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Modeling Trade Policies under Alternative Market Structures*

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Abstract

The paper focuses on the importance of assumptions made about market structure and firm behavior in empirical trade policy analysis. The contribution to the relevant literature is threefold: first the paper develops two original models which incorporate imperfectly competitive market structures in a spatial modeling framework; then it proposes a procedure to identify the degree of market power in international trading which is consistent with observed prices and traded quantities, and applies it to the banana market; finally, it assesses how analysis of the implications of recent changes in the EU import regimes for bananas (the Economic Partnership Agreements and the December 2009 WTO agreement) is affected by the assumptions made on the prevailing market structure.

JEL codes: F12, F13, F17, Q17

Key words: Spatial models, Imperfect competition, Bananas, Economic Partnership Agreements, WTO.

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Modeling Trade Policies under Alternative Market Structures

1. Introduction

Growing attention has been recently devoted to the role of intermediaries in international trade. Recent studies show that 24% of US imports are handled by "pure" intermediaries, that is, wholesalers and retailers, while on the export side they account for 11% of total trade (Bernard et al., 2010). The role of intermediaries has been highlighted also for Chilean imports - 35% are handled by wholesalers and 6% by retailers (Blum et al., 2010) - and for China - 22% and 18% of total Chinese exports and imports, respectively, are handled by Chinese intermediaries (Ahn et al., 2010). Intermediaries are particularly important in several agricultural commodity markets, such as cereals, sugar, bananas and coffee, in which a small number of trading firms (not necessarily private) account for a large share of world trade and are, potentially, in the position to exert market power. These trading firms are, by and large, "pure" middlemen, that seldom produce themselves the products they trade.

The aim of this paper is to address the relevance of the assumptions about market structure and trader behavior in empirical analyses of trade policies; in particular when studying trade policy issues concerning commodity markets in which traders play an important role, the assumption of perfect competition may be restrictive and policy prescriptions obtained based on this assumptions distorted. Yet, empirical trade policy analysis often relies on this very assumption (McCorriston, 2002).

The paper analyzes recent changes in the European Union (EU) import regime for bananas, namely the Economic Partnership Agreements (EPAs) and the December 2009 WTO agreement which put end to the "banana war". For several decades the EU import regime for bananas had been the cause of heated political confrontation, both domestically and internationally (Anania, 2006; Josling and Taylor, 2003). The EPAs made EU banana imports originating from African, Caribbean and Pacific (ACP) countries duty- and quota-free (previously they were subject to a duty-free quota, with out-of-quota imports subject to the MFN tariff), while the WTO agreement called for a reduction of the EU MFN tariff on bananas. This case study is used to provide insights into the effects of assumptions on non competitive behaviors by international traders in the evaluation of the impact of trade policies. In fact, the banana trade is among the most evident examples of high concentration in international markets, with three international trading firms accounting for over 65% of world trade. The EU Commission (EC, 2008; EC, 2011) has found that five banana traders have violated EU rules on competition, and consequently imposed fines. Making different assumptions about market structure, the paper provides a quantitative assessment first of the impact of the trade preferences the EU granted ACP countries with the EPAs, and then of the erosion of these preferences resulting from the reduction of its MFN import tariff for bananas under the December 2009 WTO agreement. The banana market is possibly the one in which benefits from trade preferences granted by the EPAs and potential losses from

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preference erosion are the greatest (Alexandraki and Lankes, 2006; Low et al., 2009; Yang, 2005).

We use a single commodity, spatial, mathematical programming model. Compared to general equilibrium models, partial equilibrium models allow for a better representation of complex policy instruments, a more detailed representation of markets and require less restrictive assumptions. The choice of a spatial model – i.e., a model which is able to generate trade flows between each pair of countries – is due to the fact that it is particularly effective in representing policies where different regimes apply to imports from different sources, without having to impose at times questionable assumptions, such as imperfect substitution between goods produced in different countries (Armington, 1969). Current and previous EU trade regimes for bananas considered in this paper include preferential tariffs and tariff rate quotas (TRQs) applied on imports from specific groups of countries. The paper develops two modified versions of the Takayama and Judge (1971) spatial trade model representing imperfectly competitive market structures: the extreme case of international trading firms forming a cartel and the intermediate case of traders behaving as downstream oligopolists and upstream oligopsonists. A two step calibration procedure is used to make the models replicate observed trade data; this allows us to address a key issue, that is, which degrees of market power and which market structures are compatible with the observed data. This approach differs from those in the relevant literature. The degree of market power and market structure in an industry are often estimated by means of econometric studies based on industrial economics models (Perloff et al., 2007), while we use a calibration procedure. Following the pioneering work of Dixit (1988), calibration has been extensively used in empirical trade policy analysis to obtain the conjectural variation parameter, as a way to represent all market structures, from perfect competition to the pure monopoly case; however, notwithstanding its extensive use, concerns have been raised about the lack of theoretical foundations of the concept of conjectural variation (Vives, 2001; Helpmann and Krugman, 1989). In this paper, we do not use conjectural variations; rather we address the issue of the market structure and the degree of market power by calibrating different models representing a range of market structures. Assumptions made on the market structure make the difference both in terms of the extent of the expected impact of a policy change and of its sign.[1]

With respect to the banana market, results show that observed data are not compatible with the existence of a cartel of international traders; in fact, observed traded quantities and prices are consistent with market structures with a relatively low degree of market power. The EPAs are expected to increase ACP exports to the EU by a considerable amount and generate consistent benefits for ACP countries, while the 2009 WTO agreement on bananas significantly reduces the preferential margin for ACP countries, but does not

[1] Soregaroli et al. (2011) show how assumptions on market structure in the supply chain of dairy products in Italy affect price transmission mechanisms and result in price responses in opposite directions to a change in the European Union Common Agricultural Policy.

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offset the benefits from the EPAs. One interesting finding is that, as the degree of market power increases, market structure becomes important not only in terms of the expected magnitude of the impact of policy changes, but in terms of its sign as well.

The paper is organized as follows: the next section discusses the significance of imperfect competition for the banana industry, while section three presents the model and section four illustrates the calibration procedure used and the results obtained in terms of feasible market structures in the banana trade; the fifth section discusses the results of the policy analysis, while the final one offers concluding remarks.

2. Market structure and firm behavior in the banana industry

Ever since the beginning of the twentieth century, the banana trade has been highly concentrated, with large firms' market share remaining relatively stable over the years (Taylor, 2003). Estimates suggest that during the eighties and the nineties the top three firms - Dole, Chiquita and Del Monte - accounted for 60-65% of world imports, with two companies - Noboa and Fyffes - lagging behind with an overall 10% and 8% of world imports, respectively (Arias et al., 2003). More recent estimates indicate the share of the top three firms on world exports in 2010 remains close to 65%, with Noboa and Fyffes together accounting for another 12%; according to these estimates, around 10% of world exports is now held by a small number of newcomer "Russian companies" controlling the rapidly growing Russian market (Bananalink, 2011). The top three firms dominate the US market, accounting for almost 90% of US imports, while their share of EU imports is around 45%, with Fyffes controlling another 20% (Arias et al., 2003; EC, 2008).

Marked concentration, small number of entries – which suggest high entry costs – and almost no exits are all, in theory, indicators of the potential exercise of market power in the banana trading industry. Although the presumption that large banana traders do not behave competitively is very common, the few empirical studies estimating the degree of market power in the banana market – which, however, are limited in time and geographical coverage – do not provide consistent evidence in support of this assumption. Focusing on the German banana market, Deodhar and Sheldon (1995 and 1996) found that trading firms selling bananas to retailers did not behave perfectly competitively, but rather engaged in Cournot behavior. With reference once again to the case of Germany, Herrmann and Sexton (2001) found no evidence of market power at the import stage.

The lack of evidence of the exercise of market power by banana traders partly explains the assumption of perfect competition in most studies assessing the impact of EU policy changes (e.g. Anania, 2006 and 2010; Guyomard et al., 1999a and 1999b; Kersten, 1995; Spreen et al., 2004; Vanzetti et al., 2005). Very few papers have assumed oligopolistic behavior by banana traders. McCorriston and Sheldon (1996) have assessed the impact of the introduction in 1993 of the banana tariff rate quotas regime using a vertically-related market model in which imperfect competition is assumed at each stage. In the model, which they calibrated with 1989 UK banana market data, they consider two stages: the ripening industry sells a homogeneous product to the retail industry, which distributes two brands of

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the product, perceived by consumers as different on the basis of their country of origin. Neither industry behaves competitively and the nature of competition is captured at each stage by a conjectural variation parameter, obtained using Dixit's approach (Dixit, 1988). They found that the degree of pass-through of the changes in tariffs to retail prices is 20% lower than under the assumption of perfect competition, 10% higher than under a pure two-stage oligopoly and 30 % higher than under a two-stage monopoly. McCorriston (2000) further investigated the impact of the 1993 EU banana trade policy reform by using a single-stage oligopoly model, in which the nature of competition is still captured by the conjectural variation parameter, calibrated for each EU member country. He found that the degree of pass-through of policy changes to the retail price varies across member countries, with UK and Italy having the lowest level of pass-through and, thus, the highest degree of market power.

Evidence of non competitive behaviors by banana traders has recently been found by the EU Commission, first for eight Northern European countries[2] during the period 2000-2002 (EC, 2008), and then for three Southern European countries[3] in 2004-2005 (EC, 2011). According to the Commission, four banana traders in the first case – namely, Chiquita, Del Monte, Dole and Weichert (by that time controlled by Del Monte) – and two in the more recent one – Chiquita and Pacific Fruit – violated EU rules on competition by explicitly coordinating their weekly decisions on the selling prices of bananas.[4] The fines imposed by the Commission amounted to 60 million euro in the first case and to 8.9 in the second one. The conclusions of the Commission, therefore, seem to indicate the existence, at least for the periods for which evidence has been found, of a cartel between some of the major banana traders, which were found guilty of collusion in the EU market. This introduces a new hypothesis regarding the behavior of banana traders: while previous literature has always assumed non-cooperative behaviors among (oligopolistic) banana traders, the findings of the EU Commission suggest that this may not be the case.

The conflicting evidence on firms' behavior in the banana trading industry leads us to contrast, in the policy simulations, the results under the assumption of perfect competition with those obtained assuming a range of different market structures.

3. The model

The model is a single commodity, spatial, partial equilibrium, mathematical programming model; following Samuelson (1952) and Takayama and Judge (1971) a "quasi-welfare" function is maximized subject to a set of constraints describing relevant demand and supply functions, price linkages (due, for example, to transportation costs and policy interventions)

[2] Austria, Belgium, Denmark, Finland, Germany, Luxembourg, the Netherlands and Sweden.
[3] Greece, Italy and Portugal.
[4] "*The parties engaged in bilateral pre-pricing communications during which they discussed banana price setting factors, that is factors relevant for setting of quotation prices for the upcoming week and discussed or disclosed price trends and/or indications of quotation prices for the up-coming week … Such communications took place before the parties set their quotation prices. All these communications were relevant for the future setting of quotation prices.*" (EC, 2008, p.17).

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and policies which cannot be represented through exogenously determined price wedges (such as import quotas). The version of the model used in this study differs from the one used in Anania (2010) in three respects: it builds on an updated data base, which now refers to 2007, rather than 2005; includes the modeling of imperfectly competitive market structures; and makes the shifts over time of the supply functions as a result of technical changes driven, in addition to expected changes in yields, by changes in land allocated to banana production.

Bananas are assumed to be a homogeneous product; this means that the effectiveness of branding in differentiating bananas is ruled out,[5] "fair trade" and organic bananas, which account for a fairly small but significant and growing portion of the market, are ignored, and consumers are assumed to be unable to differentiate bananas on the basis of their country of origin. The model includes five sources of domestic supply within the EU,[6] fourteen exporting[7] and four importing[8] countries/regions. Import demand and export supply functions, as well as domestic supply functions in the EU, are assumed to be linear, or to be well approximated by linear functions in their portions relevant for the simulations conducted.

Production functions in the EU and import demand and export supply functions in other countries/regions in the base year are obtained from observed produced, imported and exported quantities, observed production, import and export prices, and supply, export supply and import demand price elasticities at the equilibrium in each country/region (table 1). The values of the elasticities used are exogenous to the model and are based on those used elsewhere (Anania, 2010; Arias et al., 2005; Guyomard et al., 1999a and 1999b; Kersten, 1995; Spreen et al., 2004; and Vanzetti et al., 2005) (table 1). Net imports, net exports and average import and export unit values have been computed on the basis of information from the COMTRADE and FAOSTAT databases. Data for Martinique and Guadalupe, Canary Islands, Madeira and Azores, and Crete are based on information from the European Commission.

The modeling of the EU-27 import regime in 2007 includes:

(a) for bananas originating in MFN countries, the "tariff only" import regime introduced in 2006 (the import tariff equals 176 €/t);
(b) for bananas originating in ACP countries, a 775,000 t TRQ, with duty-free in-quota imports and out-of-quota imports subject to the MFN tariff (176 €/t);
(c) for bananas originating in LDCs, unlimited duty-free imports.

[5] Some evidence exists that Chiquita is able to exert a price premium (EC, 2008; Arias *et al*., 2003) due to its branding efforts as well as the somewhat higher quality of its bananas.

[6] Cyprus, France (Martinique and Guadeloupe), Greece (Crete), Portugal (Madeira and Azores) and Spain (Canary Islands). Banana production in continental Portugal is negligible and has been ignored.

[7] Five ACP countries/regions: Belize and Suriname, Cameroon, Dominican Republic, Ivory Coast, and the aggregate of other non-LDC ACP net exporters; eight MFN countries/regions: Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Panama and the aggregate of other non-LDC MFN net exporters; and LDC net exporters.

[8] EU15, EU12, United States, and the aggregate of Rest of the world net importers.

For the US and the "Rest of the world net importers" the model includes the tariffs applied in 2007 (0.5 and 22.2%, respectively).

The 2006 reform of the EU domestic policy regime for bananas "decoupled" support for banana producers outside the "outermost regions" of the EU moving it into the "single farm payment" introduced with the 2003 Fischler reform of the EU Common Agricultural Policy; this means that banana production in Greece, Cyprus and continental Portugal is driven by market forces only, while in the "outermost regions" (France; Spain; Azores and Madeira in Portugal) different regimes apply (Anania, 2008).

In the 2007 base model the reference scenario with perfectly competitive markets is modeled by maximizing a standard "quasi-welfare" function (Samuelson, 1952; Takayama and Judge, 1971):

$$\text{Max } W(x_{in}, xq_{ie}, xmfn_{ie}) = \sum_j \int_0^{q^d_j} p^d_j(m)\, dm - \sum_i \int_0^{q^s_i} p^s_i(r)\, dr - \tag{1}$$

$$- \sum_i \sum_j (TC_{ij}\, x_{ij}) - \sum_i \sum_e (xmfn_{ie}\, TMFN_{ie}) - \sum_i \sum_n (x_{in}\, T_{in}) ,$$

subject to:

$$q^s_i = \sum_j x_{ij} \tag{2}$$

$$q^d_j = \sum_i x_{ij} , \tag{3}$$

$$ss_i = BSP_i \,/\, (BSQ_i\, ES_i) \tag{4}$$

$$si_i = BSP_i - ss_i\, BSQ_i \tag{5}$$

$$p^s_i = si_i + ss_i\, q^s_i \tag{6}$$

$$ds_j = BDP_j \,/\, (BDQ_j\, ED_j) \tag{7}$$

$$di_j = BDP_j - ds_j\, BDQ_j \tag{8}$$

$$p^d_j = di_j + ds_j\, q^d_j \tag{9}$$

$$\sum_i \sum_e xq_{ie} \leq TRQ \tag{10}$$

$$x_{ie} = xmfn_{ie} + xq_{ie} \tag{11}$$

and $x_{ij}, xmfn_{ie}, xq_{ie}, p^s_i, p^d_j \geq 0$,

where :

i is an index for exporting countries and for sources of domestic supply in the EU;
j is an index for importing countries;

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e is an index for EU15 and EU12;
n is an index for non-EU importing countries;
BDP_j is country j's import price (cif) in base year (2007);
BDQ_j is country j's net imports in base year (2007);
BSP_i is country i's export price (fob) in base year (2007);
BSQ_i is country i's net exports in base year (2007);
di_j is country j's import demand intercept;
ds_j is country j's import demand slope;
ED_j is country j's import demand elasticity;
ES_i is country i's export supply elasticity;
p^d_j is country j's import price;
$p^d_j(m)$ is country j's inverse import demand function;
p^s_i is country i's export price;
$p^s_i(\mathrm{r})$ is country i's inverse export supply function;
q^d_j is country j's total imports;
q^s_i is country i's total exports;
si_i is country i's export supply intercept;
ss_i is country i's export supply slope
T_{in} is the per unit import tariff imposed by country n on its imports from country i ;
TC_{ij} is the per unit international transaction cost for shipments from country i to country j (border to border);
$TMFN_{ie}$ is the MFN import tariff imposed by EU member states e on their imports from country i (this applies to imports from MFN importers and on out-of-quota imports from ACP countries);
TRQ is EU preferential tariff rate quota for ACP countries;
x_{ij} is the trade flow from country i to country j;
$xmfn_{ie}$ is the trade flow from country i to EU member states e subject to the MFN import tariff; and
xq_{ie} is the trade flow from country i to EU member states e within the preferential duty-free TRQ for ACP countries.

In order to assess how the simulation of the effects of policy changes are affected when the assumption that international markets are perfectly competitive is relaxed, we consider two other market structures: (a) the extreme case of international trading firms jointly maximizing their profits by forming a cartel exerting monopsony power in their relations with exporters and monopoly power with respect to importers; and (b) the intermediate case of international traders behaving as downstream oligopolists and upstream oligopsonists, considering different degrees of market power. Upstream and downstream firms are assumed to have no market power.

The first non-competitive behavior considered is a cartel, that is, the presence of a number of colluding firms which maximize joint profits; this stylizes in the international market the EU Commission's detection on its domestic market of the existence of a stable

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cartel of banana traders (EC, 2008; EC, 2011). A cartel is likely to emerge and be stable if expected future losses due to sanctions as a result of deviating from the cartel are higher than the immediate gains from deviating (Belleflamme and Peitz, 2010). As in other industries where collusive behaviors have been detected, two main factors support the hypothesis of a sustainable banana cartel. First, there are few large firms and almost no entries; under these circumstances, the enforcement of the firms' agreement and the threat to punish deviating behaviors are both likely to be effective. Second, the relatively low elasticities of demand, at least in the largest developed country markets, provide a strong incentive to increase prices above the competitive level. We assume that colluding traders are able to exert market power upstream as well as downstream; thus, the cartel is assumed to exert monopsony power with respect to exporters and monopoly power with respect to importers. This market structure is modeled by maximizing traders' total profits, given by total revenues across all importing countries minus international transaction costs, banana acquisition costs across all exporting countries and tariff expenditure:

$$\text{Max } \Pi\ (x_{in}, xq_{ie}, xmfn_{ie}) = \sum_i \sum_j (p^d_j - p^s_i - TC_{ij})\, x_{ij} - \sum_i \sum_e (xmfn_{ie}\, TMFN_{ie}) - \sum_i \sum_n (x_{in}\, T_{in}) \quad (12)$$

[9]

In between perfect competition and the cartel, a range of possible non-competitive behaviors are introduced in the model by considering different mark-up values. The mark-up is defined as:

$$k = \frac{p-c}{c} \quad (13)$$

where p is the selling price and c is the marginal cost. Let $\lambda_i = \sum_{j \neq i} \frac{dX_j}{dX_i}$ be the conjecture that firm i has on the impact that a change in its output X_i has on the sum of the outputs chosen by each of its rivals, X_j. If firms are symmetric:

$$k = \frac{s_i}{\varepsilon}(1+\lambda_i) \quad (14)$$

with s_i being the market share of each firm i and ε the demand elasticity.

Under Cournot behavior equation (14) reduces to the usual Cournot equation $k = \frac{s_i}{\varepsilon}$, while under a cartel it reduces to the usual monopoly equation $k = \frac{1}{\varepsilon}$.

[9] Takayama and Judge (1971, chapter 11) discuss the potential problem of arbitraging in spatial models with imperfect competition. While procedures exist to address the problem (Anania and McCalla, 1991), in the model proposed in this paper it is ruled out *a priori* because regions are modeled either as exporters or as importers (hence, they cannot export and import at the same time).

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We model firm oligopolistic/oligopsonist behaviors by considering different percentages of mark-up. To provide the reader with a feeling of the implications in terms of market structure of the assumptions in our modeling of the banana market, the values of mark-up under three benchmark market behaviors - perfect competition or Bertrand (under which, if the product is homogeneous, the mark-up is zero), Cournot and a cartel - are reported in table 2. This table reports the values of the mark-up for two different values of the demand elasticity (assuming firms sell bananas on one market only). We believe that, among those considered in table 2, only the mark-ups in the central columns, that is, a number of (identical) firms equal to 11, 7 and 5, appear to be plausible representations for the world banana trading industry. In our model different mark-up values are considered, ranging from 3% to 25%. With the lower value of elasticity, corresponding to the one assumed in the policy simulations for the EU-15, a mark-up equal to 3% is consistent with behaviors that are close to perfect competition. A mark-up equal to 12% corresponds to conjectures that are close to Cournot only when there are more than 16 firms, which is a rather implausible hypothesis for the banana trading industry. However, with a higher elastiticity - corresponding to the one assumed for the EU-12 and close to that assumed for the aggregate of the 'Other net importers' - a mark-up equal to 12% corresponds to Cournot if there are 11 firms. Higher mark-up values, such as 20%, correspond to an industry which is less competitive than Cournot; this occurs if there are more than 10 and 6 firms, under the lower and higher elasticity value assumptions, respectively.

This third market structure is modeled by maximizing a "quasi-welfare" function (Takayama and Judge, 1971) modified to include trading firm profits calculated using the mark-up:

$$\text{Max } W(x_{in}, xq_{ie}, xmfn_{ie}) = \sum_j \int_0^{q^d_j} p^d_j(m)\,dm - \sum_i \int_0^{q^s_i} p^s_i(r)\,dr - \tag{15}$$

$$- \sum_i \sum_j (TC_{ij}\, x_{ij}) - \sum_i \sum_e (xmfn_{ie}\, TMFN_{ie}) - \sum_i \sum_n (x_{in}\, T_{in}) - \sum_i \sum_j (MU_{ij}\, x_{ij}),$$

where MU_{ij} is the traders per unit profit on shipments from exporter i to importer j obtained by applying the (exogenously determined) percentage of mark-up to total per unit costs, specific to that trade flow, incurred by the trader (acquisition price + international transaction cost).[10]

Spatial models which include imperfectly competitive market structures and assume, as we do, a perfectly homogeneous product have been proposed by Takayama and Judge (1971), Kawaguchi et al. (1997) and Yang et al. (2002). Our model differs from these in several ways. Takayama and Judge (1971, chapter 11) extend their standard model to include a profit maximizing monopolist handling production and trade across all regions. In

[10] Results do not change significantly if the mark-up is applied to a total per unit cost for the trading firm which includes the import tariff.

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the cartel case our model modifies this framework by separating producers from traders (seen as pure middlemen) and assuming the cartel of traders to hold monopolistic as well as monopsonistic power, while upstream (and downstream) firms have no market power. Kawaguchi et al. (1997) propose a modified Takayama and Judge model which explicitly includes conjectural variation parameters; however, they assume these parameters equal zero, i.e. Cournot competition to occur (with all firms exerting market power or a subset). In our model market power is exerted by traders rather than each country's producers, imperfect competition is represented through the percentage of mark-up and a range of imperfect competition market structures is simulated, including Cournot. The adoption of different percentages of mark-up to represent the market structure allows us to avoid having to identify each firm's conjectural variation parameter for each importing country, and making explicit assumptions about the number and symmetry of firms. Yang et al. (2002) propose a linear complementarity programming formulation of the classical Takayama and Judge spatial model for a market characterized by heterogeneous downward sloping demand and upward sloping supply functions (as assumed here), while they suggest the standard Takayama and Judge spatial modeling framework when a common demand function and constant marginal costs are considered. They assume Cournot competition, whereas we consider a range of firm behaviors and use a modified Takayama and Judge modeling framework.

As in most policy analyses, we also assume that firms behavior is not affected by policy changes, i.e. that the simulated policy shocks do not influence the behavior of firms.

4. The feasible market structures

One characteristic of mathematical programming spatial models is that predicted bilateral trade flows show an overspecialization with respect to those observed, i.e. the solution includes a smaller number of non-zero trade flows than those observed. This is the result of the optimization procedure used as well as the inability of the constraints included in the model to fully represent the complexity of the market under scrutiny, because of both the poor quality of available information and the simplified representation in the model of the behavior of market agents. In models like the one developed in this paper the information which appears weaker is the matrix of bilateral international transaction costs. In our model these have been generated from available industry information on international transaction costs for few specific bilateral trade flows, using distances between countries to explain differences in the variable component of transaction costs. The two step calibration procedure proposed by Paris et al. (2011) has been used to make up for the poor quality of per unit transaction costs and improve the capacity of the base model to reproduce observed net trade positions as well as bilateral trade flows. Essentially, information regarding the observed market equilibrium is used to infer the errors in bilateral international transaction costs which, once corrected, make the model perfectly calibrate

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observed country net trade positions.[11] In the first step the model is augmented by a set of constraints imposing that predicted bilateral trade flows equal observed ones. In step two these constraints are removed and the values of the dual variables associated in the solution in step one to these constraints are used to correct per unit international transaction costs. The solution of the model in step two perfectly replicates observed country net trade positions; in general, there are multiple optimal sets of bilateral trade flows associated to observed net trade positions, observed trade flows being one of these sets (Paris et al., 2011). [12]

To explain how the calibration procedure works in the modeling of the three market structures considered we shall make use of a few figures. In figure 1 a two country, perfectly competitive market is represented, with no policy intervention; ED_j and ES_i are the importer's import demand function and the exporter's export supply function, respectively, and tc_{ij} is the per unit international transaction cost, assumed not to change with the quantity traded. Point A gives the market equilibrium as generated by the model if no calibration procedure is considered (the solution is such that the quantity traded, ($X°_{ij}$), makes the import price ($P°_j$) equal to the export price ($P°_i$) augmented by the per unit transaction cost); the solution generated by the model differs from observed traded quantity (X_{ij}), and import and export prices (P_j and P_i, respectively).[13] The calibration procedure enables the model to reproduce the observed market equilibrium by correcting the per unit transaction cost; in this case by increasing it by an amount equal to λ^*_{ij}.[14] Figure 2 is analogous to figure 1 for the imperfectly competitive market where a mark-up is applied (observed traded quantity and prices in the two countries, as well as the per unit transaction cost are kept unchanged). In figure 2 ES^*_i is the mark-up inclusive export supply by the traders; in this case the uncalibrated equilibrium generated by the model would be that at point B. When the calibration procedure is applied, the adjustment of the per unit transaction cost, λ^*_{ij}, by correcting the per unit transaction cost, also modifies the mark-up inclusive export supply by the traders (which becomes ES^{**}_i); this happens because the transaction cost is part of the cost the percentage mark-up is applied to in order to obtain the traders' per unit profit. Finally, in figure 3 point C represents the equilibrium quantity

[11] The calibration procedure implicitly assumes that the only potentially ill-measured information in the model are bilateral international transaction costs.

[12] When an observed bilateral trade flow is equal to zero, the calibration procedure generates a correction which can either be positive (if the uncalibrated model solution predicts a positive trade flow) or equal to zero (if it predicts, as observed, that no trade occurs between the two countries). In the former case the corrected per unit bilateral transaction cost will give, rather than a point estimate of the unknown bilateral transaction cost, only its lower bound. From the point of view of using the calibration procedure to assess the feasible degrees of market power this issue is irrelevant; in fact, a market structure which is found feasible (or unfeasible) would remain so if more information on bilateral transaction costs associated to zero trade flows would be available. In addition, because of the way import demand and export supply functions are constructed, the calibration of bilateral transaction costs does not depend on the values of the price elasticities of these functions.

[13] Observed traded quantity, import and export prices lie on the inverse import demand and export supply functions because of the way these have been obtained.

[14] The correction of the transaction cost needed to calibrate the model can, in general, be either positive or negative.

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when traders form a cartel and act as a monopolist/monopsonist on the world market and the model is not calibrated. MR and MC represent the traders' marginal revenue and marginal cost functions, respectively (observed traded quantity and prices and the per unit transaction cost are the same as in the two other market structures represented in figures 1 and 2). In this case, in the market equilibrium obtained by solving the model with no calibration the quantity traded is below the observed one, suggesting the need to calibrate the model by correcting the transaction cost downward, rather than upward as in the previous two cases. However, even setting the per unit transaction cost equal zero is insufficient to make the model generate the observed market equilibrium. An adjustment of transaction costs to make them negative is needed for the model to reproduce the observed market equilibrium; this would mean traders receiving, for each unit of bananas traded, a "subsidy" which exceeds transaction cost.

This is exactly what happens when the model assuming in the world market for bananas a cartel maximizing joint profits is calibrated. This means that the hypothesis of traders forming a cartel that acts as a monopolist and a monopsonist in the banana market turns out to be unfeasible, being inconsistent with observed quantities traded and importer and exporter border prices. The adjustments needed for the model to reproduce observed net trade positions and import and export prices are of an order of magnitude which rules out any possibility of this result stemming from measurement errors of import and export prices, including those resulting from observed prices possibly being intra-firm transfer prices, rather than prices resulting from market transactions between different firms. In fact, the downward adjustments of transaction costs needed to calibrate the model range between 754 and 2,710 US$/t and the resulting corrected transaction costs between -553 and -2,600 US$/t.

This result may not come as a surprise, given that a world cartel, even for the banana market, is a rather extreme assumption. However, the findings for the other imperfectly competitive market structures are less predictable. Indeed, a similar outcome also emerges for imperfectly competitive world market structures with a mark-up above 12%. When, for example, a 20% mark-up was considered, four of the corrected per unit transaction costs became negative, with the largest one being equal to -36 US$/t; when a mark-up equal to 15% was modeled, the calibration generated two negative corrected transaction costs, the largest one being equal to – 21 US$/t. Even when the mark-up was set equal to 12% calibrating the model made two corrected transaction costs negative; however, in this case their values were judged to be within the range of possible measurement errors in border prices (the largest one in absolute value was – 12 US$/t). We conclude that market structures with international traders acting as non-cooperative oligopolists/oligopsonists with a resulting mark-up exceeding 12% are unfeasible in the banana market, being largely inconsistent with observed traded quantities and border prices. This means that, under the observed market shares and for the values of elasticities assumed, the competitive environment prevailing in the banana world trade is likely to be different from Cournot, and actually close to perfect competition (table 2). Policy assessments assuming a banana

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market characterized by a degree of market power by traders significantly greater than those which we found feasible would generate distorted results and unsupported policy prescriptions.

These results crucially depend on the assumptions made regarding the imperfectly competitive structures of the banana market. For example, we assume that only international traders are in the position to exert market power. However, it is often argued that downstream industries in developed countries, such as ripeners or retailers, may exert oligopsony and/or oligopoly power and, hence, in assessing the impact of a trade policy change it is necessary to take into account the vertical linkages by means of a successive oligopsony/oligopoly framework (Sexton et al., 2007; Hoque and Schroeter, 2010). To include the market power of downstream industries, such as retailers, in the models developed in this paper, information on banana retail prices and quantities in each importing country would be needed, and this information is not available. For this reason we decided not to consider additional market structures by extending to other downstream firms the possibility to exert market power and limited ourselves to the assumption that this is the case for international traders only; obviously, if this assumption is relaxed and one assumes instead that actors operating downstream exert market power, our results may no longer hold.

5. Policy analysis results

All the simulations have been generated with reference to 2019, the time horizon for the completion of the implementation of the December 2009 WTO agreement, assuming that no agreement on the modalities in agriculture in the DDA round is reached by the end of 2013.

The "2019 base" reference model has been obtained from the "2007 base" by modeling changes in production, import demand and export supply functions in all countries/regions as a result of expected shifts in domestic demand and supply functions. Import demand and export supply functions shift according to expected changes, *ceteris paribus*, in quantities produced and consumed in each country/region. Consumption is assumed to vary over time on the basis of observed changes in population and per capita incomes (in constant terms) between 1997 and 2007, and 1995-97 and 2005-07, respectively;[15] the values used for domestic demand income elasticities are provided in table 1. Banana production in each country/region is assumed to change over time, *ceteris paribus*, in line with observed changes in production due to technical changes between 1995-1997 and 2005-2007.[16] The dollar/euro exchange rate in 2019 has been assumed to be 1.4 (in the 2007 base model it was 1.371).

[15] For country aggregates these are both weighted averages obtained using the shares of population in 2007 as weights. The data source is the World Development Indicators, by the World Bank. Negative percent changes have been set equal zero; percent changes larger than 5 have been set equal to 5 (table 1).

[16] The annual rate of growth for production as a result of technical change is given by the annual rate of change in yields plus 1/3 of the annual rate of change in banana harvested area. For country aggregates these are weighted averages obtained using the shares of production in 2007 as weights. The data source is the

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The results of the simulations are presented in tables 3 and 4. Five different market structures, found to be feasible given observed traded quantities and prices, have been considered: perfect competition and oligopoly/oligopsony with mark-up percentages equal to 3%, 6%, 9% and 12%. The results for the "2007 base" scenario are the same for all of them, each of the four models having been calibrated to reproduce the observed market equilibrium.

Two policy scenarios in 2019 have been simulated in addition to the "base" reference one: a scenario in which only the EPAs are introduced, i.e. the EU removes the 775,000 t duty-free import quota on bananas originating in ACP countries and these may enter the EU duty-free and subject to no quantitative restriction, and a scenario in which, in addition to EPAs, the December 2009 WTO agreement is implemented, i.e. the MFN tariff imposed by the EU drops from 176€/t to 114€/t (import tariffs imposed by other countries remain unchanged).

It may be useful to underline at the outset that the results under the five market structures should not be compared directly, as the models which generate them differ, not only in their assumptions regarding market structure, but in the per unit transaction costs as well (because of the differences in the results of the calibration procedure for the five models); in fact, corrected transaction costs ($tc_{ij} + \lambda^*_{ij}$ in figures 1 and 2) become smaller and smaller as we move from perfect competition to increasing degrees of market power.[17]

The simulation results obtained under the five market structures appear fairly close (tables 3 and 4). This comes as no surprise, given the relatively low degrees of market power which have been found to be feasible and have been considered in the analysis.

Under all market structures the implementation of the EPAs generates consistent benefits for ACP countries, whose total exports increase by about 80% and whose export revenue triples, while MFN and LDC exports and export prices decline and imports by countries different from the EU increase; significant trade diversion occurs, with ACP exports previously directed to non-EU countries now being redirected toward the EU, and a consistent share of exports by MFN countries being diverted in the opposite direction. Assumptions made regarding the degree of market power do matter. The higher the percentage of mark-up, the higher tend to be percentage changes; this is so because calibrated transaction costs decline with the percentage of mark-up, with the effect of accentuating the impact of the policy change.[18] The most significant differences in trade

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FAOSTAT database. Negative rates have been set equal zero; rates larger than 5 have been set equal to 5 (table 1).

[17] This means that differences between simulation results referring to, for example, the perfect competition and the 6% mark-up scenario, cannot be interpreted as "the predicted changes if the market structure were an oligopoly/oligopsony represented through a 6% mark-up instead of a perfectly competitive one", because they actually provide "the predicted changes if the market structure were an oligopoly/oligopsony represented through a 6% mark-up instead of a perfectly competitive one and transaction costs were lower". In fact, while results presented in table 3 show volumes of EU imports under the "EPA + December 2009 agreement" which increase with firms' market power, the contrary would emerge if the models were run using the same per unit transaction costs.

[18] Some caution is needed when the scenario with a mark-up equal to 12% is considered, as this involves, as mentioned above, two transaction costs which are less than zero, albeit small in absolute value.

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flows between the results obtained under the five market structures relate to LDC exports. Under perfect competition, in the 2019 base scenario and in the scenario with the EPAs only all their exports are directed towards the EU, and they decline by 7.1% when the EPAs are implemented; when the imperfectly competitive market structures are assumed, LDC do not export to the EU in the 2019 base scenario, but find it profitable to do so when the EPAs are implemented, with their exports declining by between 4 and 6%, less than forecast under the perfect competition scenario. What happens here is that the profitability of LDC exports to the EU and the Rest of the world markets is very close and the reduction of the import price in the latter (because of the outward shift in the export supply towards them by MFN countries) makes exporting to the former more profitable, although LDCs are now able to export less.

As the degree of market power increases, market structure makes the difference, not only in terms of the expected magnitude of the impact of policy changes on the different agents involved, but in terms of its sign as well. This is the case for the change of the EU import price, and, as a consequence, for EU consumption and imports. This result is due to the fact that EPAs, on the one hand, make ACP exports on the EU market more competitive but, on the other, ACP export prices being higher than MFN ones, and per unit profits on ACP exports being higher than those on MFN exports, pushes the EU import price for bananas upward. When this effect, which increases with the percentage of mark-up, outweighs the effect in the opposite direction of the partial liberalization of its banana imports, the EU price increases.

Firms' profits increase with the introduction of the EPAs. Again, ACP are less efficient banana producers and show significantly higher export prices than MFN exporters; this helps the positive effect on firms' profits of increased ACP exports and export prices overcome the effect in the opposite direction of lower MFN and LDC exports and export prices.

Hence, when intermediaries exert market power and preferred country producers are less efficient than MFN ones, an expansion of the margin of preference may increase, rather than decrease, EU domestic price because of the increase in the traders' profit margin. The expected gains from expanded preferences for EU consumers can thus vanish because of the presence of intermediaries exerting market power. This outcome would not emerge under perfect competition.

When the implementation of the December 2009 WTO agreement is simulated (in addition to the EPAs), the effects of the preference erosion for ACP exports are marked and of the same order of magnitude under all market structures. ACP banana exports, all still directed to the EU, decline by around 15%, while MFN exports increase by 3.6%; those directed to the EU expand by over 90%, as trade diversion occurs in addition to trade creation. The increase in import prices in non-EU markets and the decline of the EU import price cause LDC exports to be redirected from the EU to the Rest of the world; thanks to the lower transaction costs to this destination compared to the EU, LDC exports increase by 1%. The 2009 WTO agreement causes a decline in profits, albeit by 2% only, because of the lower volume of ACP exports, which are more profitable for the traders than MFN ones; in

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addition, the decline in profits comes from the negative effects on per unit profits of the lower imports by the US and the Rest of the world, and those, of the opposite sign, of the larger volume of EU imports and higher export prices in MFN and LDC countries. While the EPAs produced little change in the EU domestic market, the WTO agreement causes a decline in the EU domestic price of around 10%, an increase in consumption of 5% and an increase in imports of a little more than 5%; on the contrary, EU production changes very little, as EU domestic policy for bananas makes only production in Greece, Portugal and Cyprus (which jointly account for a very small share of EU banana production) react to market signals (Anania, 2008). For the reasons discussed above, the magnitude of percentage changes increases with the percentage of mark-up and firms' market power.

The joint impact of the EPAs and the WTO agreement with respect to the "2019 base", which is reported in the five columns at the right end of table 4, shows that the reduction of the preferential margin due to the WTO agreement does not cancel out the benefits to ACP countries from the EPAs; in fact, when the WTO agreement is implemented their exports and export revenues remain significantly above those in the base scenario (by more than 50 and 110%, respectively). Analogously, despite the trade creation effect of the reduction from 176 to 114 €/t of the tariff they face, MFN countries are not able to fully recover from the loss of competitiveness *vis a vis* ACP countries resulting from the EPAs, and their exports and export revenue remain slightly below those in the base scenario.

6. Conclusions

The goal of this paper was to address the importance of the assumptions made about market structure and traders' behavior in empirical trade policy analysis. We believe its contribution to unraveling this issue is threefold: it develops two original models which incorporate imperfectly competitive market structures in a spatial modeling framework; it proposes a procedure to assess the degree of market power in international markets which is applied to banana trade and, finally, it shows how the assessment of the effects of the most recent EU import regimes for bananas is affected by assumptions made on the prevailing market structure.

The paper develops two modified versions of the Takayama and Judge (1971) spatial trade model. The first model includes a cartel of the firms handling international trade. The second model incorporates oligopolistic and oligopsonistic behaviors of trading firms through a mark-up; this modeling framework has the advantage of being flexible, easy to implement and does not require identification of conjectural variation parameters, which would imply making explicit assumptions about the number and symmetry of the firms exporting to each importing market. The percentage of mark-up provides a representation of the degree of market power without having to make restrictive assumptions about the nature of competition.

The two step calibration procedure used to make the model replicate observed country net trade positions provides a useful tool to address an important issue for empirical policy analysis, that is: what is the range of degree of market power in the market under

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scrutiny? Reducing the space of the feasible market structures is relevant in assessing the effects of trade policy changes as these may crucially depend on assumptions made on the degree of market power exerted by relevant actors.

Indeed, the result of the analysis presented in the paper for the banana market is that some of the market structures hypothesized turn out to be unfeasible, being largely inconsistent with observed traded quantities and border prices. This happens when a cartel maximizing firms' joint profits is assumed, but also for imperfectly competitive world market structures where the mark-up is above 12%. In fact, the results show that observed data are only consistent with market behaviors which are far away from Cournot and, actually, are close to perfect competition under most values of demand elasticities and market shares. This result appears even more important given the high concentration of international trade of bananas.

Regardless of the market structure considered, the implementation of the EPAs is expected to increase ACP exports to the EU significantly and generate overall consistent benefits for ACP countries; trade diversion occurs, with ACP exports previously directed to non-EU countries now redirected toward the latter. The 2009 WTO agreement significantly reduces the preferential margin for ACP countries, but does not offset the benefits from the EPAs; as a whole, with both the EPAs and the WTO agreement in place, ACP countries are better off in terms of both exports and export revenues. Analogously, despite the trade creation effect of the lower tariff they face on the EU market, the WTO agreement does not compensate MFN countries for the loss of competitiveness *vis a vis* ACP countries as a result of the EPAs.

Because of the relatively low level of market power, simulation results are quite similar across the five market structures considered. However, the results show that as the feasible degree of market power increases, market structure matters not only in terms of the expected magnitude of the impact on the different agents involved, but in terms of its sign as well.

The findings of this paper, and especially those concerning the degree of market power in the world market for bananas, depend upon a number of assumptions, common to most empirical studies on agricultural commodities, the most important of which are that: products are homogeneous; upstream and downstream firms have no market power; the policy changes considered have no effect on firm behavior or market structure. The removal of any of the above is likely to affect the results reached; however, this would imply the use of a completely different modeling framework and data needs which would be difficult to satisfy. Notwithstanding these simplifying assumptions, this paper proposes within a spatial framework an innovative and relatively simple procedure to assess the market power of intermediaries in empirical trade policy analysis; because of the importance of assumptions made regarding market structure in policy analysis, we believe that this approach could be useful to better evaluate the impact of trade policies.

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Table 1 - Base model input data (2007).

Country/Region	Net Imports[1] (000 t)	Net Exports[2] (000 t)	Import Prices ($/t)	Export Prices ($/t)	Export Supply Price Elasticities	Import Demand Price Elasticities	Domestic Demand Income Elasticities	% Yearly Changes in Supply Due to Technical Changes[3]	% Yearly Changes in Population	% Yearly Changes in Per Capita GDP
EU-15	5055,1		844,7			-0,50	0,5		0,49	1,95
EU-12	249,1		810,8			-0,75	0,5		-0,25	4,23
USA	3544,3		358,0			-0,40	0,4	2,79	1,00	2,01
Other importers	7249,8		491,9			-0,80	0,5	5,00	0,82	5
Spain		361,4		610,0	1,0			0,46		
France		238,8		500,0	1,0			2,10		
Portugal		17,2		1190,0	1,0			0,22		
Greece		2,9		720,0	1,0			2,08		
Cyprus		6,0		700,0	1,0			0,00		
Ivory Coast		290,8		371,0	1,5		0,5	2,95	2,36	0,00
Cameroon		224,5		290,0	1,5		0,5	1,54	2,36	1,63
Dominican Republic		215,1		347,3	1,0		0,5	5,00	1,56	3,81
Belize and Suriname		115,5		373,5	1,0		0,5	3,20	1,98	2,46
Other ACP non LDC		89,4		450,0	1,0		0,5	3,28	2,06	1,06
Ecuador		5285,6		246,4	1,3		0,5	0,33	1,24	1,88
Colombia		1660,7		325,6	1,3		0,5	1,02	1,62	1,20
Costa Rica		2273,4		299,0	1,0		0,5	1,57	2,00	2,95
Panama		436,3		255,6	1,0		0,5	0,06	1,85	3,09
Honduras		514,9		270,0	1,5		0,5	0,27	2,06	1,96
Brazil		185,7		238,5	1,0		0,5	2,58	1,33	1,21
Guatemala		1518,6		211,4	1,5		0,5	2,76	2,46	1,24
Other MFN exporters non LDC		2578,9		195,2	1,0		0,5	3,30	1,57	3,77
LDC		82,6		204,5	1,5		0,5	5,00	2,75	1,70

Source: Comtrade, Faostat.

[1]: For EU-15 and EU-10 apparent consumption (imports + domestic production - exports).

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Table 2 : Mark-up values under different market structures *(%)*

	number of firms					
	20	*16*	*11*	*7*	*5*	*3*
ε=0.5						
Perfect competition/Bertrand	0	0	0	0	0	0
Cournot-Nash	10	12.5	18	28.6	40	66.7
Cartel	200	200	200	200	200	200
ε=0.75						
Perfect competition/Bertrand	0	0	0	0	0	0
Cournot-Nash	6.7	8.3	12.1	19.0	26.7	44.4
Cartel	133	133	133	133	133	133

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Table 3 - Simulation results.

	2007 base	Perfect competition			Mark-up 3%			Mark-up 6%			Mark-up 9%		
		2019 base	EPA only	EPA + Dec 2009 Agreement	2019 base	EPA only	EPA + Dec 2009 Agreement	2019 base	EPA only	EPA + Dec 2009 Agreement	2019 base	EPA only	EPA + Dec 200 Agreeme
EU production (000 t)	***626***	**575**	**574**	**572**	**574**	**574**	**572**	**574**	**574**	**572**	**574**	**574**	**572**
EU consumption (000 t)	***5.304***	**6.415**	**6.451**	**6.753**	**6.441**	**6.451**	**6.762**	**6.470**	**6.451**	**6.771**	**6.498**	**6.451**	**6.781**
EU15 border price (euro)	***616,1***	**600,6**	**593,9**	**536,5**	**596,0**	**593,8**	**534,8**	**591,0**	**593,8**	**533,1**	**586,1**	**593,8**	**531,4**
EU imports (000 t)	***4.678***	**5.840**	**5.876**	**6.181**	**5.867**	**5.877**	**6.190**	**5.895**	**5.876**	**6.199**	**5.924**	**5.877**	**6.208**
EU imports from ACP (000 t)	*855*	*950*	*2.433*	*2.068*	*923*	*2.407*	*2.041*	*896*	*2.381*	*2.016*	*867*	*2.357*	*1.992*
EU imports from MFN (000 t)	*3.823*	*3.448*	*2.103*	*4.113*	*4.944*	*2.126*	*4.149*	*5.000*	*2.148*	*4.183*	*5.057*	*2.169*	*4.216*
EU imports from LDC (000 t)	*0*	*1.443*	*1.340*	*0*	*0*	*1.344*	*0*	*0*	*1.347*	*0*	*0*	*1.351*	*0*
USA imports (000 t)	***3.544***	**4.440**	**4.486**	**4.454**	**4.436**	**4.487**	**4.454**	**4.434**	**4.488**	**4.453**	**4.433**	**4.489**	**4.453**
ROW imports (000 t)	***7.250***	**7.949**	**8.095**	**7.994**	**7.937**	**8.099**	**7.993**	**7.932**	**8.102**	**7.993**	**7.928**	**8.105**	**7.992**
ACP total exports (000 t)	***935***	**1.353**	**2.433**	**2.068**	**1.328**	**2.407**	**2.041**	**1.302**	**2.381**	**2.016**	**1.274**	**2.357**	**1.992**
MFN total exports (000 t)	***14.454***	**15.434**	**14.684**	**15.205**	**15.514**	**14.712**	**15.236**	**15.556**	**14.738**	**15.265**	**15.601**	**14.762**	**15.293**
LDC total exports (000 t)	***83***	**1.443**	**1.340**	**1.356**	**1.398**	**1.344**	**1.360**	**1.404**	**1.347**	**1.364**	**1.410**	**1.351**	**1.368**
ACP export revenue (mill US$)	***331,1***	**489,5**	**1.449,0**	**1.066,7**	**474,0**	**1.419,9**	**1.042,0**	**458,7**	**1.392,7**	**1.019,1**	**443,1**	**1.367,4**	**997,8**
MFN export revenue (mill US$)	***3.642,1***	**3.758,6**	**3.443,2**	**3.661,0**	**3.793,3**	**3.454,4**	**3.674,0**	**3.811,6**	**3.465,1**	**3.686,5**	**3.830,8**	**3.475,3**	**3.698,3**
LDC export revenue (mill US$)	***16,9***	**289,4**	**256,2**	**261,2**	**274,7**	**257,4**	**262,5**	**276,6**	**258,5**	**263,8**	**278,6**	**259,6**	**265,0**
Traders' profits (mill US$)		**0,0**	**0,0**	**0,0**	**250,1**	**289,1**	**282,6**	**484,1**	**561,6**	**548,6**	**703,6**	**819,0**	**799,5**

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Table 4 - Simulation results. Expected impact of policy changes under different market structures (% changes)

	'EPA only' vs. '2019 base'					'EPA + Dec 2009 Agreement' vs. 'EPA only'					'EPA + Dec 2009 Agreement' vs. '2019 base'				
	Perfect competition	Mark-up 3%	Mark-up 6%	Mark-up 9%	Mark-up 12%	Perfect competition	Mark-up 3%	Mark-up 6%	Mark-up 9%	Mark-up 12%	Perfect competition	Mark-up 3%	Mark-up 6%	Mark-up 9%	Mark-up 12%
EU production	-0,2	0,0	0,0	0,0	0,0	-0,3	-0,3	-0,3	-0,3	-0,3	-0,5	-0,3	-0,3	-0,3	-0,3
EU consumption	0,6	0,2	-0,3	-0,7	-1,8	4,7	4,8	5,0	5,1	5,3	5,3	5,0	4,7	4,4	3,3
EU15 border price	-1,1	-0,4	0,5	1,3	3,8	-9,7	-9,9	-10,2	-10,5	-10,8	-10,7	-10,3	-9,8	-9,3	-7,4
EU imports	0,6	0,2	-0,3	-0,8	-2,0	5,2	5,3	5,5	5,6	5,8	5,8	5,5	5,2	4,8	3,7
EU imports from ACP	156,1	160,8	165,7	171,9	170,3	-15,0	-15,2	-15,3	-15,5	-15,6	117,7	121,1	125,0	129,8	128,0
EU imports from MFN	-39,0	-57,0	-57,0	-57,1	-57,4	95,6	95,2	94,7	94,4	94,1	19,3	-16,1	-16,3	-16,6	-17,3
EU imports from LDC	-7,1	...	...	...	...	-100,0	-100,0	-100,0	-100,0	-100,0	-100,0	...	...	...	...
USA imports	1,0	1,1	1,2	1,3	0,5	-0,7	-0,7	-0,8	-0,8	-0,8	0,3	0,4	0,4	0,5	-0,3
ROW imports	1,8	2,0	2,1	2,2	0,7	-1,2	-1,3	-1,3	-1,4	-1,4	0,6	0,7	0,8	0,8	-0,7
ACP total exports	79,8	81,3	82,9	85,0	83,1	-15,0	-15,2	-15,3	-15,5	-15,6	52,8	53,7	54,8	56,4	54,5
MFN total exports	-4,9	-5,2	-5,3	-5,4	-6,4	3,5	3,6	3,6	3,6	3,6	-1,5	-1,8	-1,9	-2,0	-3,1
LDC total exports	-7,1	-3,9	-4,1	-4,2	-5,8	1,2	1,2	1,3	1,3	1,3	-6,0	-2,7	-2,8	-3,0	-4,6
ACP export revenue	196,0	199,6	203,6	208,6	202,4	-26,4	-26,6	-26,8	-27,0	-27,2	117,9	119,8	122,2	125,2	120,0
MFN export revenue	-8,4	-8,9	-9,1	-9,3	-11,1	6,3	6,4	6,4	6,4	6,5	-2,6	-3,1	-3,3	-3,5	-5,3
LDC export revenue	-11,5	-6,3	-6,5	-6,8	-9,4	2,0	2,0	2,1	2,1	2,1	-9,7	-4,4	-4,6	-4,9	-7,5
Traders' profits		15,6	16,0	16,4	53,3		-2,2	-2,3	-2,4	-2,4		13,0	13,3	13,6	49,6

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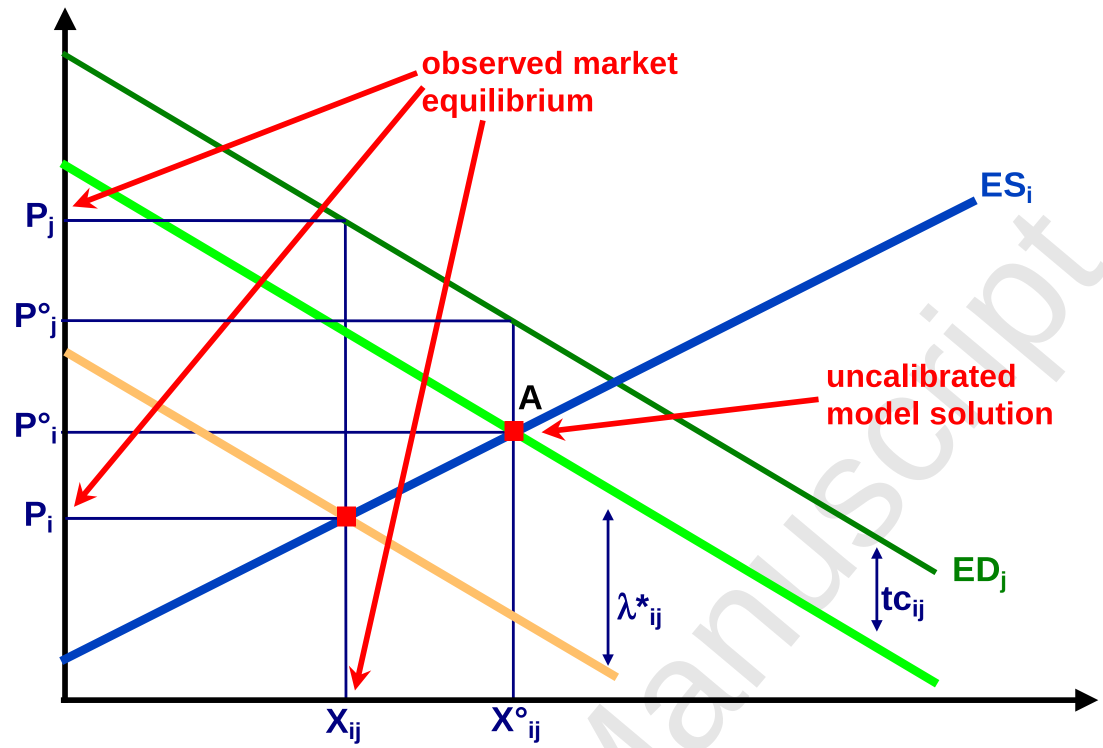

Figure 1 Perfect competition. Observed market equilibrium, uncalibrated and calibrated model solution.

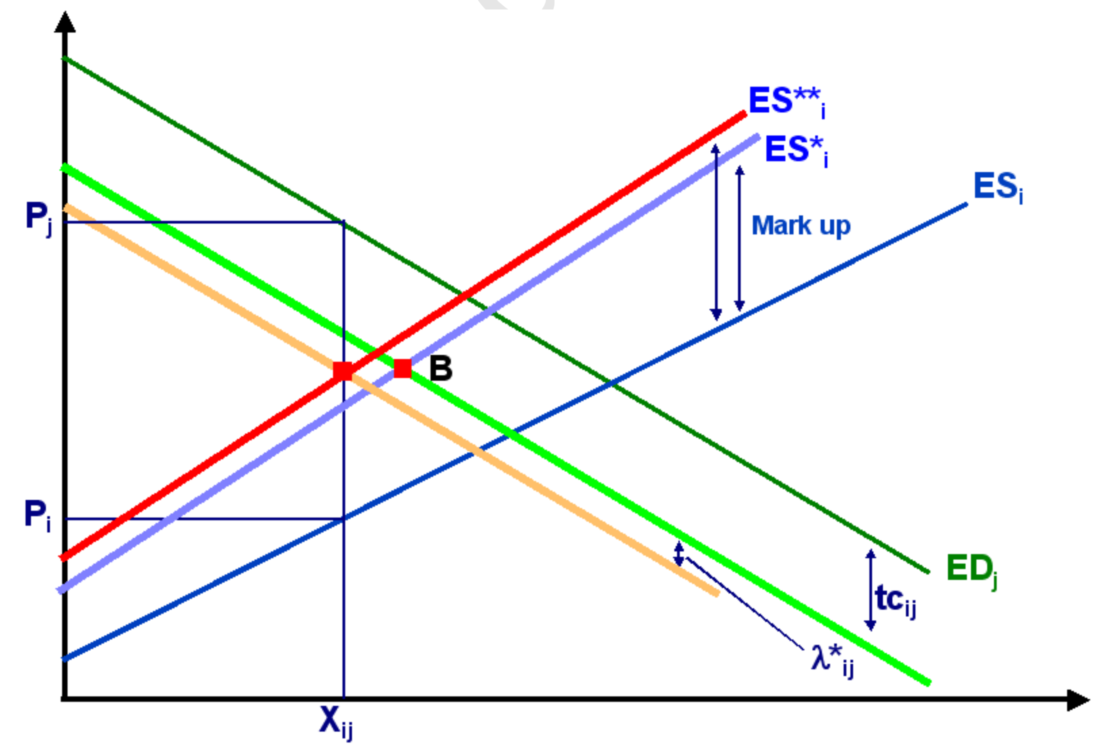

Figure 2 Imperfect competition, mark-up. Observed market equilibrium, uncalibrated and calibrated model solution.

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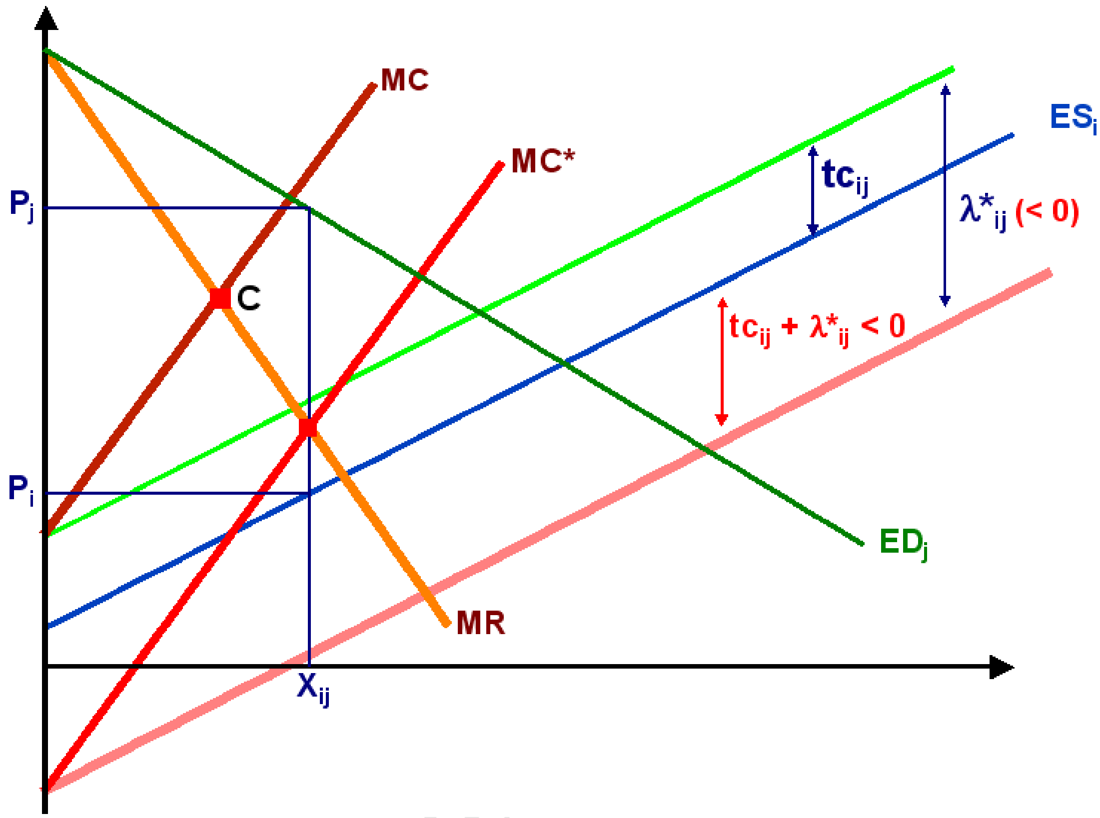

Figure 3 Imperfect competition, cartel. Observed market equilibrium, uncalibrated and calibrated model solution.

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