).

2.2. Scenarios

We conduct four scenarios which are summarized in Table 3. The first scenario, called hereafter the Trade Liberalization (TL) scenario, examines the consequences of reciprocal tariff liberalization between the EU and NAF countries, and between NAF countries. The

second scenario (TL-NTM) deepens the first one by including *ad valorem* equivalents for each partner NTMs.

The third scenario reflects increases in *broad* public and private investment (BI) which are traduced in productivity gains in the whole NAF economies. These investments are part of a growth agenda promoted by EU programs and within the foreseen DCFTAs.

The fourth scenario assumes productivity gains through improvements of food chain efficiency. It focused on *targeted* public and private investments (TI) aiming to reduce losses (waste) in NAF agricultural production, post-harvest handling and storage. These scenarios echo an EU joint communication stating that "*events in the Southern Mediterranean combined with rising food prices have demonstrated the urgency for the EU to help its partner countries to improve the efficiency and productivity of its agricultural sector and assuring the security of food supply*" (European Community, 2009).

(Table 3 here)

The aforementioned scenarios are compared to the baseline, which constitutes the Business-as-Usual (BaU) scenario.[i] In MAGNET, the BaU scenario is run for the period 2007-12 to project the model towards the current year, and then up to 2020. It is generated using information on the expected growth path of the economy (GDP) and endowments (capital, labor, land and natural resources) over time for all countries and/or regions in the world, and the productivity of these endowments, most notably that of land, i.e. yields.[ii] We do not model any change in European and NAF countries' agricultural policies or cooperation such as the European Neighbourhood Programme for Agriculture and Rural Development (ENPARD).

2.2.1. The case of tariff and non-tariff removal: Scenarios TL and TL-NTM

The trade liberalization scenario (TL) quantifies the impacts of preferred market access that could be part of DCFTAs between the EU and NAF countries. In detail, the TL scenario assumes reciprocal elimination of import tariffs for trade flows between the EU and NAF countries as well as among the NAF countries (intra-NAF trade). In addition to tariff liberalization, NTMs that hamper trade between the countries involved in the DCFTA are usually addressed as a main provision in DCFTAs. In the TL-NTM scenario, we simulate a reduction of NTMs by reducing so-called "iceberg costs". The TL-NMT scenario is simulated in two steps. First, TL simulates the elimination of tariff between the EU and NAF and among NAF countries. Second, TL-NTM scenario adds non-tariff liberalization with NTM estimates by Kee et al. (2009).

According to the database used (GTAP v8, 2007 reference year), the EU imposes the highest ad valorem tariff rates on imports of vegetable oil and fats, and sugar. Regarding vegetable oil, EU tariffs are the highest for Tunisia (42.6%); EU tariffs on sugar are the highest for Morocco (42.8%). It should be noted that olive oil is part of the product category "vegetable oils and fat", and the high level of EU protection of olive oil (including tariff rate quotas) is reflected in the high tariff rate (Commission Regulation 1918/2006).

The NAF countries impose tariffs on imports from the EU of meat products, fish and processed food and beverages. By far, Egypt imposes the most restrictive tariff rate on EU products of food and beverages (254.2%). Morocco mainly protects paddy rice (93.5%) and beef meat (94.2%), while Tunisia imposes high tariffs on wheat (67.7%) and coarse grains (71.2%), fruit and vegetables (73.1%), live cattle animals (78.5%), dairy products (61.8%) and beef meat (64.6%). Overall, tariffs for trade across the NAF countries (intra-NAF trade) are very low. This could be because these countries may not have an interest for tariff protection of trade amongst each other. Note that Egypt, Morocco and Tunisia are part of

further preferential agreements, for example the Agadir Agreement of 2004. Overall, trade flows amongst these countries are limited (Eurostat, 2009).

Looking at manufactures, the EU does not impose tariffs on manufacturing products from NAF countries. NAF countries, however, implement tariffs on manufacturing products from the EU. All three NAF countries under review impose tariffs on EU textiles and clothes, petroleum and coal products and other manufactured products. With regard to intra-NAF trade, only Morocco and Tunisia respectively impose tariffs but the tariff rates are comparably small. As a general remark, tariff barriers amongst the NAF countries can be considered as being rather minor.

NTMs can cause barriers to trade. We consider the abolishment of such measures in the simulation of trade liberalization, which ultimately reflects the situation of free trade between the countries under review. There are several different types of NTMs; for an up-date classification of measures see UNCTAD (2007). Tariff rate quotas (TRQs) are a relevant category of NTMs related to traditional trade policy measures. For the NAF countries, TRQs are particularly relevant for access of fruit and vegetables but also processed products thereof, such as olive oil for example, to the EU market. Another important category of NTMs are standards and other requirements that exporters have to comply with to supply foreign markets. It is usually distinguished between SPS measures, which are implemented for human, animal and plant health reasons, and TBT measures, which specify technical and information requirements. In general, such requirements are behind the border measures and cause trade costs in terms of compliance costs. For NAF countries, main issues of complying with SPS and technical requirement have been identified by ITC surveys in the respective countries (ITC, 2012a and b). Exports of agri-food products seem to be particularly affected, with more than half of the NTM issues reported being linked to compliance with SPS and technical requirements. In summary, product-specific tolerance limits for residues (Maximum

residue levels, MRLs), hygiene measures, labelling and packaging have caused problems for exporting to the EU market. Exporters in NAF countries consider the EU conformity assessment, involving testing and certification that products meet the requirements as demanded, as being particularly burdensome.

In the simulation, we depict the removal of such trade barriers by the standard "iceberg cost" approach.[iii] "Iceberg costs" are considered real trade costs that use up resources of exporters. As such, "iceberg costs" melt away a fraction of the export value on the way from the exporting to the importing country, causing efficiency losses in the exporting country. Reducing "iceberg cost" implies lowering real trade costs, which in turn boosts the efficiency of producing export products. Hence, exports increase and export prices decrease. In essences, the "iceberg cost" approach depicts the reduction of NTMs in terms of a positive technological change for producing for the world market.

We use the estimates of equivalent values by Kee et al. (2009). In a gravity estimation, they quantified the effects of NTMs, which are subsequently transferred into price effects expressed in terms of average value equivalents. The estimates are based on imports and thus reflect the barrier that the respective countries impose on imports from *all* partner countries. With current trade relations between Egypt, Morocco, Tunisia, and the EU as one entity, the estimates by Kee et al. (2009) can overestimate the NTM barriers. Note that the estimates for the EU only capture barriers between the EU Member States and third countries outside the EU (extra-EU trade). Another limitation is the lack of detailed information about barriers at product level. In the case of Morocco, a survey on the impacts of NTMs in trade flows suggests a close link between the types of product exported and the impact of these measures (Gonzalez Mellado et al., 2011).

Equivalent effect estimates of NTMs that Egypt, Morocco and Tunisia impose on agri-food product are 14%, 39% and 45%, respectively. Those on manufacturing products are lower in the three countries, i.e. 8%, 4%, and 10% respectively. For the EU, ad valorem equivalent of NTMs on agri-food products presents a rate of 27%, the one on manufacturing only 2% (Kee et al., 2009).

2.2.2. The case of investment rise: Scenarios BI and TI

One objective of DCFTAs is to boost overall economic growth which can be achieved *inter alia* by increased FDIs and capital flows in the partner countries. Literature on the link between foreign direct investment and TFP is extensive. Results are inconclusive as effects crucially depend on the type of investment and specificities of the partner countries. Based on the findings of Cecchini and Lai-Tong (2008), the scenario on the promotion of broad public and private investment in NAF countries (BI scenario) assumes that that FDI (within the DCFTAs) in Mediterranean countries would lead to a TFP increase of approximately 0.15%. In a period of ten years, this amounts to roughly 1.5%. We incorporate this higher growth path over the second period (1.5% over 2012-2020) assuming that technological progress is impacting sectors and factors in the same way as in the BaU.

Recent literature focuses on the link between reducing food losses and waste in agri-food systems on the one hand, improvement of food security and effects on wide economy on the other hand (Rutten, 2013). In agriculture, the high losses in agricultural production and post-harvest handling and storage in North African countries, but also elsewhere in the developing world, are a big cause for concern in view of the importance of safeguarding food security.

(Table 4 here)

Given this background, we consider a scenario that addresses food waste through targeted investments that simulate TFP increases in the agricultural sector. The TI scenario targets the

losses (food waste) in the stages of agricultural production and post-harvest handling and storage in NAF countries. Due to the boost in agricultural productivity more output will be produced resulting in higher production, but also less input will be used in producing these outputs. The model determines the optimal input-output mix, whereby losses on both input and output side will be reduced. The productivity increases have been derived from FAO data on estimated waste percentages for commodity groups in the steps of agricultural production and post-harvest handling and storage of the food supply chain for North Africa, West and Central Asia (FAO, 2011). The resulting productivity shocks are shown in the last column of Table 4, and equals total losses in the agricultural supply. Note that we incorporate this higher agricultural growth path over the second period (2012-2020), in addition to the technological progress as assumed in the baseline.

3. Results

This section presents the results of the simulation scenarios at the aggregated country level. Given the focus of the analysis, we concentrate on agri-food sectors in NAF countries and the EU. The results are reported for the year 2020 and refer to differences from the BaU scenario. Trade liberalization encompasses bilateral trade between the EU and the three NAF countries under review (Egypt, Morocco and Tunisia) as well as across the NAF countries (intra-NAF). [iv] The scenarios are evaluated separately as each one represents a different, hypothetical, future for 2020.

3.1. Trade liberalization scenarios

A first observation is that the results of tariff liberalization (TL) are, overall, less prominent than the results combing both tariff liberalization and NTM reduction (TL-NTM). This is due to the modelled efficiency boost when lowering non-tariff barriers by the "iceberg-cost".

Reducing NTMs involves a liberalization that takes place behind the borders of the partner countries, as foreseen in the DCFTAs between the EU and NAF countries.

EU imports of agri-food products from NAF countries approximately double under TL and more than triple under TL-NTM. This is an increase of 3,680 million USD and 11,519 million USD, respectively. The increase in trade value varies across the commodities depending on the initial level of the ad-valorem tariffs. The highest increase is observed for vegetable oils and fats: EU imports from NAF countries increase by two times and four times under TL and TL-NTM, respectively. This increase is because the import tariffs the EU imposes on NAF products are rather high, but are eliminated in the simulation. EU fruit and vegetables imports from NAF countries and in particular from Morocco increase but the increases of EU fruit and vegetables imports is not as large as the increase of EU imports of vegetable oils and fats (increase of 24% under TL and about a doubling under TL-NTM especially from Tunisia).

NAF imports of agri-food products from the EU increase by 2020 from 4,719 million USD to 9,779 million USD under TL and to 13,674 million USD under TL-NTM. This is linked to the initially higher import tariffs for food, beverages and tobacco in Egypt and cereals and animal products in Tunisia and Morocco. More precisely, imports of food, beverages and tobacco increase by 75% and 100% under TL and TL-NTM respectively. NAF wheat imports from the EU are more than three times and more than five times higher under TL and TL-NTM, respectively. The most remarkable increase is observed for imports of beef, sheep and horse meat which reach 609 million USD under TL and to 1,121 million USD under TL-NTM. These increases are the highest for Morocco and are less pronounced for Tunisia and Egypt.

Most of the agri-food trade expansion is achieved in the southern EU Member States. Specifically, agri-food imports of France, Greece, Italy, Spain and Portugal together increase

by 3,049 million USD under TL and by 8,475 million USD under TL-NTM, which corresponds to 83% and 74% of the increase of the EU agri-food imports from NAF countries. NAF countries increase their imports from France, Greece, Italy, Spain and Portugal by 3,566 million USD under TL and by 6,143 million USD under TL-NTM. The increase of imports from the rest of the EU is about 2 times less (1,496 million USD and 2,813 million USD under TL and TL-NTM respectively). As a result intra-EU trade declines by 1,396 million USD and by 5,273 million USD under TL and TL-NTM respectively. The decline involves trade flows both in the north-south and south-north axis as well as in the south-south and north-north axis, and is mainly because of lower intra-EU trade of fruit and vegetables and of processed food, beverages and tobacco. Regarding south-south trade, the decline is mainly for vegetable oils and fats. Italy reduces its imports of vegetable oils and fats mostly from Spain, and less from Greece, France and Portugal, whereas it increases its imports mainly from Tunisia and to a lesser extent from Morocco and Egypt. It should be noted that olive oil is grouped in the category vegetable oils and fats and hence these developments reflect the current olive oil trade flows around the Mediterranean; Italy is the major EU importer of bulk olive oil imported from Spain and Greece and to a lesser extent from NAF countries and is the main olive oil supplier of northern EU countries (Eurostat, 2012). It should also be noted that in relative terms the decline of intra-EU trade is rather limited. In fact, in this simulation the share of agri-food import from the southern EU Member States into the rest of EU did not change and the same holds for the share of agri-food imports from the rest of EU into France, Greece, Italy, Spain and Portugal.

NAF imports of EU manufactured products expand by 44% under TL-NTM, and only by 20% under TL. The respective figures for EU imports of NAF manufactured products are 12% and 5%. These impacts seem to result from lower agri-food input costs for manufactures.

Trade liberalization hardly results in any trade effects amongst NAF countries (intra-NAF trade) which reflects the limited intra-NAF trade; imports into NAF from other Mediterranean countries were below 3% in 2007 (Eurostat, 2009). It is worth mentioning that in 2011, the EU imports of agri-food from Mediterranean countries (including NAF countries) accounted 5.9% of the total EU imports. The EU was the main trading partner of the Mediterranean countries (including NAF countries), where EU products made up for almost 40% of their total imports (European Commission, 2013). We also observe that trade liberalization between the EU and NAF countries does not result in substantial trade diversion effects from the EU perspective.

Table 5 reports the effects of trade liberalization on the production volume of EU and NAF countries. Production expands in the EU for products that are demanded more by NAF countries (i.e. for which NAF imports increase the most), namely wheat, other cereals and livestock products, and decreases for the products with more import competition from NAF countries, namely vegetable oils and fats. In the EU, the production of vegetable oils and fats as well as wheat is affected the most. For vegetable oils and fat, production decreases mainly in the southern EU Member States; the decrease is about 7.3% under TL and 14% under TL-NTM. For wheat, on the other hand, production increases in the EU by 5.7% under TL and 8.1% under TL-NTM, with the increase in the southern EU Member States being slightly above this average.

The impact on production in the NAF countries is opposite to the impact on production in the EU. In the NAF countries, production declines for those products that face higher import competition by EU products. Production increases for the products which are demanded more by the EU. The results are most pronounced for wheat (-19% and -39% under TL and TL-NTM, respectively), and for vegetable oils and fats (130% and 217% under TL and TL-NTM, respectively). Regarding manufactures, production of textiles and clothing increases by

almost 2% in the NAF countries, and this is linked to the lower production costs and expansion of their exports into the EU, as described above.

(Table 5 here)

Looking at food security indicators[v], household consumption increases in the NAF countries by 4% and 9% under TL and TL-NTM respectively as consumers' food prices decrease by about the same magnitude. Consumption of domestic food in the NAF countries however decreases by 6% (TL) and 11% (TL-NTM), while consumption of imported agri-food products increases by almost 80% (TL) and by about 160% (TL-NTM). Since total household consumption increases slightly, and consumption of imported food increases strongly, it suggests that imported agri-food products are not so important in the household food basket compared to domestic products. However, these results do point out that the NAF countries become more dependent on imports for satisfying their food demands. In conclusion, trade liberalization boosts total household consumption of food and can hence be seen as enhancing food security in the NAF countries, but it should be noted that at the same time import-dependence increases and as a result NAF countries become more vulnerable to price fluctuations on the world market.

Bilateral trade liberalization affects government revenues and results in a reduction of import tariff revenues. The decrease depends on the initial level of the import tariffs and on how imports changed (increased or decreased) because of trade liberalization. For the EU the reduction of import tariff revenues is of 1% and 1.5% under TL and TL-NTM respectively, whereas for the NAF countries it is of 52% and 60% under TL and TL-NTM respectively. Among the NAF countries, the highest fall of import tariff revenues is achieved in absolute terms in Egypt (fall of 2,943 million USD under TL and 3,392 million USD under TL-NTM) and in relative terms in Tunisia (the observed fall of 1,384 million USD under TL and of

1,729 million USD under TL-NTM is equivalent to 57% and 70% of Tunisia's import tariff revenues in the BaU scenario).

GDP growth in NAF countries increases by about 10 billion euros in 2020 (2.7% of GDP) with TL-NTM compared with the status quo in trade matters. While the increase in EU GDP is much less (6 billion), the gain from a stable and transparent regulatory environment (conducive to investments), and especially the non-monetary gains (political stability), are not taken into account. Model results suggest GDP increase of about 0.03% for the EU, slightly higher with 0.05% in southern EU.

The employment and wage changes follow the changes in production observed earlier in this scenario. In the EU, employment in agriculture in TL slightly goes up, and as a result real agricultural wages also go up slightly (mostly in rest of the EU), whereas in TL-NTM employment and real wages in agriculture fall (mostly in southern EU). In TL, due to tariff liberalization the rest of EU benefits from increased wheat production and exports to NAF countries, which draws in more employment. In TL-NTM, due to a reduction in NTMs, southern EU countries experience higher import competition from vegetable oils and fats which goes at a cost of domestic production and employment. The latter effect outweighs the positive effect on the wheat sector in terms of employment.

In NAF countries, the effects on wages and employment are more pronounced. Employment in agriculture decreases under TL, but increases under TL-NTM. In TL, due to tariff liberalization NAF countries wheat production contracts, which outweighs the increases observed in production of other primary agricultural sectors in terms of employment. In TL-NTM, the reduction in NTMs result in a higher increase in the more labor demanding primary agricultural sectors (fruit and vegetables and oil seeds). This outweighs the contraction of the wheat sector and resulting loss in employment. These results confirm that NAF countries can

complete efficiency gains by reducing trade barriers behind the border, giving a boost to agricultural production and employment.

Finally, both wages in agriculture and non-agriculture rise, with the increase being more pronounced in the non-agricultural sector. This is because processed food commodities (for example vegetable oil and fats) are not part of primary agriculture and fall in the category of non-agriculture in the model's factor market segmentation. Production of these commodities in TL-NTM increases, which draws in more labor in non-agriculture and puts upward pressure on real wages. These results suggest that rural households engaged in primary agricultural activities in NAF countries will be better off if trade liberalization does not involve only tariff elimination (TL) but also reduction of NTMs (TL-NTM). Combined with the positive impacts observed with respect to food security (higher household consumption of food at lower prices), this seems to suggest that rural households could become less vulnerable.

3.2. Broad productivity gain scenario: FDI and capital flows

The broad investment scenario (BI) elucidates how increases in FDIs and capital flows as promoted within the DCFTAs may affect NAF countries, in difference from the BaU. The BI scenario assumes an increase of FDIs and capital flows in the NAF countries. A TFP growth of 1.5% over the period 2012-2020 in NAF countries, leads to a higher GDP (and GDP per capita) of 3.5% on average in 2020 (in difference from the BaU). Other countries and regions in the world are not affected in terms of GDP growth and therefore not shown (impacts less than 0.01%). The same is observed for production, employment, incomes and consumption impacts. We thus concentrate on the outcomes for the NAF countries as a whole.

In terms of production, almost all sectors in NAF countries benefit, with the exception of wool, paddy rice, oil and milk sectors. Comparing relative growth rates, services and

manufacturing/processed sectors benefit more than primary agricultural sectors, which is a similar trend as what is happening under the BaU.

Sectorial employment impacts are roughly the same across NAF countries and change in favour of non-agricultural sectors (goes up by 0.1% for NAF countries on average), at a cost of employment in agriculture (falls by 1.2%). As a result real wages in non-agricultural sectors rise faster than real wages in agricultural sectors (growth of 4.1% and 2.5% respectively).

The higher incomes in NAF countries are expected to benefit consumption. Household consumption of all commodities on average goes up by 3.9%, but most of this is attributable to manufacturing and services categories. With respect to food, growth in household consumption of grains (0.1 to 0.2%) lags behind compared to more nutritious food items such as milk products (1%), fruit and vegetables (1.5%), meat products and sugar (around 1.8%), other food, beverage and tobacco (3.1%), and fish and vegetable oils and fats (3.6%). This reflects expected trends in diets. Focussing in more detail on food security in NAF countries, we observe that in this scenario NAF household consumption of food items, improves slightly by 2%. This improvement stems from domestic and a little more from imported sources. NAF households nonetheless pay a higher price for their food (over 1% on average).

Last, NAF imports in the BI scenario grow faster for non-agricultural commodities, whereas on the export side the opposite is true as is visible from higher growth rates for agricultural commodities, most notably wheat. This results in a deterioration of NAF trade balance; the higher growth fuels the need for industrial and services imports. In this scenario the trade balance of NAF countries vis-à-vis the EU deteriorates by 2,869 million USD in total.

In conclusion, the BI scenario seems to magnify the results of the baseline, i.e. services and manufacturing/processed sectors grow higher than primary agricultural sectors. This result

seems key if one considers that in Arab countries, manufacturing and services-led growth is more pro-poor than agriculture-led growth (IFPRI, 2012).

3.3. Targeted productivity gain scenario: agricultural supply loss

By contrast to the BI scenario, the targeted investment scenario (TI) does not assume an increase of FDIs and capital flow in *all* sectors of the NAF countries but only in *primary agricultural* sectors of the NAF countries. In the TI scenario, we show how a promotion of agricultural growth in NAF countries by investments that target losses (waste) in agricultural production, post-harvest handling and storage may impact, in difference from the BaU scenario. We assume a TFP growth in North African agricultural sectors in the range of 7% to 30% over the period 2012-2020, leads to a higher GDP (and GDP per capita) in North African countries of 2.3% on average in 2020 (in difference from the BaU). Other countries and regions in the world are not affected in terms of GDP growth and therefore not shown (impacts less than 0.01%).

Impacts are different across sectors. Primary sectors of NAF countries benefiting from an increase in TFP by reducing losses in production, handling and storage, experience an increase in production. Other crops, wheat and oil seeds seem to benefit most (production increases by close to 70% and 30% respectively), followed by fruit and vegetables (increase of 17%). As these commodities become cheaper, sectors using these commodities as intermediate input in production also benefit, as is shown by growth in the various processed food categories. Production of vegetable oils and fats expands most (37%). With primary sectors expanding, resources flow out of other sectors in NAF countries, notably other manufacturing which contracts by 1.7%.

As NAF countries produce more primary commodities for the market at lower cost, the EU primary production decreases. Most notably fruit and vegetables, and wheat sectors suffer from a loss in competitiveness and contract by 1.7% and 1% respectively.

Agricultural employment in the North African region declines by 3.6% on average due to more efficient production so that less inputs are needed, including labor. Real wages in agriculture also fall (by 1% on average). This benefits non-agricultural sectors in terms of both employment and real wages, which rise by 0.4% and 2.9% on average. In the EU the loss in competitiveness in agriculture also translates into lower employment and real wages (both fall by 0.5% on average).

The changes on the labor markets and other factor markets combined influence income and so consumption. Prices also matter. We observed that GDP per capita in the NAF countries is going up. We also observed that agricultural sectors in NAF countries are producing more due to more efficient production (lower waste or losses). When addressing impacts on household consumption, primary and processed food sector consumers in NAF countries face much lower market prices and, combined with higher (real) incomes, increase consumption. Consumption rises particularly for fish, raw milk, fruit and vegetables (increases of 7.6%, 5.2% and 4.8% respectively), which reflects the gains in efficiency and so lower costs and prices of primary production, as well as the expected trends in diets (away from staple foods towards more nutritious food).

Given aforementioned developments, food security in the NAF region improves. Specifically, improved agricultural efficiency leads to a higher household consumption of food (increases by 3.1%) at lower food prices on the market (fall by 9.6% on average). It would particularly benefit the vulnerable group whose food spending absorbs most of their income. Latest available data from the World Bank reveal that the share of population living on less than 2

US dollars a day in PPP affects 15.4%, 14.0% and 4.3% in Egypt (2008), Morocco (2007) and Tunisia (2010) respectively.

Taking into account the previously observed labor market impacts, rural households who suffer from lower wages and increasing unemployment, may well be worse off as the fall in their income may outweigh the reduction in food prices. However this development has to be seen with the expansion of both jobs and real wages in non-agricultural sector. When looking at the source of food consumption, it becomes clear that whilst food consumption from a domestic origin goes up (by 5.5%), that from abroad goes down (by 15.5%). There is thus some substitution away from imported food products which reduces the North African dependence from the world market. Imports of agri-food commodities by NAF countries fall, whereas exports rise even more so, resulting in an improvement in NAF trade balance in agri-food commodities.

4. Concluding remarks

This paper provides a quantitative assessment of options to promote growth and improve food security in the South Mediterranean region. Simulations are viewed in the context of the Euro-Med integration and framed within expected DCFTAs between the EU and respectively Egypt, Morocco and Tunisia. They focus on reciprocal tariff and non-tariff liberalization between these partners (scenarios TL and TL-NTM) and productivity gains promoted by investments either in the whole economy or agricultural supply aiming to reduce losses (waste) in NAF agricultural production, post-harvest handling and storage (scenarios BI and TI). Table 6 summarizes the effects of each scenario on growth, labor market and food security in the NAF countries, and draws three concluding remarks.

(Table 6 here)

First, each scenario has a positive impact on GDP, with higher growth in NAF countries of about 2.7% (TL-NTM), 3.5% (BI) and 2.3% (TI) on average in 2020. Economic growth is stimulated mostly by a productivity boost, and effects are more pronounced if productivity gains involve all sectors of the economy. Growth is also boosted by trade liberalization which makes the NTMs removal a key issue of further trade integration between the EU and NAF countries. This suggests that the positive impact on economic growth could be intensified by combining policies that aim to foster both productivity and trade flows. Alternative assumptions on NTM cuts or on productivity changes would obviously have different implications on economic performance. In other words, performing a sensitivity analysis of the results would help to better capture the range of possible futures.

Second, the results confirm that as the economy of NAF countries grows, less labor is demanded by agricultural sectors and real wages in agricultural sectors increase. Specific agricultural productivity growth reduces agricultural employment and wages (TI scenarios) which may have negative implications for rural households that are more dependent on primary agricultural sectors. However, positive effects on agricultural employment may emerge if productivity growth is combined with trade liberalization. The latter aligns with the objectives of the DCFTAs that specifically foresee not only trade liberalization but also increased investment flows to promote growth and efficiency gains. It remains to be seen the origin and profit destination of these capital flows.

Third, economic growth leads to more demand for food and thus to higher prices. Increasing agricultural productivity and cutting down losses (waste) in food production, improved storage and handling can be considered as being a first step to reduce dependence on and vulnerability to changes in the world market. Indeed results show that food security can be reinforced by lowering prices and increasing food consumption of households in NAF countries. This finding is crucial since many authors have identified high food prices as one

of the contributing causes for the Arab awakening (Maystadt et al., 2014). A further disaggregated analysis of agri-food markets could provide deeper insights in terms of changes for both rural and urban households.

Tables

Table 1. *Key socio-economic indicators for Egypt, Morocco, Tunisia and the EU*

	Egypt	Morocco	Tunisia	EU
Population				
2013 (thousands, projections)	85,378	32,926	10,814	505,090
2050 (thousands, projections)	123,452	39,200	12,649	511,661
Agriculture value added as % of GDP				
2011 (%)	12.1	13.1	7.5	1.6
Inflation				
2008 (%)	18.3	3.7	4.9	3.7
2011 (%)	10.1	0.9	3.6	3.1
Unemployment				
2011 (%)	12.0	8.9	13.0*	9.6
Employment in agriculture				
2011 (% of total employment)	28.2*	39.8	17.7*	2.9

* 2010 data.
Source: DataM provided by the European Commission/ Joint Research Centre, www.datamweb.com.
Elaboration based on original data coming from: EUROSTAT, UN Population and World Prospects, IMF
International Financial Statistics, World Development Indicators. Data accessed on 15/07/2013.

Table 2. *GTAP data aggregation*

Countries, regions		Sectors		Factors
egy	Egypt	pdr	Paddy rice	Land
mor	Morocco	wht	Wheat	Unskilled labour
tun	Tunisia	gro	Cereal grains nec	Skilled labour
tur	Turkey	v_f	Fruit and vegetables	Capital
MENA	Rest of Middle East and North	osd	Oil seeds	Natural resources
esp	Spain	c_b	Sugar cane, sugar beet	
fra	France	pfb	Plant-based fibers	
grc	Greece	ocr	Crops nec	
ita	Italy	ctl	Cattle,sheep, goats, horses	
prt	Portugal	oap	Animal products nec	
EUIS	Cyprus and Malta	rmk	Raw milk	
RE27	Rest of EU27	wol	Wool, silk-worm cocoons	
EFTA	European Free Trade Association	frs	Forestry	
cro	Croatia	fsh	Fishing	
ROE	Rest of Europe	coa	Coal	
US	United States of America	oil	Crude oil	
NAM	Rest of North America	gas	Gas	
CSA	Central and South America	cmt	Meat: cattle, sheep, goats, horse	
OCE	Australia, New Zealand and Rest	omt	Meat products nec	
ASIA	Asia	vof	Vegetable oils and fats	
SSA	Sub Saharan Africa	mil	Dairy products	
		pcr	Processed rice	
		sgr	Sugar	
		FBT	Food, bev & tobac prod nec	
		TCL	Textiles & clothing	
		p_c	Petroleum, coal products	
		MNF	Other manufacturing	
		TRA	Trade & transport (services)	
		SVC	Other services	

Source: Adapted from GTAP database v.8.

Table 3. *Overview of scenarios*

Acronym	Scenario description	Data source
TL	Trade liberalization through the elimination of tariffs for EU – NAF, NAF – EU, intra-NAF flows	GTAP-v8 Narayanan et al. ,2012
TL-NTM	TL scenario that includes ad valorem equivalents of non-tariff measures	GTAP-v8 Narayanan et al. ,2012 Kee et al., 2009
BI	Broad investment through general increase in FDI and capital flows, i.e. whole economy productivity gain	GTAP-v8 Narayanan et al. ,2012 Cecchini and Lai-Tong, 2008
TI	Targeted investment to agricultural losses/waste, i.e. specific productivity gain in agricultural supply	GTAP-v8 Narayanan et al. ,2012 FAO, 2011

Table 4. *Losses in agricultural supply and TFP growth in the targeted scenario, %*

	Agricultural production	Postharvest handling and storage	Total losses in agricultural supply
Cereals	6	8	14
Vegetables and fruits	20	10	30
Oil seeds	18	6	24
Sugar cane, sugar beet	6	10	16
Other crops	20	10	30
Cattle, sheep, goats and horses	7	0	7
Other animals and products	7	0	7
Raw milk	4	6	10
Fishing	7	5	12

Source: FAO (2011).

Table 5. *Trade liberalization scenario effects on production volume,*
% differences from BaU, 2020

	EU		Southern EU		Rest of EU2		NAF	
	TL	TL-NTM	TL	TL-NTM	TL	TL-NTM	TL	TL-NTM
Agri-food of which:	0.1	0.0	0.2	0.0	0.1	0.0	-2.6	0.4
‑ Rice paddy	-1.0	-2.8	-0.9	-2.5	-2.2	-7.5	2.5	5.4
‑ Rice milled	-2.6	-6.7	-1.9	-5.1	-3.9	-10.1	4.3	8.0
‑ Wheat	5.7	8.1	7.4	11.3	4.1	5.0	-19.2	-38.9
‑ Other cereals	0.5	0.7	0.5	0.9	0.5	0.5	-1.4	-1.8
‑ Sugar cane & beet	-0.2	-0.2	1.0	3.9	-1.0	-3.0	2.3	8.5
‑ Sugar	-0.3	-0.6	1.0	4.0	-1.1	-3.3	6.5	18.4
‑ Fruit & vegetables	-0.8	-3.1	-1.0	-3.6	-0.6	-2.4	2.9	10.7
‑ Oilseeds	-3.3	-5.9	-5.3	-9.7	-0.8	-1.3	2.6	4.3
‑ Vegetable oils/fats	-3.5	-6.6	-7.3	-14.0	-0.7	-1.1	130.3	217.1
‑ Dairy products	0.1	0.2	-0.1	-0.1	0.2	0.4	-6.0	-8.6
‑ Meat beef, sheep, goat, horse	1.0	1.9	2.2	3.9	0.0	0.1	-12.2	-23.7

- Meat pork, poultry, other	-0.1	-0.1	-0.1	0.1	-0.1	-0.3	-2.1	3.3
- Food, beverages, tobacco	0.2	0.1	0.3	0.2	0.2	0.0	-9.8	-5.7
Manufactures	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-3.1
of which:								
- Textiles and clothes	0.3	0.4	0.4	0.7	0.1	0.1	2.0	2.3
- Petroleum and coal products	0.1	0.1	0.1	0.2	0.1	0.1	-0.9	-2.0
Trade services & com.	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.9
Transport	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2

Source: MAGNET calculations.

Table 6. *Trends of the impacts on growth, labor market and food security of different scenarios for NAF countries, 2020*

Scenario	Trade liberalization (TL-NTM)	Broad investment (BI)	Targeted investment (TI)
GDP	+	++	+
Employment			
(agriculture)	+	-	-
(non-agriculture)	+	+	+
Real wages			
(agriculture)	+	+	-
(non-agriculture)	+	+	+
Household consumption of food (per capita)			
(domestic food)	-	+	+
(imported food)	++	+	-
Household prices	-	+	--

Note: Since the shocks and reference scenario differ, the table shows only trends; magnitudes of effects cannot be compared. The trends refer to the end-point difference in percentage changes in 2020; + indicates an increase and ++ indicates a more pronounced increase; – indicates a decrease in the simulation result; - - indicates a more pronounced decrease.

Source: authors own compilation based on MAGNET calculations.

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[i] For sake of simplicity BaU outcomes are not reported in the paper but are available upon request to the authors.

[ii] This information is used to derive the implied technological change by region, which is subsequently fixed so as to endogenously generate the targeted GDP.

[iii] For a stylist application of the "iceberg" costs approach, see Fugazza and Maur (2008). Rau (2009) provides an overview of different modelling approaches of NTMs and their trade effects.

[iv] Ben Abdallah et al. (2013) present country-specific results for Egypt, Morocco and Tunisia, paying special attention to social accounting matrix analyses.

[v] Food security is most commonly defined as "*...when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" (definition by FAO: http://www.fao.org/docrep/013/al936e/al936e00.pdf, accessed on 15/07/2013). A variable for food security does not exist in GTAP or MAGNET, but we take it that a rise (fall) in the consumption of food, which could originate from changes in domestic supply or imports, represents an improvement (deterioration) in food security. When reporting outcomes in terms of consumption or consumer prices we show consumption and prices faced by households, the group of consumers the government is mostly concerned with when it comes to food security.