MODELLING THE EFFECTS OF AN ABOLITION OF THE EU SUGAR QUOTA ON INTERNAL PRICES, PRODUCTION AND IMPORTS

STEPHAN NOLTE [1,*], **JEROEN BUYSSE** [1], **BART VAN DER STRAETEN** [1], **DAKERLIA CLAEYS** [2], **LUDWIG LAUWERS** [2] and **GUIDO VAN HUYLENBROECK** [1]

[1] Ghent University, Department of Agricultural Economics, Coupure links 653, 9000 Gent, Belgium

[2] Institute for Agricultural and Fisheries Research, Merelbeke, Belgium

[*] Corresponding author. Tel.: +32 (0)9 264 59 29; fax: +32 (0)9 264 62 46; e-mail: Stephan.Nolte@Ugent.be

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Abstract

We apply a spatial price equilibrium model of the world sugar market to simulate an abolishment of the EU quota system in 2015/16. To overcome the normative nature of the approach, we calibrate the model by attaching a non-linear cost term to each trade flow. This is in some regards similar to positive mathematical programming. We suggest an economic interpretation and an econometric specification of the cost term. Production in the EU increases to almost 16 million tons. Twelve member states increase production, seven reduce it. Preferential imports are significantly reduced. Simulated effects are found to be more pronounced the higher the world market price.

Keywords: CAP, structural change, sugar, TRQ, spatial modelling, trade preferences, PMP;

1. Introduction

The reform of the European Union's (EU) common market organisation for sugar entering into force in 2006[1] was assessed as a success by the European Commission (Agra-Europe Weekly, 19 June 2009, European Policy News: 4-5). The majority of EU beet sugar production is now concentrated in the member states with the most efficient industries. The price for consumers and industrial users of sugar was decreased, processors and beet growers were compensated for their loss of quota and the latter even for a part of the reduction of the statutory price for sugar beet within the quota. The restructuring scheme[2] was successful in reducing the overall sugar quota[3] of the EU by almost 6 million tons, equivalent to one third of the pre-reform level of A- and B-quotas. This reduction in quantity was regarded necessary in order to keep the common market in balance, once imports from Least Developed Countries (LDC) under the 'Everything but arms' initiative (EBA) and ACP (African, Caribbean and Pacific countries) under the European Partnership Agreements (EPA), the successor of the Lomé and Cotonou treaties, became fully duty and quota free as of 2009 and 2015, respectively. As a consequence, the commission decided not to enact a further mandatory quota cut in February 2010, as it would have been entitled to, should the restructuring process not lead to a sufficient reduction in quantity (Agra-Europe Weekly, 29 January 2010, European Policy News: 2).

Agricultural Economists, however, while acknowledging the success of the reform with respect to the specified objectives were disappointed by some specific aspects which led to a needless loss of efficiency. In particular, they criticised that free movement of quotas especially between member states is still not possible and that the incentives set by the restructuring scheme led to the persistence of sugar sectors in member states that are not competitive. A proper implementation of one or both of these measures could have facilitated

[1] Council Regulation (EC) 2006/318.
[2] Council Regulation (EC) 2006/320.

a structural adaption of the EU sugar industry embodying a full concentration of production in regions with a comparative advantage for beet production and of processing enterprises being able to optimally exploit economies of scale (Nolte and Grethe, 2010).

The current CMO is expiring after the sugar marketing year (MY) 2014/15. No concrete proposal for a successor has yet been tabled, but statements from staff of the European Commission (Agra-Europe Weekly, 19 June 2009, European Policy News: 4-5) as well as the general environment of agricultural policy changes, such as for instance the abolishment of the dairy quota, make an abolishment of the quota a rather likely possibility. In that case, producers in the EU would still be protected by comparatively high MFN tariffs even more so, since a quick completion of the Doha round of WTO (World Trade Organisation) negotiations does not seem very likely in the next five years. However, increased competition within the EU alone can be expected to lead to a substantial structural reallocation of sugar production to more competitive regions. It will also most likely lead to discouragement of a part of the preferential imports from ACP, LDC and others and thus to an increased market share of domestic producers. In case of world market prices as high as currently, it seems even possible that the EU might re-emerge as an exporter of sugar on the world market – without export refunds, although it is highly questionable whether this current high level of world market prices is sustainable in the medium and long run.

The objective of this paper is to model the abolishment of EU sugar quotas in 2015/16 in order to analyse its impact on production, prices and imports of the EU. For that purpose, An ESTJ[4] spatial price equilibrium (SPE) model is applied. The preferential imports of the EU, which are next to quota bound production and relatively stable consumption the only variable element in the current market balance, are of crucial importance for the effectiveness of the EU sugar policy. They are also of interest of their own, though, since for the countries of origin, they are a major source of export earnings and agricultural gross domestic product (GDP). Therefore, the SPE model, which is particularly suited to simulate bilateral policy changes for homogeneous products, is an adequate choice as a tool for this analysis. The approach is known, though, to perform poorly in reproducing observed trade matrices. To overcome this problem we calibrate the model by attaching a non-linear cost term to each trade flow. This approach is similar to positive mathematical programming (PMP), a method

[3] Including renouncements of Inulinsyrup and Isoglucose.
[4] Enke (1951), Samuelson (1952), Takayama and Jugde (1964).

developed in the 1990s to solve the problem of normative farm or sector supply models being unable to reproduce an observed set of decision variables.

The abolishment of quotas in the EU can be viewed as a structural break in the sugar policy with the potential to induce a considerable reallocation of production between member states. As a consequence, isoelastic supply functions, whose parameters are estimated over a rather limited range of observed price variations, will have difficulties in properly depicting the supply response to this structural break, most notably the possible liquidation of sugar industries in some member states. Thus, we decided to employ a different functional form, which will be described in more detail below.

In the next section, we will give a short overview of the modelling approach. In section three, we will define the scenarios with respect to the development of the world market price, which will be a crucial determinant of the imports of various preferential trading partners, of possible exports of EU producers, of the price level on the community market and thus of the level of production and the structural consolidation of the EU sugar industry. In section four, we present and discuss the results and in the final section, we draw conclusions with respect to both the stated research objective and the adequacy and potential of the applied model.

2. The modelling approach

2.1. The original SPE model

The model we use for the simulation of the scenarios formulated in section three has first been developed and described by Nolte (2008a) and since been applied for the simulation of various scenarios of EU and world sugar policies (Nolte, 2008b; Nolte *et al.*, 2010). For reasons of transparency and flexibility, it is formulated as a Mixed Complementarity Problem (MCP) rather than an optimisation problem (Nolte *et al.*, 2010). In its basic, uncalibrated version, the equations of the model are as follows:[5]

[5] Endogeneous variables are written in capital letters while exogenous parameters are written in lower case letters.

$$D_i = \alpha_i * (PD_i - c\_subs_i)^{\beta_i} \tag{1}$$

$$S_j = MAX\{0, \gamma_j + \delta_j * (PS_j + p\_subs_j)^{\varepsilon_j}\} \tag{2}$$

$$EST_i = \zeta * stock\_shr_i * D_i * PD_i^{\eta_i} \tag{3}$$

$$D_i + EST_i \leq \sum_{sch}\sum_{j} X_{sch,j,i} \qquad \perp PD_i \geq 0 \tag{4}$$

$$S_j + ost_j \geq \sum_{sch}\sum_{i} X_{sch,i,j} \qquad \perp PS_j \geq 0 \tag{5}$$

$$S_j \leq quota_j \qquad \perp PPQ_j \geq 0 \tag{6}$$

$$X_{sch,j,i} \leq trq_{sch,j,i} \qquad \perp PQ_{sch,j,i} \geq 0 \tag{7}$$

$$\begin{aligned}&(PS_j + PPQ_j + PQ_{sch,j,i} + exw\_fas_j \\ &+ loading_j + freight_{j,i} + tc_{sch} - ex\_sub_{j,i}) \\ &*(1 + tar\_av_{sch,j,i}) + tar\_sp_{sch,j,i} \\ &+ unloading_i + inld\_transport_i \geq PD_i\end{aligned} \qquad \perp X_{sch,j,i} \geq 0 \tag{8}$$

with *i* being the set of consuming regions, *j* the set of producing regions and *sch* being the set of different schemes under which sugar can be traded between two regions. Equations (1) and (2) represent demand and supply functions. In the isoelastic demand equation, D_i stands for demand in country *i*, PD_i for the consumer price, and c_subs_i for consumer subsidies. β_i is the (negative) own price elasticity of demand and α_i is a calibrated intercept. S_j represents supply in country *j*, PS_j the producer price and p_subs_j producer subsidies. Supply functions are isoelastic for most regions. In isoelastic supply functions, the parameter γ_j is zero and the exponent ε_j is the own price elasticity of supply. For some beet producing countries, among them the EU member states, the additive parameter γ_j is negative which allows production to cease at a positive price (Nolte and Grethe, 2007). The *MAX*-function ensures supply cannot assume negative values. Ending Stocks EST_i (3) are modelled as a share ($stock\_shr_i$) of domestic consumption and as a function of the domestic price. ζ_i is a calibrated intercept and η_i is the elasticity of stockholding with respect to the own price. In Equations (4) and (5), $X_{sch,j,i}$ represents trade flows from country *j* to *i* (including domestic sales) under scheme *sch*. Total demand in region *i* plus the ending stocks cannot exceed the sum of shipments to that region and total trade flows from region *j* cannot exceed the regions total production plus opening stocks ost_j. The latter are identical to the ending stocks of the previous period. Complementary slackness provides for consumer and producer prices to become zero if the equations do not hold with strict equality. Equation (6) requires production of region j to be smaller or equal than the production quota of that region. If supply falls short of the quota, the quota loses its value and the quota rent PPQ_j becomes zero. Equation (7) limits trade flows under certain schemes to a tariff rate quota (TRQ), $trq_{sch,i,j}$. If the TRQ is not filled, complementary slackness provides for the quota rent $PQ_{sch,j,i}$ to become zero. Equation (8), the price transmission equation, requires that the duty paid price of imported sugar be either larger than the domestic price in the import market - in which case no imports take place - or equal to the price in the import market - in which case imports do take place. The duty paid price of imported sugar on the import market consists of the marginal costs of production (PS_i), any rents for production quotas and for TRQ, transportation costs from factory to port (exw_fas_j), loading and unloading costs for ocean vessels ($loading_j$, $unloading_i$), ocean freight rates ($freight_{j,i}$), transaction costs (tc_{sch}), *ad valorem* and specific tariffs ($tar\_av_{sch,j,i}$, $tar\_sp_{sch,j,i}$), export subsidies ($exs_{sch,j,i}$) and transportation costs from the port or the factory to the wholesale market ($inld\_transport_i$).

2.2. Critique of the SPE model and response

The SPE model in its original form essentially behaves as a normative i.e. optimisation model notwithstanding it usually being used as a tool of positive economic analysis. The Linear Programming (LP) formulation of the transport module is technically restricted to a non-degenerate solution of a maximum of *2n-1* trade flows, *n* being the number of regions. The model suffers thus from two sources of misspecification which usually prohibit it from reproducing an observed matrix of trade flows, even if all real world constraints were captured adequately, which is also almost impossible for a sufficiently complex model. First, the solution of the normative transport model represents an optimal situation, which is usually not the case in reality, *inter alia* due to the conditions of full information and rationality of all agents not being fulfilled. Second, however well the (linear) model is specified, the restriction to a maximum number of trade flows does not allow to replicate observed trade matrices for most products which contain a larger number of observed trade flows. In particular, it does not allow for cross-hauling. As a consequence, the model performs poorly in reproducing observed matrices of trade flows as is noticed by many authors (Bröcker, 1988; Harker, 1988; Batten and Westin, 1989; Roy, 1990; Ostrovsky, 2005; Nolte, 2008b, to name but a few), some of which also tried to offer alternative approaches for the modelling of spatial trade in homogeneous commodities. None of these, however, proved successful in replacing the SPE model.

As a consequence of the mentioned points of critique and various observed trends in international agri-food trade, notably the growing importance of intra-industry trade, consumer concerns about food safety and the emergence of biotechnology in agriculture, Sarker and Surry (2006) argue that trade models resting on the assumption of homogeneous products will in future be ‘less and less suited to study trade in agri-food products’.

Some recent developments on global agricultural markets, however, seem to point in another direction. In mid 2007, for instance, the sugar refining industry in the Persian Gulf, which had by then been supplied entirely by raw sugar from Brazil, switched completely to raw sugar of Indian origin for a period of more than a year. Indian sugar had become competitive, because the country had a large exportable surplus in that year and ocean freight rates surged at the same time, affecting freight costs from distant Brazil relatively stronger (ISO, various issues). This example clearly rebuts the assumption of product heterogeneity for the case of raw sugar. In fact, no existing spatial modeling framework allowing for cross hauling would have been able to reproduce this complete switch of origins as a result of changing cif prices of raw sugar from different origins. A further example illustrates that a complete shift cannot only occur between origins, but even between different crop species: In the first half of the grain marketing year 2008/09 South Korea is reported to have replaced imports of maize from the US completely by imports of feed wheat from Ukraine (AgriMarket, 2009).

As a consequence, while the hypothesis of Sarker and Surry appears to be valid for processed agri-food products, it must be rejected for agri-bulk commodities, especially those not intended for final human consumption, as is the case with the two examples discussed above. For these cases, we rather advocate a modification of the SPE framework, which is able to cope with the described problems as an alternative to the original SPE on the one hand and to models resting on the assumption of heterogeneity with regard to origin, the so-called Armington (1969) assumption on the other hand.

2.3. The calibrated SPE model

Nolte (2008b) suggests to overcome the problem of non-reproducibility of observed trade matrices by attaching additional cost terms to each trade flow, an approach that was originally developed by agricultural supply modellers (Howitt, 1995) to overcome a similar problem as the one we deal with in trade modelling: The solution of an LP farm or higher aggregate supply model did not reflect the observed production program of the farm. The reasons are similar to those we mentioned already: The neoclassical assumptions are not fulfilled in reality and the number of activities is bound by the number of binding, linearly independent constraints, besides the fact that all models suffer, of course, from the fact that real world constraints cannot be captured fully in the model.

In the case of SPE as well as supply models, it is necessary that the additional cost terms be at least partly non-linear in order to overcome the limitation in the number of trade flows and activities. The absolute value of the additional cost terms as well as their first order derivative will have a large influence on the simulation behaviour of the model. It is therefore essential that both be empirically well-founded. The absolute size of the cost term is determined endogenously by the calibration procedure, but only for trade flows and activities that are observed in the base equilibrium. The first order derivative of the cost term needs to be positive in order to avoid non-convexities of the model which would lead to multiple local rather than one global optimum of the model. In reality this would mean, that the costs of trade between two regions are increasing with the amount of trade of the product in question. However, an increase in freight costs cannot be observed, and there are good arguments to even assume the contrary, decreasing freight costs due to economies of scale. Furthermore, discussions with traders led to the result that an SPE model parameterised with empirically well-founded freight costs proves to be an excellent indicator of local prices.

For the specification of the calibrating cost terms, these considerations lead to three important conclusions. First, the first order derivative of the cost term does not reflect freight costs, but other component(s) of total trade costs, usually summarised as transaction costs. Second, this first order derivate cannot be all to large, since otherwise it would conflict with the observation of the SPE's high predictive power for prices. Third, the absolute size of the cost term for non-observed trade flows can be very well approximated by the freight cost.

An attempt to calibrate SPE models which is similar to ours has recently been made by Paris *et al.* (2009). In their approach, they tackle the net trade position of a country by attaching linear cost terms to trade flows. As a result, the model is not only able to reproduce an observed net-trade position of a country, but also to reproduce observed local prices and to eliminate inconsistencies in observed trade costs. Due to their calibration term being linear, however, the model is still limited to *2n-1* trade flows, and thus not able to reproduce observed trade matrices, or more precisely, only as one solution out of an infinite number of possible solutions due to their model not being strictly convex, at least in the base period.

As a possible explanation of how transaction costs are influenced positively by the volume of trade between two regions, we use the hypothesis that exporters in one country pursue a risk minimising strategy by diversifying their export destinations. Heckelei (2002) illustrated that the presence of risk can provide a justification for a non-linear objective function in the case of calibrated constrained supply models. The same argument is applicable to trade models where traders have to manage risk. In particular, they might want to insure themselves against price crashes in specific markets and thus be willing to export to markets where lower than optimal fob prices for their products can be fetched. They also might be willing to sell for a lower than optimal fob price in order to be present in certain markets which could potentially become optimal fob price destinations.

To test the hypothesis of increasing transaction costs as a function of the quantity traded between two regions, the model is solved with all quantities, prices and rents fixed exogenously and trade costs variable. This step, which in some aspects is analogue to the first step of classical PMP, is performed for six consecutive years, for which data on production consumption and stock changes (F.O. Licht, 2009) as well as bilateral trade data (ITC, 2007; Eurostat, 2009; USDA, 2009) are available (1999/00-2004/05).[6] One fundamental difference between our approach and the analogue first step of original PMP is, however, that we use *a priori* information on the value of rents. In doing so, we avoid the inconsistency of the first step of PMP as described by Heckelei and Wolff (2003). In the next step, we compare these trade costs to observed freight rates and calculate the difference. On routes where trade is both observed and simulated by the normative, uncalibrated version of the SPE, this difference is zero. In case trade is observed, but not simulated by the model, the difference was negative. In cases where trade is not observed, but simulated, which happened very rarely, the difference is positive. In the next step, an OLS (ordinary least square) regression of the relationship between the trade cost difference and the share of the trade on one route in the total production of the exporting country is performed. Many trade flows that occur, though, are not determined by economic reasoning of the involved agents, but rather politically induced. That is, of course, the case for trade that occurs under TRQs, but unfortunately also in less obvious situations, such as for instance the former C-sugar, now out-of-quota sugar, exports of the EU which are not directly subsidised, but are also not flowing freely, since the set of destinations is determined by the licensing policy of the EU. Another case are the exports of

[6] Unfortunately, the quality of the bilateral trade data is rather poor (Nolte, 2008a) and the data needs to be processed to match the balances of supply, demand and stock changes. This affects the reliability of the estimations.

Cuba to China and Russia. To avoid a bias in the estimation results from that direction, we include only those observations where we can be relatively sure they follow economic rather than political rationales, i.e. those by established exporters of sugar at world market conditions.[7] The regression confirms the hypothesis that per unit trade costs increase with the share of domestic production that is shipped to one destination, with a coefficient of 0.614 Euro per percent of domestic production.[8] It also confirms the expectation that this increase is not very large. Although the regression and the coefficient are highly significant, the r^2 of the model is rather low, indicating, that although there is certainly a positive correlation between the two variables, there are other determinants which have a much stronger influence on transaction costs and/or measurement errors of freight costs might have occurred.

In the next step, analogue to the second step of classical PMP, we replace the price transmission equation of the normative SPE by equation (9), containing an additional, calibrated cost term for every possible trade flow.

$$\begin{aligned}&(PS_j + PPQ_j + PQ_{sch,j,i} + exw\_fas_j \\ &+ loading_j + freight_{j,i} + tc_{sch} - ex\_sub_{j,i}) \\ &*(1+tar\_av_{sch,j,i}) + tar\_sp_{sch,j,i} \\ &+ unloading_i + inld\_transport_i + \theta_{sch,j,i} + \iota * \frac{\sum_{sch} X_{sch,j,i}}{S_j} \geq PD_i\end{aligned} \quad \perp X_{sch,j,i} \geq 0 \qquad (9)$$

In equation (9), ι is the estimated coefficient of transaction costs as a function of the production share which is traded on one route. θ is a linear parameter[9], which is calibrated such that when added to ι multiplied by the production share, the result is the identical to the calculated difference between observed freight cost and endogenously determined trade costs in the first step of our calibration procedure. The resulting model perfectly reproduces the observed matrix of trade flows, analogue to the third step of PMP.

3. Scenarios

After the expiry of the current CMO as of the MY 2015/16, we use as a reference scenario for our analysis the continuation of current policies, specifically, current levels of quotas and tariffs. Our main counterfactual scenario embodies an abolishment of the quota regulation and

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[7] Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Colombia, Brazil, Argentina, South Africa , Thailand and Australia.

[8] The regression equation is: Cost difference / ton $_{j,i} = \beta_0 + \beta_1$ * production share + $\varepsilon_{j,i}$; R^2: 0.024; F-test: 0.000.

[9] Complying with the hypothesis that exporters are willing to pay a premium to be present in a market, this parameter is negative in most cases. In general, the larger the exports to that market, i.e. the more important this market is for the exporter, the higher this premium.

of any price policy instruments in the current CMO such as private storage aid in case of and undercut reference price or additional import quotas in case of a price surge.

A second dimension of scenarios is derived from different expectations with respect to the development of the world market price, which will especially have an influence on the amount of preferential imports. As a reference, we take projections from FAPRI (2009) and convert the Caribbean fob price for raw sugar in US$, in a middle east cif price for white sugar in Euro. The commonly applied world market price for white sugar is a London fob price. If, however, the EU ceases to export sugar, this price is not applicable anymore. We thus choose the middle east as a reference location, since it is extremely unlikely that that region might change its net trade position. As scenarios for a lower and higher than expected world market price, we deduct or, respectively, add one standard deviation calculated from a ten years time series of world market price observations. These prices amount to 238 US$ and 382 US$ per ton of raw sugar, respectively, instead of 310 US$, fob Caribbean. The resulting Near East cif landed prices for white sugar in real 2004/05 Euro, as they will be used in the model, are 251 € for the reference situation, 204 € for a low and 298 € for a high world market price.

Additionally, it would also have been interesting, to model the effects of an agreement of the Doha Round of WTO negotiations, and its interplay with the effects of the quota abolition. This extra dimension of scenarios would, however, have increased the total number of scenarios to 12 rather than six as it is now. In case of a variation of the applied modalities, which also would have been interesting, the number of scenarios would even increase further. We, therefore, settled with the two dimensions of world market price development and EU quota policy in order to keep the analysis focused.

4. Results

The results of the simulation runs are presented in tables 1 and 2 below. Table 1 shows the results for the EU and its member states. In the reference scenario, with a perpetuation of the quota system and standard assumptions about the world market price development (the column is shown in bold letters), the total EU production quota is almost filled with only two member states' production, Greece's and Romania's, falling short. The internal price is at 431 € per ton, and thus comfortably above the reference price which is at 323 € in real terms.[10] Total imports under preferential schemes amount to 5 million tons.

[10] 404,40 € in nominal terms.

An abolition of the quota in 2015/16 leads under standard assumptions regarding the world market price to an increase of EU production to 15.8 million tons. The internal price falls to 370 €, discouraging a substantial share of preferential imports which fall to 2.9 million tons. The world market price is interestingly almost unaffected by the abolition of EU production quotas. Out of 19 member states which continued to produce sugar after the restructuring period from 2006-2009, twelve are simulated to increase their production beyond their quotas after abolition, seven are simulated to decrease production. These are, as widely expected, member states located at the southern and northern peripheries of the EU, including the two member states which are simulated not to fill their quotas already in the reference scenario. Out of those member states which expand their production, Germany, France and Poland see the largest absolute increase, Hungary, Germany and Belgium the largest relative increase.

In case of a lower world market price of 204 €, the EU price strongly decreases in the non-abolition scenario to 379 €. Production in the EU is affected negatively, with three additional member states not filling their quota. Preferential imports increase as a result of the low world market price. An abolition of the quota nevertheless leads to an aggregate increase of EU production, with 13.9 million tons. This is, however, less than under the standard world market price development. The decrease of preferential imports is also less pronounced.

Under assumptions of a high world market price of 298 €, the community price increases to 490 €. Only Romania fails to fill its quota under the non-abolition scenario. Preferential imports are about 300,000 tons lower than under standard assumptions about the world market price. An abolition of EU quotas under this setting is simulated to trigger a strong production increase to 17 million tons, which is almost equivalent to the pre-2006 level of quotas. Preferential imports, on the other hand, decline sharply to 1.7 million tons. In both instances of world market price variation, the abolition of the quota system does not have a noteworthy effect on the world market price of sugar.

[Insert Table 1 here]

Table 2 presents results for preferential imports of the EU under the various policy and world market price scenarios simulated in this paper. The EU currently imports sugar under four different schemes and is simulated do so in 2015/16. The first of these is called CXL.[11] Countries which supplied certain member states prior to their EU membership negotiated these quotas upon accession in order not to be worse of in terms of market access. The

[11] Number of the WTO goods schedule of the EU (140 in roman numerals).

scheme is strictly quota restricted and all countries holding quotas, being competitive exporters at world market prices, fill these quotas under all scenarios, despite an in-quota tariff of 98 € per ton (raw sugar). The second scheme of quotas is granted to a number of western Balkans countries and quota limited as well. While Croatia fills its quota under all scenarios, Serbia and Albania (not visible due to rounding) are adapting their exports as a response to a falling EU price or an increasing world market price.

The next group of countries which are granted preferential access are the LDC. In the implementation phase of the ‘Everything But Arms’ Initiative, imports of LDC were quota limited. These quotas were abolished, however, as of October 2009 and imports since can flow freely. Imports under the non-abolition scenario and standard world market price development are about 1 million tons. If the EU quota system is abolished, imports from LDC decrease strongly to 176,000 tons and all but six countries cease to export under this scheme. Under a low world market price, imports from LDC are naturally higher, under the non-abolition as well as under the abolition scenario. Under high world market prices, most, but interestingly not all, countries reduce their exports to the EU in the non-abolition scenario. This effect of countries increasing their preferential exports in spite of a higher world market price (Ethiopia, Sudan and Zambia)[12] is the – sometimes combined – result of higher production due to an overall increased price level and prices in other (domestic and export) markets increasing less than the community price level. Under the assumption of high world market prices, an abolishment of the EU production quotas for sugar and the resulting price decrease on the community market entirely discourage preferential imports from LDC.

The last group presented in table 2 are ACP countries[13], which under the EPA will enjoy quota and duty free market access as of 2015/16 as well. Under the non-abolition scenario and standard world market price development, these imports are simulated to be 3.1 million tons at the end of the projection horizon. The abolition of the EU production quota and the resulting price decrease lead to a reduction of these exports by more than one third to 1.9 million tons. Under high world market prices, imports from ACP are 3.5 million tons in the non-abolition scenario. The abolishment of the quota leads to a much smaller reduction than under standard world market price development. Under low world market prices, imports are simulated to be 2.8 million tons. In case of production quota abolishment in the EU, imports fall by more than half to 1 million tons.

[12] The same can be observed for Serbia and Zimbabwe under their respective preferential schemes.
[13] Countries belonging to both groups, LDC and ACP, are listed under LDC.

[Insert Table 2 here]

5. Conclusions

The paper applies a ESTJ SPE model with calibrated non-linear cost terms attached to each trade flow in order to simulate the effect of an abolishment of the EU production quota system for sugar after the expiry of the current CMO in 2014/15. The variables in the focus of the analysis are production quantities, domestic and world market prices, and preferential imports of the EU under various schemes. The strong increase of world market prices in the second half of 2009 shows that preferential imports of the EU can be inhibited by high world market prices since exporting countries may find it more profitable to export to regional markets or to substitute imports on their domestic markets. Therefore, two sub-scenarios taking into account a lower than expected and a higher than expected world market price are simulated.

Under all world market price scenarios, the abolition of quota leads to an increase in production in the EU and correspondingly to a decrease in preferential imports. The higher the world market price, the more pronounced is this tendency. Under no scenario, the EU turns to exporting sugar to the world market again.

If world market prices are developing as projected by FAPRI (2009), production in the EU will increase by 2.5 million tons to almost 16 million tons. Member states in the geographical center of the EU, which are known as more competitive producers of sugar beet, increase their level of production beyond the quota, whereas countries at the southern and northern limits of the community decrease their production. No country ceases to produce sugar under any of the simulated scenarios, although the functional form of the supply curves explicitly allows this to happen. It must, however, be noted that it is questionable whether sectors which are simulated to shrink very strongly are still viable at that level of production.

The simulation revealed that the world market price for sugar by virtue of the abolition of quota limitation of LDC and ACP imports, as well as reduction of the internal price by the 2006 CMO reform has gained a strong influence on the internal price level of the EU. Table 1 shows that under the non-abolition scenario, a world market price variation triggers a movement of the community price in the same direction which in our cases is even more pronounced than the world market price shift itself. This is due to preferential trading partners alternative markets are usually shielded by *ad valorem* tariffs so the price level on these markets, which they compare with the EU price in order to decide where to ship their exports, also varies stronger than the world market price. Since the quota-bound production in the EU is not price responsive, these price variations cannot be dampened by reactions of EU producers. This changes if the production quota in the EU is abolished. The world market triggered variations of the community price then are merely one fifth of the world market price variations themselves, price variability is thus significantly reduced. The sub-scenarios for different world market price developments must, however, not be confused with temporary price spikes, to which producers, unlike in our model, cannot react. The effects of such price spikes on preferential imports can be expected to be more pronounced than what is shown in our results. While the EU price turns out to be influenced by the world market, the quota policy of the EU proved not to have the potential to prompt a significant effect on the world market price.

The paper also introduced a new method of modelling international trade by calibrating an ESTJ SPE model with quadratic cost terms. This approach goes beyond the work of Paris *et al.* (2009), who engaged in calibrating a SPE with linear cost terms, in several regards. With the cost terms being non-linear, we are able to build a strictly convex model which perfectly calibrates to any observed base situation. We, furthermore, offer an economic explanation for the cost functions we introduce and engage in an econometric specification of these. Several questions with respect to the implications and the further potential of this approach are still open and currently being addressed in a technical paper. These are, among others, possible solutions for the immense data requirement for a geographically sufficiently disaggregated model to perform meaningful trade policy analysis and an enhanced empirical base for the estimation of the cost functions.

We apply functional forms for the supply of the EU (and some other beet producing countries) which are different from isoelastic functions and allow production to cease at a positive price. This leads to functions which are very price responsive if compared to standard elasticities from literature. Implicitly, our supply functions have elasticities usually larger than 2, in some cases even more.[14] However, it is commonly acknowledged, that current marginal costs of sugar production in the EU move somewhere between 300 € and 450 € per ton and that EU production is not competitive at prices below 200 € – 250 € per ton. The only way, though, to simulate this with a continuous function is to choose one with a rather high price elasticity, which furthermore increases, the closer it moves to zero.

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[14] This is also a result of the supply functions being combined beet supply and processing functions. The latter is assumed to be perfectly elastic in the long run.

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Table 1. Model Results for the EU (2015/16)

		Quota				Abolishment of Quota		
		Quota	Low P_{WM}	**Standard**	High P_{WM}	Low P_{WM}	**Standard**	High P_{WM}
(1)	P_{WM} (€/t, real 2004/05)		204	**251**	298	204	**250**	294
(2)	P_{EU} (€/t, real 2004/05)		379	**431**	490	359	**370**	378
(3)	$Demand_{EU}$ (mill. t WSE)		18.1	**17.9**	17.7	18.2	**18.2**	18.2
(4)	$Imports_{EU}$ (mill. t WSE)		5.6	**5.0**	4.7	4.8	**2.9**	1.7
(5)	$Production_{EU}$ (mill. t WSE		12.8	**13.3**	13.3	13.9	**15.8**	17.0
(6)	Austria (1000 t WSE)	351	351	**351**	351	347	**388**	415
(7)	Belgium/Luxemburg	676	676	**676**	676	780	**886**	957
(8)	Czech Republic	372	372	**372**	372	392	**424**	446
(9)	Denmark	372	372	**372**	372	364	**412**	445
(10)	Spain	498	306	**498**	498	171	**245**	295
(11)	Finland	81	81	**81**	81	68	**76**	82
(12)	France	3,437	3,437	**3,437**	3,437	3,721	**4,322**	4,673
(13)	Germany	2,898	2,898	**2,898**	2,898	3,483	**3,920**	4,216
(14)	Greece	159	43	**125**	159	7	**27**	40
(15)	Hungary	105	105	**105**	105	190	**219**	238
(16)	Italy	508	361	**508**	508	210	**293**	349
(17)	Lithuania	90	64	**90**	90	47	**56**	62
(18)	Netherlands	805	805	**805**	805	861	**961**	1,030
(19)	Poland	1,406	1,406	**1,406**	1,406	1,606	**1,799**	1,930
(20)	Portugal	10	10	**10**	10	3	**7**	10
(21)	Romania	105	51	**66**	80	47	**52**	55
(22)	Slovakia	112	112	**112**	112	107	**119**	128
(23)	Sweden	293	293	**293**	293	318	**343**	359
(24)	UK	1,056	1,056	**1,056**	1,056	1,127	**1,226**	1,294

Source: Own Simulations.

Table 2. Model Results for EU Imports, 1000 t WSE (2015/16)

		Quota			Abolishment of Quota		
		Low P_{WM}	**Standard**	High P_{WM}	Low P_{WM}	**Standard**	High P_{WM}
(1)	**Total**	**5,649**	**4,952**	**4,668**	**4,753**	**2,860**	**1,673**
(2)	**CXL**	**575**	**575**	**575**	**575**	**575**	**575**
(3)	Cuba	54	**54**	54	54	**54**	54
(4)	Brazil	508	**508**	508	508	**508**	508
(5)	Australia	9	**9**	9	9	**9**	9
(6)	Other Countries	4	**4**	4	4	**4**	4
(7)	**BALKAN**	**276**	**251**	**257**	**204**	**181**	**89**
(8)	Croatia	180	**180**	180	180	**180**	88
(9)	Serbia	93	**69**	76	23	**-**	-
(10)	Albania	1	**1**	1	1	**1**	0
(11)	Other Countries	2	**1**	-	-	**-**	-
(12)	**LDC**	**1,297**	**1,034**	**1,057**	**859**	**176**	**-**
(13)	Benin	6	**5**	5	5	**2**	-
(14)	Congo, D.R.	54	**45**	43	35	**-**	-
(15)	Ethiopia	374	**352**	363	273	**69**	-
(16)	Gabon	9	**6**	5	5	**-**	-
(17)	Guinea	20	**16**	15	12	**-**	-
(18)	Madagascar	24	**21**	19	20	**4**	-
(19)	Malawi	84	**67**	58	71	**6**	-
(20)	Mozambique	298	**270**	241	253	**68**	-
(21)	Senegal	71	**58**	55	45	**-**	-
(22)	Sierra Leone	5	**4**	4	3	**-**	-
(23)	Sudan	177	**51**	56	-	**-**	-
(24)	Zambia	129	**110**	166	116	**27**	-
(25)	Bangladesh	49	**28**	26	22	**-**	-
(26)	**ACP**	**3,501**	**3,092**	**2,779**	**3,114**	**1,927**	**1,009**
(27)	Congo, Rep.	42	**32**	29	29	**0**	-
(28)	Côte d'Ivoire	114	**97**	94	86	**24**	-
(29)	Mauritius	619	**563**	527	604	**471**	-
(30)	Swaziland	872	**806**	577	834	**719**	297
(31)	Zimbabwe	150	**117**	162	122	**48**	451
(32)	Barbados	46	**42**	39	45	**26**	-
(33)	Belize	123	**102**	94	111	**67**	13
(34)	Dominican Republic	360	**306**	272	316	**77**	4
(35)	Jamaica	3	**-**	-	-	**-**	-
(36)	Saint Kitts and Nevis	7	**5**	6	6	**4**	1
(37)	Trinidad and Tobago	33	**30**	28	32	**18**	9
(38)	Guyana	347	**313**	292	338	**248**	84
(39)	Papua New Guinea	51	**46**	43	49	**33**	5
(40)	Fiji	313	**272**	254	273	**193**	145
(41)	Other Countries	423	**360**	362	270	**-**	-

Source: Own Simulations.