An econometric investigation of EU's import demand for fresh potato: a source differentiated analysis focusing on Egypt

Received 5 October 2021
Revised 4 January 2022
Accepted 26 April 2022

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Abstract

Purpose – A better understanding of the determinants of demand through accurate estimates of the elasticity of import demand can help policymakers and exporters improve their market access and competitiveness. This study analyzed the EU's demand for imported potato from major suppliers between 1994 and 2018, with the aim to evaluate the competitiveness of Egyptian potato.

Design/methodology/approach – This study adopted an import-differentiated framework to investigate demand relationships among the major potato suppliers to the EU's. To evaluate the competitiveness of Egyptian potato on the EU market, expenditure and price demand elasticities for various suppliers were calculated and compared.

Findings – The empirical results indicated that as income allocation of fresh potatoes increases, the investigated EU markets import more potatoes from other suppliers compared to imports from Egypt. The results show that EU importers may switch to potato imports from other suppliers as the import price of Egyptian potatoes increases, which enter the EU markets before domestically produced potatoes are harvested.

Research limitations/implications – Due to data unavailability, the present study relied on yearly data on quantities and prices of EU potato imports. A higher frequency of observations should allow for considering seasonal effects, and thereby providing a more transparent picture of market dynamics and demand behavior of EU countries with respect to potato import from various sources of origin.

Originality/value – The study used a system-wide and source differentiated approach to analyze import demand. In particular, the empirical approach allowed for comparing different demand models (AIDS, Rotterdam, NBR and CBS) to filter out the superior and most suitable model for that data because the suitability and performance of a demand model depends rather on data than on universal criteria.

Keywords Import demand, General differential model, Potato, Egypt, EU

Paper type Research paper

1. Introduction

In recent decades, agricultural exports from low- and middle-income countries (LMICs) to high-income countries have increased and shifted from traditional commodities (e.g. coffee

Journal of Agribusiness in Developing and Emerging Economies
Vol. 14 No. 2, 2024
pp. 393-411
Emerald Publishing Limited
2044-0839
DOI 10.1108/JADEE-10-2021-0254

and cotton) towards horticultural commodities, especially fresh and processed fruit and vegetables (Karing'u *et al.*, 2021). Previous research has shown that developing the horticultural export industry and linking smallholder farmers to high-value markets are crucial for LMICs' development agenda through creating jobs and income-generating activities in farming communities, and contributing to poverty alleviation and food security (Abu Hatab, 2016; Mwambi *et al.*, 2016). Therefore, in recent decades, many LMICs have implemented policies to promote horticultural exports and prioritized the modernization of the horticultural sector as an export diversification and poverty reduction strategy (Abu Hatab and Hess, 2013; Annor *et al.*, 2016).

It is therefore of great interest for the agribusinesses and food chain actors, who are concerned with maintaining their competitiveness, and for policymakers, who seek to promote the competitiveness of the agrifood industry, to understand the market behavior relative to the demand for horticultural commodities in high-income countries. In this respect, an analysis of policy decisions related to international marketing of horticultural commodities requires information about the response of importers' demand as prices and income changes. By estimating demand elasticities, policy makers can assess the degree of responsiveness of the importing markets to such changes and infer their impact on the import demand. In addition, better understanding of the determinants of demand through accurate estimates of the elasticity of import demand is crucial for assessing the gains from trade, to test hypotheses on the performance of those markets, and to predict the impact of agricultural trade policies (Ferguson and Smith, 2021).

A closer look at the extant literature on high-income countries' demand for LMICs' agricultural exports underscores three main limitations. First, "horticultural" commodities have been the focus of a small number of studies (Scott and Kleinwechter, 2017), despite the progressive increase in the share of horticultural commodities within developing countries' agricultural exports and their income-generating and poverty-reducing effects (Abu Hatab, 2016). Second, few empirical studies have paid attention to the "product origin" and fewer had used of source-differentiated approaches to analyze import demand for horticultural commodities (Miroslav *et al.*, 2014). Third, to the best of the authors' knowledge, no notable effort has been put into comparing different approaches to model import demand and justify the selection of the employed demand model. Particularly, in the presence of a variety of approaches to model import demand, the selection of the most appropriate approach becomes a crucial issue (Barnett and Seck, 2008).

Against this brief background, the present study adopts an import-differentiated framework to examine the competitiveness of Egyptian potato (*Solanum tuberosum*) exports on the EU market between 1994 and 2018. This was empirically performed in two subsequent steps. First, the study analyzed demand relationships among major potato suppliers to the main importing markets of Egyptian potato in the EU (Germany, Italy and the United Kingdom). Next, the study used import demand relations to derive expenditure and price elasticities for suppliers in each of the three importing markets.

The present study contributes to the exiting literature in three main ways. First, the study used a system-wide and source differentiated approach to empirically analyze import demand, which nests four commonly used demand models in the empirical literature: the AIDS model, the Rotterdam model, the National Bureau of Research (NBR) model, and the Central Bureau of Statistics (CBS) model. Comparisons between different models to filter out the superior model are methodologically beneficial because the suitability and performance of a model depends rather on data than on universal criteria (Barten, 1993; Widenhorn and Salhofer, 2014).

Second, by taking potato as a case, the study adds to the existing literature in on the determinants of import demand for LMICs' horticultural exports. In many LMICs including Egypt, potato enjoys multiple characteristics that make it significantly important for smallholder farmers' income and livelihood, economic growth, food security and sustainable development (Kyomugisha *et al.*, 2017). From an agronomic perspective, potato has both remarkable adaptive capacity and resilience to climate variability that enable the crop to continue yielding reliably under variable climatic conditions (Devaux *et al.*, 2014). Moreover, potato is a water-use efficient crop, while the per-unit water yield of potato is much higher than many other major crops (Fandika *et al.*, 2016). From a socioeconomic perspective, potato represents about 20% of the total vegetable area in Egypt, 25% of the total vegetable production, and close to 10% of the country's total agricultural exports in recent years (Abd-Elradi *et al.*, 2016). Potato production systems generate direct incomes for more than a hundred thousand Egyptian smallholder farmers, provide employment to around 1 million workers, and contribute vital nutrients to the diets of many poor segments of the population in rural and urban areas (Makled and Elkodosy, 2018). In addition, potato value chains provide both on-farm and off-farm income, and employment opportunities for many smallholder producers (Dersseh *et al.*, 2016), and the export of the crop contributes significantly to agricultural trade and foreign exchange earnings (IPC, 2017). Therefore, knowledge about import demand parameters, including income and expenditure elasticities, is instructive for projections of future trends in the international market for imported potato and for designing broader policies aiming to enhance the competitiveness of Egyptian potato exports.

The third contribution of this study is buttressed by its implications for agribusiness and policymaking generally in LMICs and more particularly in Egypt. In this respect, it should be noted that a special characteristic of Egypt-EU potato trade is the complex interlinkages in potato exports and imports between the two sides. That is, Egypt is the largest non-EU supplier of early potato to the EU, and is the largest importer of EU's potato, with around 10.2% in quantity terms and 14% in value terms of total EU potato exports to non-EU member countries (EUROSTAT, 2019). This is because domestic potato production in Egypt relies largely on pre-germinated seedlings imported from the EU (Abdullah, 2015). As the cost of potato seeds represents between 40% and 50% of the production cost, prices and stability in seed supplies from the EU are a determinant factor of Egypt's export capacity and competitiveness on the EU market for imported potato (Al-Shareef, 2016; Abdullah, 2015). Therefore, a better understanding the competitiveness of potato exports through new and more accurate demand (elasticities) parameters can help policymakers and agrifood exporters design effective production and supply chains to enhance market access and competitiveness of Egyptian potato exports on the EU market.

The remaining part of this paper is structured as follows. Section 2 provides a brief overview of Egyptian potato exports into the EU during the period 1994–2018. Section 3 discusses the potato import model used in the econometric estimations. Section 4 presents the data and descriptive statistical analysis. Section 5 reports the estimation results and Section 6 discusses the results and concludes the study.

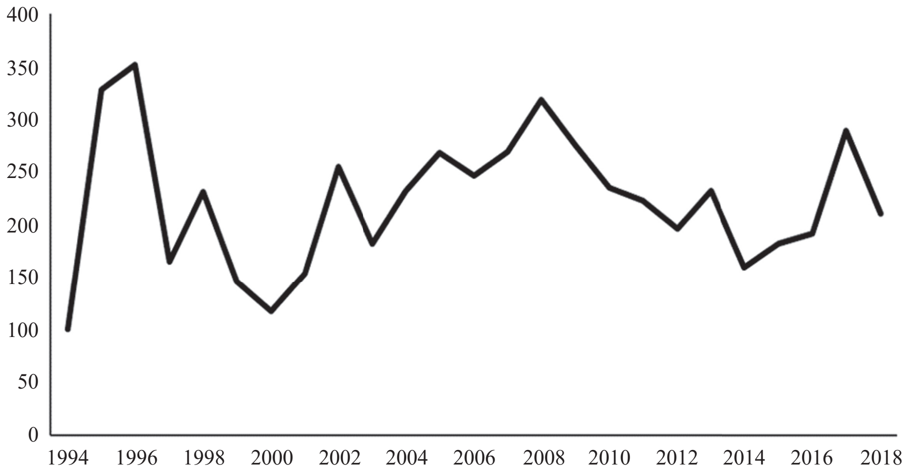
2. The performance of Egyptian potato on the EU market

Export-oriented horticultural value chains in Egypt continue to have considerable weight in government export and development strategies. In particular, potato has traditionally been a cash crop in Egypt that receives a special attention in national strategies for agricultural development and export promotion (Makled and Elkodosy, 2018). Due to the special importance of the EU as an importer of Egyptian potato, sustaining and increasing Egypt's share in the EU market has always been an integral part of Egyptian strategies conducive to promoting horticultural exports (Abu Hatab *et al.*, 2019). Especially, Egypt's relative geographical proximity to the EU gives its potato exports a unique competitive advantage by lowering the transportation and export costs for Egyptian exporters compared to their non-EU counterparts. In addition, the EU has traditionally been a major trading partner for Egypt, with an import share amounting to approximately 30% of the country's total agricultural exports during the last 2 decades. Of these exports, horticultural commodities represent around 66% (WITS, 2018). In regards to potato, the EU has always remained the largest importing market for Egyptian potato, with a market share of around two-thirds of the county's total potato exports to the world (Assad *et al.*, 2018). In 2018, EU's potato imports from non-EU countries amounted to 356 thousand metric tons at a value of about 130 million Euros (EUROSTAT, 2019). Overwhelmingly, early potato dominates EU's potato imports from non-EU countries (around 80% of total imports). Egypt and Israel represent the two main suppliers of early potato to the EU with market shares of 61% and 37%, respectively (EUROSTAT, 2019). Therefore, the Egyptian Sustainable Agriculture Development Strategy places special emphasis on the importance of exploiting the potato export opportunities offered by the EU-Egypt Association Agreement (MALR, 2014).

Nevertheless, a look at Figure 1 shows that cyclical variations have continued to characterize Egyptian potato exports to the EU in recent decades, with three distinct phases. In the first phase (1994–2000), EU potato imports from Egypt experienced sharp fluctuations, in contrast to the general upward trend in EU potato imports from the rest of the world (RoW). Frequent detections of brown-rot disease in potato shipments from Egypt during this phase resulted in subsequent embargoes on Egyptian potatoes. In response, Egypt's authorities introduced strict measures to ensure the conformity of potatoes to the EU's quality standards and have, since 1998, restricted potato exports to farms located in specified fields certified as "pest-free zones" in the Nile delta and the desert (ITC, 2016).

The second phase goes from 2000 to 2008, where potato exports grew from about 117 thousand tons to 318 thousand metric tons, registering a growth rate of 16% annually. Besides the measures taken to ensure compliance with EU standards, a major factor that contributed to the remarkable growth in Egyptian potato exports to the EU was the implementation of the EU-Egypt Association Agreement in 2004. As noted by Helmy *et al.* (2018), the agreement provided a comprehensive framework to liberalize agricultural trade between the two sides by creating a free-trade area, increasing import quotas, and facilitating the access of Egyptian agricultural exports to the EU market.

The period 2009–2014 marks a third phase in Egypt's potato exports to the EU, where exports decreased from 274 thousand metric tons in 2009 to around 160 thousand metric tons



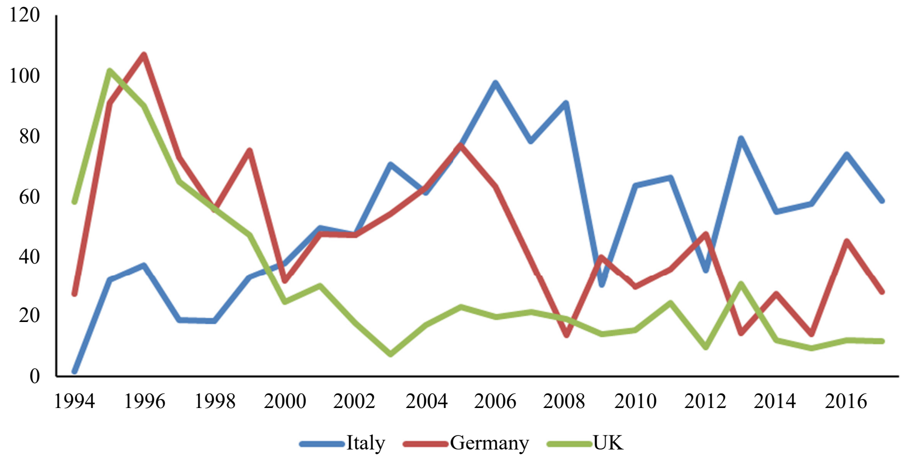
Source(s): World Bank, World Integrated Trade Solution (WITS) database, 2018

Figure 1.
EU potato imports from Egypt 1994–2018, thousand metric tons

in 2014. This decline is ascribed to a number of economic and political events at both the domestic and global level that affected the demand and supply of Egyptian potatoes. These include the global food and financial crises between 2008 and 2010, and the sociopolitical revolts that led to the emergence of the "Arab Spring" in 2011 and adversely impacted the country's international trade flows. During the period 2015–2018 Egyptian potato exports to the EU witnessed sharp fluctuations due to what was a so-called "potato crisis" on the domestic market. The crisis broke out due to a mixture of agricultural production and marketing policies and practices. In particular, volatile prices of agricultural inputs and the late arrival of imported potato seeds were two major factors that negatively affected farm-gate prices of Egyptian potato for a number of years during this phase. For instance, the availability of potato seeds was significantly reduced in later years, dropping from around 160,000 in 2014–2015 to 100,000 metric tons in 2018. In addition, the devaluation of the Egyptian pound in November 2016 almost doubled the prices of seed potatoes on the domestic market and significantly increased production and post-harvest costs. Together, these factors discouraged many small farmers from growing potatoes and adversely affected production and exports.

As noted in the introduction, the empirical analysis in the next sections will examine the demand relationships among major potato suppliers to the main importing markets of Egyptian potato in the EU, namely: Germany, Italy and the United Kingdom (UK). Together, these three countries absorbed on average more than two-thirds of Egyptian potato exports to the EU during the period 1994–2018. Figure 1 portrays the development in Egyptian potato exports to the EU in general during this period, and Figure 2 specifies the three largest importing markets in the EU during the period 1994–2017. The following paragraphs provide descriptions of each of the three markets focusing on import origins and expenditure shares of potato suppliers.

For the Italian market, France, the Netherlands, Germany and Egypt were responsible for 93.1% of total potato imports during the period 1994–2017, while the rest was supplied by the RoEU (4.8%) and the RoW (2.1%). With an import budget share of around 47%, France is the main exporter of potatoes to Italy, followed by the Netherlands and Germany with around 19% and 17.3%. Egypt ranks last with an import budget share averaging around 11%. Notably, the share of Egypt's potato in the Italian market grew remarkably from 0.3% in 1994



Source(s): World Bank, WITS database, 2018

Figure 2. Egyptian potato exports to the EU, 1994–2017, thousand metric tons

to 18.5% in 2007 before it slowed down in recent years to around 10.4% for the period 2011–2017.

With respect to the UK market, close to two-thirds of potato imports were supplied by Egypt, the Netherlands, France, Spain and Cyprus during the period 1994–2001, while the remaining third originated in other countries in the EU (31%) and the RoW (6%). In the period between 2001 and 2017, the UK's import dependency on the RoW has more than tripled (21%); whilst potato imports from both the RoEU and major suppliers decreased to 25% and 54%, respectively. In particular, Egypt's import budget share averaged around 8% during the period 1994–2017, fluctuating between an average of around 14% for the sub-period 1994–2001 and around 5% in recent years. With budget shares amounting to about 22% and 12%, respectively, France and the Netherlands are the main potato suppliers to UK, followed by Cyprus (8%) and Spain (7%).

3. Proposed model

Several theoretical frameworks have been proposed in the literature to assess export competitiveness at the levels of country, industry, firm and product (e.g. Bhawsar and Chattopadhyay, 2015; Bojnec and Fertő, 2016; Pascucci, 2018). The varied nature of agricultural commodities, which consist of undifferentiated and differentiated primary products to semi-processed and consumption-ready products, together with the varying demand of consumers, make an analysis of import demand more complex. Sarker and Surry (2006) note that an analysis of import demand and export competitiveness of agricultural commodities should focus on the perspectives of demand and should not treat agricultural commodities as homogenous products, but as differentiated products on the basis of country of origin, quality attributes and marketing features. In the same vein, Boonsaeng and Wohlgenant (2009) illustrate that source differentiation is particularly important in analyzing demand for agricultural commodities because perceptions about imported commodities from different supplying countries significantly influence consumer demand.

Building upon the above-mentioned streams of literature, Lange and Kawchuk (2014) note that fresh potato may not be necessarily viewed as a primary agricultural product or a commodity, but it should rather be viewed as a differentiated product. In this respect, Greenway *et al.* (2010) show that segmentation of the potato market is feasible, and observations on this feature have been noted as affecting consumer demand. From this perspective, the general differential approach proposed by Barten (1993), and applied to demand functions for agricultural commodities by Brown *et al.* (1994), Lee *et al.* (1994), and Fousekis and Revell (2000), among others, was used to analyze the demand relationships between Egypt and its major competitors on the main EU importing markets of Egyptian potato. Barten's model (1993) makes sense because it provides more flexibility than some frequently used demand models such as the Rotterdam model specification, which is characterized by constant marginal budget shares. Assuming that each of the three markets imports potato from m sources, and let q_j denotes quantity of potato imports from supplier j, and p_j denotes the price of potato imports from supplier j, Barten's model can be specified as follows (Lee *et al.*, 1994):

$$\omega_t \delta\lambda\nu\theta_t = (d_j + \theta_1 w_j)\mathrm{d}\lambda\nu\mathrm{Q} + \sum_{j=1}^{n} (e_{ij} - \theta_2 w_i(\delta_{ij} - w_j))\mathrm{d}\lambda\nu p_j \ \varphi o \rho \ t = 1, \ \ldots, \ \nu \qquad (1)$$

where $d_i = \theta_1\beta_i + (1-\theta_1)\mu_i, e_{ij} = \theta_2\gamma_{ij} + (1-\theta_2)\pi_{ij}, \theta_1$ and θ_2 are two additional parameters to estimate, $\delta_{ij} = 1$ for $i = j$ and zero otherwise. Subscript i indicates import source i, d_i and e_{ij} are composite parameters associated to real income and price variables, respectively. Table S1 in the supplementary material provides definitions of the parameters β_i, μ_i, γ_{ij} and

π_{ij}. w_i represents the average budget share for import source i, $d\ln p_i$ and $d\ln q_i$ represent dp_i/p_i and dq_i/q_i, respectively, and $d\ln Q$ is a Divisia volume index for the change in total real imports of potatoes obtained as follows:

$$d\lambda\nu Q = \sum_{i=1}^{n} w_i d\ln q_i \tag{2}$$

A look at expression (1) clearly shows that Barten's model is the same as the Rotterdam model specification when $\theta_1 = \theta_2 = 0$. The CBS restricted model specification is derived when $\theta_1 = 1$ and $\theta_2 = 0$. When $\theta_1 = 0$ and $\theta_2 = 1$, the NBR restricted model specification is obtained, and the AID model specification is obtained when $\theta_1 = 1$ and $\theta_2 = 1$. By contrast, if Barten's model is maintained with $\theta_1 \neq \theta_2 \neq 0$, then it can be viewed as an independent demand model. Table S1 in the supplementary material provides a description of the specifications of the four restricted demand models and the derivation of price and income (expenditure) elasticities. Laws of demand are imposed on (1) as follows:

$$\text{Adding} - \text{up} : \sum_{i=1}^{n} d_i = 1 - \delta_1 \alpha\nu\delta \sum_{i=1}^{n} e_{ij} = 0 \tag{3a}$$

$$\text{Homogeneity} : \sum_{j=1}^{n} e_{ij} = 0 \tag{3b}$$

$$\text{Symmetry} : e_{ij} = e_{ji} \tag{3c}$$

Noteworthy, the condition that the Slutsky matrix of pure price effects must be semi-definite negative cannot be applied in a straightforward manner to the general Barten's demand model. This can only be undertaken for the CBS and Rotterdam restricted models, which are characterized by a symmetric (Slutsky) matrix of constant price effects. For the other two restricted cases (NBR and AIDS) and the general differential case, Cranfield and Pellow (2004) illustrate that as long as the parameter θ_1 and θ_2 are positive, global concavity of the underlying expenditure function can be satisfied by applying a Cholesky decomposition to the matrix of compensated price effects in expression (1), the elements of which are represented by the term, $e_{ij} - \theta_2 w_i(\delta_{ij} - w_j)$. In this process, the concavity condition however could also be applied locally at the sample mean point (see the attached supplementary material for more details).

Provided that the laws of the demand are fulfilled for n sources of potato import supplies, the general differential model is in line with economic theory and can be estimated with an equation system estimation approach. To respect the adding up condition (3a), a maximum likelihood (ML) procedure applied to (*n-1*) import sources is employed to estimate Barten's general demand model for Germany, Italy and the UK. Because equation (1) nests the various restricted differential demand specifications, a likelihood ratio (LR) test is used to check whether one of the four differential demand model specifications best fits the data relative to Barten's general demand model (Brown *et al.*, 1994). In this process and as suggested by Moschini *et al.* (1994), we used a corrected LR statistic (denoted by LRC) which is adjusted for degrees of freedom and the size of the sample.

As the aim of this empirical work was to derive theoretically consistent price and expenditure elasticities, we assumed that homogeneity and symmetry conditions for the system of estimated import demand equations are maintained hypotheses. Next, we adopted a two-step approach to estimate and select the final model specification for each EU importing market. In the first step, three possible outcomes were expected from estimating the ML of the general differential model (1): (1) one of the four restricted model specifications can be accepted, (2) the four restricted model specifications are rejected in favor of the general model represented by expression (1), and (3) the LRC cannot discriminate between two or more of the four restricted models (Fousekis and Revell, 2000). In the latter case, one of the restricted model specifications has to be selected using a selection criterion such as the Bayes information criterion (BIC). Thus, the objective of the second step of our estimation approach was to ensure the negativity of the Slutsky matrix, based on a Cholesky approach in the case of Rotterdam or CBS model specifications, or one suggested by Cranfield and Pellow (2004) for the NBR and AID model specifications or Barten's general model. In this process, the matrix of compensated price effects for n sources of import supplies might be of a rank lower than $n\text{-}1$, and thus, it could affect the value of the BIC indicator as the number of estimated parameters would be reduced. The general demand model represented by expression (1) has been exposed and discussed by employing infinitesimal changes, but would be estimated with discrete data by substituting w_i by $(w_{it} + w_{it-1})/2$, $d\ln q_i$ by $\ln(q_{it}/q_{it\text{-}1})$ and $d\ln p_i$ by $\ln(p_{it}/p_{it\text{-}1})$, where subscript t indicates time.

4. Data and related statistics

The empirical analysis was based on annual data, spanning 1994 to 2018 for Germany and the UK and from 1994 to 2017 for Italy, on quantities and values of potato imported by Germany, Italy and the UK from Egypt and other major suppliers both in the EU and beyond. When estimating import demand by each country, the selection of supplying countries was based on import shares by source. That is, exporters with relatively large shares were identified as individual suppliers, whereas the remaining countries were aggregated into a rest of the EU and a RoW.

Annual data on import values (expressed in cost, insurance and freight (CIF) terms), and quantities (in thousand metric tons) of potatoes from each EU importing market were compiled from the World Bank, World Integrated Trade Solution (WITS) database for the period 1994–2018. The unit import value was used as a proxy for import prices from each potato supplier. All import unit values are normalized to one at the sample mean. The attached supplementary material and its Table S2 summarize the descriptive statistics for each model's variables including the dependent and explanatory variables. All the figures in this latter table are expressed in percentages. Estimated standard deviations exhibit large magnitudes as it is confirmed by the wide range of minimum and maximum percentages presented for each dependent and explanatory variable. This state of affairs shows that the volume of imports and import prices of potatoes into Germany, Italy and the UK fluctuate significantly during the period 1994–2018. It also shows that import prices of potatoes exhibit significant variability, thus confirming that Egyptian exporters, when shipping fresh potatoes to the EU, must be aware of this constraint, which may hamper their competitiveness and export sales to the EU fresh potato market.

5. Empirical results

5.1 Model selection

Table 1 presents the results of the two-step approach to select the adopted demand model for Germany, Italy and the UK. A look at these results indicates that the Barten's general differential model cannot be a selected choice of model specification for any of the three countries. Indeed, even though it is case that some of the two estimated parameters θ_1 and θ_2 defining Barten's general model could be statistically significant for the three countries, the corresponding Log-likelihood value does not differ much for some of the four counterpart models. Therefore, the above discussed selection criteria were implemented to choose a restricted demand model for each importing country.

Countries	Types of models: Model designation	Parameters θ_1 and θ_2		First step: Negativity conditions not imposed: Log L	LR[a]	LRC[b,c]	Second step: Negativity conditions imposed: Log L	BIC[d]
Germany	General	$\theta_1 = 0.858^{***}$	$\theta_2 = 0.153$	379.184				
	Rotterdam	$\theta_1 = 0.000$	$\theta_2 = 0.000$	374.349	9.670	6.080		
	CBS[d]	$\theta_1 = 1.000$	$\theta_2 = 0.000$	*378.908*	*0.552*	*0.347*	*367.192*	*−307.554*
	AID	$\theta_1 = 1.000$	$\theta_2 = 1.000$	373.076	12.216	7.681		
	NBR	$\theta_1 = 0.000$	$\theta_2 = 1.000$	370.918	16.532	10.395		
Italy	General	$\theta_1 = 0.542$	$\theta_2 = 0.642$	298.003				
	Rotterdam	$\theta_1 = 0.000$	$\theta_2 = 0.000$	*297.153*	*1.700*	*1.113*	293.105	−248.028
	CBS	$\theta_1 = 1.000$	$\theta_2 = 0.000$	*296.025*	*3.956*	*2.589*	295.964	−250.887
	AID	$\theta_1 = 1.000$	$\theta_2 = 1.000$	*296.565*	*2.876*	*1.882*	283.870	−250.656
	NBR	$\theta_1 = 0.000$	$\theta_2 = 1.000$	*297.695*	*0.616*	*0.403*	*284.899*	*−251.685*
United Kingdom	General	$\theta_1 = 0.470^{**}$	$\theta_2 = 0.590^{*}$	292.742				
	Rotterdam	$\theta_1 = 0.000$	$\theta_2 = 0.000$	*290.220*	*5.044*	*3.172*	288.180	−223.572
	CBS	$\theta_1 = 1.000$	$\theta_2 = 0.000$	283.314	18.856	11.856		
	AID	$\theta_1 = 1.000$	$\theta_2 = 1.000$	*290.462*	*4.560*	*2.867*	*280.045*	*−227.862*
	NBR	$\theta_1 = 0.000$	$\theta_2 = 1.000$	288.487	8.510	*5.351*	274.559	−221.976

Note(s): Log L = Log likelihood, LR = likelihood ratio statistic, LRC = Corrected likelihood ratio statistic, BIC=Bayesian information criterion

[a]LR = −2 × (Log$L_{restricted}$-Log $L_{general}$)

[b]$LRC = LR\left[\frac{MT - 0.5(N_U + N_R) - 0.5M(M+1)}{MT}\right]$ where M is the number of equations, T is the number of time series observations, N_U is the number of parameters in the unrestricted model specification (i.e. Barten's general model), N_R is the number of parameters in the restricted model specification

[c]The null hypothesis of selecting one of the four restricted model specifications is not rejected if the LRC statistic is smaller than a critical χ^2 value with two degrees of freedom. The adopted critical χ^2 value to perform the above model specification tests is 5.99 for a 5% level of significance

BIC = −2 × Log L + Log(MT) × N where N is the number of parameters

[d]Headings and figures marked in bold characters are the selected model specifications

Table 1. Log-likelihood values of the different models and specification tests

With regard to the German market, the LRC test did not reject the hypothesis that the restricted CBS demand model should be selected. This implies that a Cholesky decomposition can be directly applied to the Slutsky matrix of constant compensated price effects (denoted by elements π_{ij}). Therefore, the CBS model for Germany was estimated by ML estimation considering seven import sources. In relation to the Italian market, the selection of a relevant demand model was more complicated because we faced a situation similar to the one described by Fousekis and Revell (2000) whereby the LRC tests indicated that the four restricted models, i.e. Rotterdam, CBS, NBR and AID, cannot be rejected at all (see Table 1). Thus, a recourse to a selection criterion such as BIC was the only feasible option to select the final demand model specification for Italy. A comparison of the BIC values in the second step in Table 1 led to the selection of the NBR demand model specification that exhibits the lowest BIC with a value of −251.685. With respect to the UK market, the LRC test results in Table 1 suggested that Rotterdam, AID and NBR model specifications are equally plausible candidates to represent the import demand patterns. However, the BIC values indicated that AID model is the one that should be employed. Imposition of the negativity condition of the Slutsky matrix at the sample mean results in the derivation of price and expenditure elasticities that satisfy all laws of demand.

The econometric results of the three selected demand models are presented in Tables S3, S4 and S5 and briefly discussed in Section B of the supplementary material. Overall, the econometric results of the estimated demand models provide a mixed picture of their respective performance, which varies among the three countries under study. On the one hand, the econometric findings for Germany look satisfactory. For Italy, the response of each import demand to prices and the overall explanatory power of each estimated demand model raise some concerns on the reliability of this estimated demand model. The econometric performance of the UK demand model led us to conclude that it posits itself between Germany and Italy.

5.2 Elasticity results

Tables 2–4 present price and expenditure elasticities based on the estimated demand models for Germany, Italy and the UK, respectively. Elasticities were computed at the sample mean and all of them satisfy the various constraints imposed by the laws of demand. This implies that through the Slutsky relationship and assuming that all income effects are positive, Hicksian own-price elasticities are smaller in absolute values than their Marshallian counterparts. Concerning the cross-price effects, positive income effects offset Marshallian gross cross-price effects and, for this reason, it would not be surprising that two sources of potato imports, which are gross substitutes, could become net complements through a sign reversal.

5.2.1 The German model. Table 2 shows that expenditure elasticities across all supplying sources to Germany, except for potato imports from France, are statistically significant with coefficients ranging from 0.63 (Italy) to 1.52 (RoEU). The computed expenditure elasticity for Egypt implies that a 1% increase in total German imports of fresh potatoes would increase potato imports from Egypt by around 1.12%, although the estimate is statistically insignificant. The estimated expenditure elasticities for the Netherlands (1.2) and the RoEU (1.5) are statistically highly significant and greater than one, implying that compared to Egypt, European potato suppliers stand to benefit most from an increase in Germany's expenditure on imported potato. This finding goes in line with previous studies on EU countries' import demand for agricultural commodities, which find that increased expenditure on imported commodities would always favor other EU member states (e.g. Abd-Elradi *et al.*, 2016). This is because imports from non-EU countries may be constrained by the existence of quotas and other policy-induced barriers to trade. The positive but less than values of expenditure elasticity estimates for Spain (0.78) and the RoW (0.72) suggest that an increase in the German imports of potato would increase their total exports but that their market shares would decrease.

Each of the Marshallian own-price elasticities is statistically different from zero and most of them but one have values that are close to one in absolute values. A *t*-test undertaken on these latter own-price elasticities clearly shows that all of them are indifferent from -1, indicating that a 1% increase in the price of one import source, *ceteris paribus*, results in a 1% reduction in the corresponding import shipment. This pattern, observed for the Marshallian own-price elasticities, is also occurring to a lesser extent for its Hicksian counterparts. In this latter case, however, due to the opposite income effects, these computed Hicksian own-price elasticities reveal that the corresponding compensated import demands are more price inelastic than their Marshallian counterparts.

Regarding the interrelationships among potato import sources on the German market, the most significant results occur in terms of Hicksian cross-price elasticities. As exemplified by its cross-price elasticity equal to 0.86, it is interesting to note that imports from Egypt are the only significant net substitute for the Netherlands' shipments of potatoes. These findings indicate that Germany tends to switch to potato imports from the Netherlands, which is the largest exporter of fresh potatoes to Germany with an average budget share of around 48%, when Egyptian potato becomes relatively expensive. In addition, the results reveal that the

Table 2. Price and expenditure elasticities in Germany

Import sources	Egypt $j = 1$	Netherlands $j = 2$	France $j = 3$	Spain $j = 4$	Italy $j = 5$	RoEU $j = 6$	RoW $j = 7$	Expenditure elasticities
	Marshallian price elasticities (prices ↓)							
Egypt	**−1.0375** (0.3292)	0.3233 (0.3206)	0.0838 (0.1627)	−0.0132 (0.2074)	−0.2316 (0.1860)	***−0.3758*** (0.1535)	0.1260 (0.1584)	**1.1251** (0.3904)
Netherlands	0.0591 (0.0552)	**−1.0138** (0.0733)	−0.0230 (0.0275)	**−0.1195** (0.0377)	−0.0991 (0.0386)	***−0.0557*** (0.0279)	0.0349 (0.0255)	**1.2171** (0.0859)
France	0.1953 (0.1613)	**0.4830** (0.1614)	**−1.000** (0.1252)	0.2153 (0.1359)	**0.4460** (0.1157)	−0.1409 (0.0951)	***−0.1888*** (0.0933)	−0.0098 (0.1998)
Spain	0.0186 (0.2425)	*−0.4828* (0.3177)	0.1913 (0.1616)	**−0.9276** (0.2814)	0.3177 (0.1948)	0.2439 (0.1913)	−0.1421 (0.1559)	***0.7811*** (0.3720)
Italy	−0.2449 (0.2383)	−0.3149 (0.2936)	**0.5258** (0.1508)	0.3437 (0.2161)	**−0.7479** (0.2624)	−0.1415 (0.1533)	−0.0469 (0.1535)	*0.6267* (0.3660)
RoEU	***−0.4196*** (0.1628)	***−0.4113*** (0.1840)	**−0.3098** (0.1038)	0.1401 (0.1701)	−0.1829 (0.1221)	**−0.3294** (0.1082)	−0.0074 (0.1218)	**1.5204** (0.2079)
RoW	0.2846 (0.3167)	*0.5566* (0.3103)	***−0.4576*** (0.1890)	−0.2195 (0.2673)	−0.0786 (0.2323)	0.0659 (0.2169)	**−0.8720** (0.2966)	***0.7204*** (0.3543)
	Hicksian price elasticities (prices↓)							
	Egypt $j = 1$	Netherlands $j = 2$	France $j = 3$	Spain $j = 4$	Italy $j = 5$	RoEU $j = 6$	RoW $j = 7$	Budget shares
Egypt	**−0.9236** (0.3241)	**0.8617** (0.2558)	0.2025 (0.1653)	0.0798 (0.1935)	−0.1423 (0.1830)	−0.2630 (0.1610)	0.1849 (0.1597)	0.1012
Netherlands	**0.1823** (0.0541)	**−0.4113** (0.0611)	**0.1055** (0.0273)	−0.0188 (0.0351)	−0.0025 (0.0376)	**0.0663** (0.0287)	**0.0986** (0.0256)	0.4786
France	0.1943 (0.1586)	**0.4783** (0.1237)	**−1.0010** (0.1275)	*0.2145* (0.1279)	**0.4452** (0.1155)	−0.1419 (0.0999)	***−0.1893*** (0.0943)	0.1055
Spain	0.0977 (0.2369)	−0.1090 (0.2030)	*0.2737* (0.1632)	**−0.8630** (0.2645)	*0.3796* (0.1934)	*0.3222* (0.1934)	−0.1012 (0.1587)	0.0827
Italy	−0.1815 (0.2335)	−0.0149 (0.2270)	**0.5919** (0.1536)	*0.3955* (0.2041)	**−0.6982** (0.2620)	−0.0787 (0.1575)	−0.0141 (0.1535)	0.0794
RoEU	−0.2657 (0.1627)	***0.3164*** (0.1370)	−0.1494 (0.1051)	0.2658 (0.1595)	−0.0623 (0.1247)	−0.1770 (0.1178)	0.0722 (0.1214)	0.1002
RoW	0.3576 (0.3089)	**0.9015** (0.2337)	***−0.3816*** (0.1900)	−0.1599 (0.2506)	−0.0214 (0.2327)	0.1381 (0.2325)	**−0.8343** (0.3001)	0.0524

Note(s): Figures in parentheses are estimated standard errors. Values in bold fonts = statistically significant at 1% level. Values in bold italic fonts = statistically significant at 5% level. Values in italic fonts = statistically significant at 10% level

Table 3.
Price and expenditure elasticities in Italy

Import sources	Egypt $j = 1$	Netherlands $j = 2$	Marshallian price elasticities (prices ↓) France $j = 3$	Germany $j = 4$	RoEU $j = 5$	RoW $j = 6$	Expenditure elasticities
Egypt	−**0.9753** (0.008)	0.0387 (0.1556)	0.1517 (0.4241)	0.0012 (0.1956)	0.0255 (0.0692)	0.0270 (0.1172)	0.7312 (0.8546)
Netherlands	***0.0874*** (0.0385)	−**0.8643** (0.0571)	***0.4267*** (0.1703)	0.0646 (0.1002)	0.0596 (0.0392)	0.0694 (0.0714)	0.1566 (0.2884)
France	−0.0535 (0.0363)	−***0.0855*** (0.0480)	−**1.2820** (0.1462)	−0.0378 (0.0922)	−0.0412 (0.0341)	−0.0368 (0.0432)	**1.5367** (0.2318)
Germany	0.0045 (0.1175)	−0.0304 (0.1354)	0.2899 (0.3956)	−**1.3205** (0.2989)	0.0968 (0.1059)	***0.2623*** (0.1234)	0.6973 (0.5438)
RoEU	0.0841 (0.1170)	0.1591 (0.1324)	0.1000 (0.4207)	0.3726 (0.3231)	−**1.0443** (0.1561)	−0.1618 (0.1515)	0.4904 (0.5178)
RoW	0.0789 (0.7949)	0.4905 (0.7990)	−1.0814 (1.8742)	2.5492 (1.1909)	−0.5379 (0.4623)	−**3.1420** (0.7884)	1.6427 (2.5998)
	Egypt $j = 1$	Netherlands $j = 2$	Hicksian price elasticities (prices↓) France $j = 3$	Germany $j = 4$	RoEU $j = 5$	RoW $j = 6$	Budget shares
Egypt	−**0.8940** (0.0403)	**0.1725** (0.0402)	**0.4935** (0.1159)	0.1272 (0.1588)	0.0617 (0.0506)	0.0392 (0.1138)	0.1112
Netherlands	**0.1048** (0.0245)	−**0.8356** (0.0445)	**0.4999** (0.0790)	0.0915 (0.1036)	0.067 (0.0335)	0.0720 (0.0697)	0.1830
France	**0.1174** (0.0275)	**0.1957** (0.0310)	−**0.5637** (0.0842)	***0.2270*** (0.0917)	0.0349 (0.0307)	−0.0112 (0.0420)	0.4674
Germany	0.0821 (0.1025)	0.0972 (0.1101)	***0.6158*** (0.2487)	−1.2004 (0.3125)	0.1314 (0.0966)	***0.2739*** (0.1201)	0.1723
RoEU	0.1386 (0.1138)	***0.2488*** (0.1238)	0.3291 (0.2898)	0.4571 (0.3428)	−**1.0201** (0.1463)	−0.1537 (0.1478)	0.0495
RoW	0.2615 (0.7597)	0.7911 (0.7648)	−0.3136 (1.1791)	***2.8322*** (1.2419)	−0.4566 (0.4391)	−**3.1147** (0.7699)	0.0167

Note(s): See Table 2

Table 4. Price and expenditure elasticities in the United Kingdom

Import sources	Marshallian price elasticities (prices ↓) Egypt $j = 1$	Netherlands $j = 2$	France $j = 3$	Spain $j = 4$	Cyprus $j = 5$	RoEU $j = 6$	RoW $j = 7$	Expenditure elasticities
Egypt	**−1.0310** (0.0886)	0.1815 (0.1994)	0.0537 (0.2059)	0.0163 (0.1327)	0.2399 (0.2430)	−0.1028 (0.1553)	−0.0101 (0.1767)	***0.6525*** (0.2913)
Netherlands	0.1152 (0.1420)	**−1.6732** (0.1617)	0.1284 (0.1493)	−0.0791 (0.1561)	−0.1158 (0.1812)	***0.2429*** (0.1036)	**0.5646** (0.1788)	**0.8171** (0.1531)
France	−0.0030 (0.0727)	0.0510 (0.0779)	**−1.1688** (0.1792)	0.1122 (0.1005)	0.0978 (0.1675)	0.0261 (0.1111)	−0.0478 (0.0970)	**0.9326** (0.2236)
Spain	0.0162 (0.1416)	−0.1056 (0.2337)	0.4055 (0.2953)	**−1.2020** (0.1792)	0.0145 (0.2501)	−0.0481 (0.1720)	0.2480 (0.2598)	**0.6714** (0.2620)
Cyprus	0.1155 (0.2288)	−0.3259 (0.2589)	−0.0165 (0.4287)	−0.1014 (0.2296)	**−2.1637** (0.6154)	0.4643 (0.2997)	−0.2464 (0.2973)	**2.2743** (0.5965)
RoEU	−0.0556 (0.0504)	*0.0874* (0.0492)	0.0235 (0.0963)	−0.0308 (0.0526)	***0.2370*** (0.1026)	**−1.1951** (0.0955)	0.0053 (0.0653)	**0.9233** (0.1457)
RoW	−0.0352 (0.0712)	**0.3385** (0.1079)	−0.0876 (0.1051)	0.0771 (0.1042)	−0.0165 (0.1239)	−0.0250 (0.0804)	**−1.2983** (0.1623)	**1.0470** (0.1435)

	Hicksian price elasticities (prices↓) Egypt $j = 1$	Netherlands $j = 2$	France $j = 3$	Spain $j = 4$	Cyprus $j = 5$	RoEU $j = 6$	RoW $j = 7$	Budget shares
Egypt	**−0.9803** (0.0940)	0.2534 (0.1996)	0.1986 (0.2067)	0.0631 (0.1309)	0.2902 (0.2308)	0.0734 (0.1710)	0.1015 (0.1578)	0.0777
Netherlands	0.1787 (0.1408)	**−1.5832** (0.1645)	**0.3099** (0.1529)	−0.0205 (0.1541)	0.0527 (0.1780)	**0.4635** (0.1148)	**0.7043** (0.1702)	0.1102
France	0.0695 (0.0723)	***0.1538*** (0.0758)	**−0.9617** (0.1868)	*0.1790* (0.0971)	0.1698 (0.1593)	***0.2779*** (0.1138)	0.1116 (0.0821)	0.2221
Spain	0.0684 (0.1418)	−0.0316 (0.2367)	***0.5547*** (0.2996)	**−1.1538** (0.2882)	0.0664 (0.2394)	0.1332 (0.1887)	0.3628 (0.2463)	0.0717
Cyprus	0.2922 (0.2323)	−0.0753 (0.2542)	0.4886 (0.4583)	0.0617 (0.2224)	**−1.9882** (0.5889)	**1.0784** (0.3387)	0.1425 (0.2651)	0.0772
RoEU	0.0211 (0.0492)	**0.1892** (0.0469)	***0.2286*** (0.0936)	0.0354 (0.0968)	**0.3083** (0.0968)	**−0.9457** (0.1088)	**0.1632** (0.0555)	0.2701
RoW	0.0461 (0.0717)	**0.4539** (0.1070)	0.1450 (0.1067)	0.1521 (0.1033)	0.0643 (0.1197)	**0.2577** (0.0876)	**−1.1192** (0.1541)	0.1710

Note(s): See Table 2

Hicksian cross-price elasticities between Egypt and other import sources are statistically insignificant. This may be attributable to the early harvest of Egyptian potato compared to other major suppliers, which gives Egyptian potato a competitive advantage on the German market and mitigates the competition effect of other import sources, other than the Netherlands, which occur later during the potato marketing season (King-Okumu and Aboukheira, 2015).

With regard to other potato suppliers to the German market, the Hicksian cross-price elasticities in Table 2 show that Dutch potato competes with other sources of imports including France, the RoEU and the RoW. France, Italy and Spain are net substitutes to each other as is confirmed by their positive and significant Hicksian cross-price elasticities. Lastly, because their Hicksian cross-price elasticities are negative, there is only one significant (net) complementarity relationship that takes place between French potato and those originating in the RoW. Several of the significant interrelationships that were identified using Hicksian cross-price elasticities do not stand up anymore when an analysis of the Marshallian cross-price elasticities is undertaken. The most obvious example of this pattern occurs between Egypt and the Netherlands whereby it is impossible to state that these two import sources are significant gross substitutes as their Marshallian cross-price elasticities, although positive, are not statistically different from zero. This result is not surprising *per se* because it reflects the fact that there is a significant income effect neutralizing in the opposite direction the pure substitution effect represented by the corresponding Hicksian cross-price elasticities.

5.2.2 The Italian model. The results reported in Table 3 reveal that, except for France, all estimated expenditure elasticities for potato suppliers to Italy are statistically insignificant. That is, if Italy increases its expenditure on imported potato by 1%, the market share of France would increase by 1.53%. A pattern similar to the one observed for Germany seems to prevail for Italian potato imports concerning own-price elasticities. This is equally valid for the Marshallian and Hicksian own-price elasticities. As for Germany, most of the Marshallian own-price elasticities are not different from -1.

It is also worth pointing out that some of the own-price elasticities are quite large in absolute values. For instance, the Marshallian own-price elasticities of the RoW is equal to -3.142. The examination of the Hicksian cross-price elasticities provides several significant net substitution effects among sources of Italian potato imports. Although the number of the latter interrelationships is rather limited, it is interesting to note that it mainly concerns three sources of imports, namely Egypt, France and the Netherlands. More specifically, the results indicate that a 1% increase in the price of Egyptian potato, *Ceteris paribus*, would lead to around a 0.5% and 0.2% increase in the quantity demanded of French and Dutch potatoes, respectively. Notably, as in the case of Germany, Egyptian potato tends to substitute for the "leading supplier" of imported potato to the Italian market, which is France that has an average budget share of around 22% of the Italian market.

5.2.3 The UK model. The estimated price and expenditure elasticities for potato suppliers to the UK, presented in Table 4, generally follow similar patterns as those observed in the German and Italian models. For instance, as for the German market, all expenditure elasticities for the UK potato imports are statistically different from zero and most of them gravitate around the unity. The only exception is the expenditure elasticity for UK imports from Cyprus, which is greater than 2. With regard to price elasticities, similarly to Italy and Germany, own-price elasticities for all UK potato imports are all significant from a statistical viewpoint and most of them are quite large and greater than 1 in absolute values, such as those related to Cyprus (-1.67) and the Netherlands (-2.16). Moreover, it is noticeable to a lesser extent than for Germany and Italy that several of the significant interrelationships among UK import sources of potatoes are well measured by Hicksian cross-price elasticities and not by their Marshallian equivalents. This result is unsurprising and can be explained by the fact the income effect seems to neutralize and offset the pure substitution effect.

Nevertheless, some aspects could be viewed as specific to the UK import market for fresh potatoes. An examination of average budget shares in Table 4 shows that there is not a leading supplier of potatoes to the UK, but rather the UK has a diversified source of imports that includes all import sources represented in the import demand model adopted for this country. From this perspective, and looking at the Hicksian cross-price elasticities, it is worth pointing out that significant substitution occurs between UK imports originating in the Netherlands, France, and the RoEU and RoW regions. Unlike Germany and Italy, UK potato imports from Egypt do not share any significant interrelationships with other import sources. This pattern is rather unexpected in the sense that several UK import sources of potatoes originate in countries that, as Egypt, are located in the Mediterranean region such as Cyprus and Israel. Egyptian potatoes, which are produced from varieties identical to these countries, especially Israel, were expected to compete with them on the EU market. However, Abdullah (2015) and Hashem *et al.* (2017) illustrate that Egyptian potato exporters have since the last decade been able to compete successfully with their Mediterranean competitors on the EU market by lowering relative export prices and supplying consistently higher quality potatoes that meet the demands of the EU markets.

6. Discussion and policy implications

This study adopted an import-differentiated framework to examine the competitiveness of Egyptian potato exports on three EU markets, namely Germany, Italy and the UK, between 1994 and 2018. Overall, the results revealed several findings with useful policy implications that may help Egyptian agribusinesses and policymakers better understand the structure and dynamics of the EU market for imported potato and improve the market access and competitiveness of Egyptian potato exports. Specially, the estimated expenditure elasticities for Egypt were insignificant in the German model, and significant but inelastic in the Italian and the UK models. These estimates indicate that as income allocation on potato imports increases, the investigated EU markets would import much more potatoes from other suppliers compared to imports from Egypt. In this regard, upgrading quality control procedures, improving export infrastructure and logistics, and building capacity and coordination between organizations and actors along the potato's export supply chain are crucial undertakings for enhancing the competitiveness of Egyptian potato exports on the EU market.

Consistent with economic theory, the own-price elasticities in the three estimated models across different source countries were negative and statistically significant as expected. In the German and UK markets, the Marshallian own-price elasticity of potato demand from Egypt was slightly above one, whereas it was almost equal to one in the Italian market. This finding suggests that the EU importers may switch to potato imports from other suppliers as the import price of Egyptian potato increases. However, a look at the export prices of Egyptian potato during the last few years show that they have been adversely affected by the instability in the country's macroeconomic policies together with the currency devaluation in 2016, which significantly increased the cost of imported potato seeds required for exporting to the EU market. While Egypt sources more than two-thirds of its yearly seed potato requirements from the Netherlands and the UK, the devaluation of the Egyptian pound in 2016 has doubled the cost of imported seeds, which represents up to 40% of the production and export cost and adversely impacted the price competitiveness of Egyptian potato on the EU market. Our findings related to own-price elasticities are in concert with previous studies showing that lack of competitive prices is a major market access barrier to Egypt's agricultural commodities (e.g. Abu Hatab, 2016; Fawaz and Soliman, 2016). These studies suggested that Egypt should upgrade technology and increase efficiency along the potato supply chain to lower marginal cost, and implement a pricing strategy that builds upon firms' internal capacities, skills and comparative advantage against their competitors while also considering the EU customer's needs in terms of both quality and price. For instance, Fawaz and Soliman (2016) point out that it is crucial for Egypt to increase efficiency along the potato supply chain to lower export costs, which can be achieved through better coordination among actors along the potato chain and improving infrastructure to effectively connect potato producers with their markets, reduce transportation cost and post-harvest losses.

The (Hicksian) cross-price elasticities showed few demand interrelationships between Egypt and other potato suppliers in the investigated markets. This finding may indicate that the early harvest of Egyptian potato enables Egypt to avoid fierce competition with domestically produced potato in the EU, which appears in the spring (Khalifa and Mahmoud, 2016). However, relying on seasonality does not seem to be an effective long-term competiveness strategy for the Egyptian potato, since burgeoning environmental challenges in Egypt (e.g. climate change) are expected to shorten the suitable period for potato production, reduce potato yields, and increase irrigation demand for Egyptian potatoes and other problems related to pests and diseases.

In light of the study findings, future research should address three main issues. First, more research is needed to understand the determinants of import demand for potato and other horticultural exports from LMICs, which are progressively gaining larger shares in their agricultural exports to the EU and other high-income countries. Especially, the recent changes that the EU market has undergone in relation to potato supply and demand offer both opportunities and uncertainties for LMICs' potato exports. For instance, the cultivated area of potato in the EU has almost halved over the last 2 decades and harvests dropped by around 37% between 2000 and 2018 (EUROSTAT, 2019). In addition, record-breaking summer heatwaves and lack of rain across Europe in recent years have hurt potato supply and increased volatility in both producer and consumer prices. These fluctuations in EU potato supply, combined with the uncertainty in potato producer and consumer prices, have resulted in a significant variability in EU's import prices and hence influenced the competitiveness and viability of Egypt's firms and producers exporting potatoes to the EU. Another major change in the EU's agricultural market landscape is the UK's withdrawal from the EU in 2017, commonly referred to as Brexit, which has further implications for EU's imported potatoes. As the UK was the most important single potato export market, the Brexit presented considerable uncertainties in regards to many aspects of potato trade between the UK and the EU. Therefore, it is crucial for LMICs' exporters such as Egypt to have up-to-date and accurate demand parameters in order to implement effective measures for enhancing market access and competitiveness of their horticultural exports to the EU. In addition, future research undertakings should examine the effect of other important variables on import demand for potato in the EU, such as exchange rate, domestic export incentives, cost of agricultural inputs, and the pressure of domestic demand and its impact on domestic prices and exports, which have been used rigorously in empirical studies to assess import demand and export competitiveness.

Second, more analyses on the supply-side issues that account for the effects of the rapid transformation of horticultural systems in LMICs on their horticultural exports are necessary to supplement the body of literature on analysis of changing preferences and demand patterns in importing markets. Only when side aspects of both supply and demand are well understood can policies be designed to enhance effectively the competitiveness of LMICs' horticultural commodities in their import destinations.

Third, due to data unavailability, the present study relied on yearly data on quantities and prices of EU potato imports. Using a higher frequency of observations, (e.g. monthly data), should allow for taking seasonal effects into account and thereby provide a more transparent picture of market dynamics and demand behavior of EU countries with respect to potato import from various sources of origin.

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Appendix

The supplementary file for this article can be found online.

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