Assessing the Impact of Recent Trade Policy Changes in the Banana Market under Alternative Market Structures

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Abstract

The paper focuses on the importance of the assumptions made about market structure and firm behaviors in empirical trade policy analysis. It addresses this issue with reference to recent changes in the EU import regime for bananas, namely the Economic Partnership Agreements and the December 2009 WTO agreement on bananas. The paper's contribution to the literature on the issues addressed is threefold: first it develops two original models which incorporate imperfectly competitive market structures in a spatial modeling framework; then it proposes a methodology to assess the degree of market power in international trading which is applied to the banana market and, finally, it assesses how analysis of the implications of the most recent changes in the EU import regimes for bananas is affected by the assumptions made on the prevailing market structure.

JEL codes: Q17, Q18, F13

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

1. Introduction

International markets of agricultural products are often highly concentrated. There are several example of markets - cereals, sugar, bananas or coffee - in which a small number of trading firms (private or not) account for a significant share of world trade. While a considerable body of literature has addressed the issue of concentration in the food and retailing industries and its consequences in terms of market power, not many studies have focused on the structure and behavior of firms trading agricultural products in international markets; in fact, there are few empirical studies and they are not recent. However, for more than twenty years, there has been a growing consensus that the assumption of perfect competition - in general terms and in modeling agricultural trade in particular - may often be

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restrictive (McCorriston, 2002). Yet, empirical agricultural trade policy analysis mostly relies on the assumption of perfect competition.

The aim of this paper is to address the relevance of the assumptions about market structure and firms behavior in empirical analyses of trade policies. The paper focuses on the most recent changes in the European Union (EU) import regime for bananas, namely the Economic Partnership Agreements (EPAs) and the December 2009 WTO agreement. This case study can provide insights into the effects , if any, of non competitive behaviors in evaluating the impact of trade policies. In fact, the banana trade is among the most evident examples of high concentration in international markets, with three multinational firms accounting for over 65% of world trade. Recently, the EU Commission (EC, 2008) has found that four banana traders have violated EU rules on competition, and consequently imposed fines. On the other hand, for several decades the EU import regime for bananas has been the cause of heated political confrontation, both domestically and internationally (Anania, 2006; Read, 2001; Josling and Taylor, 2003). In July 2008 the longest ever meeting in the history of WTO negotiations failed to reach any final agreement of the Doha round but in the course of these negotiations eleven Latin American countries, the US and the EU reached a tentative provisional agreement to bring an end to the long-standing WTO "banana war". However, failure to conclude the Doha round left the banana dispute unresolved. In December 2009 the same countries signed an agreement along the lines of what had been agreed 18 months previously. This called for a reduction of the EU MFN tariff on bananas from 176 to 114 €/t between January 1 2010 and 2019 (2017 if an agreement on the modalities on agriculture in the Doha round is reached by December 31 2013), with a 28 €/t tariff cut in the first year. Meanwhile, on 1 January 2008 the EU implemented the EPAs (EC, 2007), progressively removing barriers to trade between the EU and regional groupings of ACP countries. Agricultural exports from ACP countries which successfully concluded the negotiations now enter the EU market duty- and quota-free. For bananas the EPAs have meant the removal of the duty-free 775,000 t quota for imports originating from ACP countries. It is expected that bananas, sugar and rice will be for ACP countries the agricultural commodities that benefit most from the EPAs.[2]

The paper provides a quantitative assessment, under different assumptions about market structure, first of the impact of the trade preferences the EU granted ACP countries with the EPAs, and then of the erosion of these preferences through the reduction of the MFN import tariff for bananas under the December 2009 WTO agreement. The banana market is possibly the one in which benefits from trade preferences and potential losses from preference erosion are the greatest (Alexandraki and Lankes, 2006; Low *et al*, 2009; Yang, 2005) and conflicts between different interests are most evident and vociferous.

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[2] In March and June 2010 the EU reached trade agreements with Colombia, Peru and six Central American countries which include significant provisions on bananas. However, these agreements have not yet been implemented, pending ratification by relevant bodies in all countries involved.

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 generates 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 questionable assumptions, such as imperfect substitution between goods produced in different countries (Armington, 1969).[3] Current and recent previous EU trade regimes for bananas considered in this paper include preferential tariffs and tariff rate quotas applied on imports from specific groups of countries. Following Samuelson (1952) and Takayama and Judge (1971) a "quasi-welfare" function is maximized subject to a set of constraints. The paper develops two modified versions of the Takayama and Judge (1971) spatial trade model: the extreme case of international trading firms jointly maximizing their profits by 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 market structure is compatible with the observed data.

Overall, the results show that observed data are not compatible with the existence of a cartel by international traders; in fact, observed traded quantities and prices are consistent with market structures involving a relatively low degree of market power. The EPAs are expected to increase ACP exports to the EU significantly and generate overall consistent benefits for ACP countries, while the 2009 WTO agreement on bananas significantly reduces the preferential margin for ACP countries, but does not offset the benefits from the EPAs. One interesting finding is that as the degree of market power increases, market structure becomes more important 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.

The paper is organized as follows: the next section discusses the relevance of imperfect competition for the banana industry, while the third presents the model, the calibration procedure used and the outcomes in terms of feasible market structures; the fourth discusses the results, while the final section offers concluding remarks.

2. Market structure and behavior in the banana industry

Since the beginning of the twentieth century, 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; two companies - Noboa and Fyffes - were 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

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[3] A discussion of the advantages and disadvantages of different types of empirical trade models is provided in Francois and Reinert (1997), Anania (2001), van Tongeren *et al* (2001) and Bouët (2008).

exports in 2010 to remain 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, 2010 and 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).

Although the organization of firms has changed over time, and obviously differs from one firm to another, one distinguishing feature of banana traders is their vertical integration along the international marketing chain. While only few trading firms control banana production directly through their own plantations, companies generally control at least some of the stages of the marketing chain (packaging in the producing countries, domestic and international transportation, and ripening and wholesale in the countries where bananas are consumed) (UNCTAD, 2003; Arias *et al.*, 2003; Preville, 2004). The main reason for vertical integration is to be found in the perishable nature of bananas, which requires a timely and efficient coordination along the marketing chain to guarantee that the final product sold to consumers it is of the expected quality. By coordinating at least some of these activities within the firm, traders aim to avoid high transaction costs arising in the negotiation, stipulation and enforcement of contracts with independent shippers, ripeners and wholesalers.

Marked concentration, vertical integration, 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 thesis. 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. Analyzing, again, the case of Germany, Herrmann and Sexton (2001) found no evidence of market power at the import stage, i.e. upstream with respect to the ripening and wholesale industries. To the best of our knowledge, there are no other studies assessing the degree of market power in the banana market in other EU countries or in the US. Hatirli *et al* (2003) found evidence of market power exerted at the import stage in Turkey.

The lack of evidence of the exercise of market power by banana traders partly explains the assumption of perfect competition in most papers assessing the impact of EU policy changes (e.g. Anania, 2006, 2008 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 (TRQs) 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 the product, perceived by consumers as different according to their country of origin. Neither industry behaves competitively and the nature of competition is captured at each stage by a conjectural variation parameter. 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. Mc Corriston (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. Finally, Scoppola (2008) used a capacity constraint model with differentiated products to find the tariff equivalent of the TRQ for non-ACP country exports in place up to 2005. The model assumes that firm behavior ranges from Bertrand to Cournot according to the effectiveness of the capacity constraint, which is given by the amount of import licenses within the TRQ held by firms. The paper concludes that, because the elimination of the TRQ for non-ACP countries has also implied eliminating the capacity constraint, firms behaved more competitively after 2005 than under the TRQ.

Evidence of non competitive behaviors by banana traders has recently been found by the EU Commission for eight Northern European countries[4] during the period 2000-2002 (EC, 2008). According to the Commission, four banana traders – namely, Chiquita, Del Monte, Dole and Weichert (by that time controlled by Del Monte) - violated EU rules on competition, because they explicitly coordinated their weekly decisions on the selling prices of bananas.[5] Although the Commission takes the period 2000-02 of infringements as the relevant one for its decision and for computing the amount of the fines (which amounted to 60 million euro), according to the Commission *"there are strong indications that collusion arrangements… occurred already before 2000… and continued even after 2002"* (EC, 2008, p. 124).

The conclusions of the Commission, therefore, seem to indicate the existence of a stable cartel between the three major banana traders, which were found guilty of collusion. This introduces a new hypothesis regarding the behavior of banana traders: while previous

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[4] Austria, Belgium, Denmark, Finland, Germany, Luxembourg, the Netherlands and Sweden.

[5] *"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).

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.

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 modified and updated version of the one used in Anania (2010) to allow for different non competitive market structures; its data base has been updated (it now refers to 2007, while in Anania (2010) the model was constructed with reference to 2005), and the shift over time of supply functions as a result of technical changes has been modified to take into account, in addition to expected changes in yields, the effects on land allocation for banana production. It is a single commodity, spatial, partial equilibrium, mathematical programming model; an objective 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) and policies which cannot be represented through exogenously determined price wedges (such as import quotas).[6]

The assumption that bananas are a homogeneous product means that the effectiveness of branding in differentiating bananas is ruled out,[7] "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, [8] fourteen exporting countries,[9] and four importing countries/regions.[10] 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 the relevant portions 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

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[6] The basic structure of the model's constraints is provided in Anania (2010).
[7] 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.
[8] 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.
[9] 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.
[10] EU15, EU12, United States, and the aggregate of Rest of the world net importers.

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.

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.[11]

In order to assess how the simulation of the effects of policy changes are affected when the assumption that 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 traders behaving as downstream oligopolists and upstream oligopsonists,

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[11] In France banana producers are entitled to receive a direct payment which has been calculated for each farm based on the support received by that farm in the past. In order to receive their full entitlements of the direct payments, farms have to produce at least 80% of what they produced, on average, in a reference period; if production is between 70% and 80% of what it was in the reference period, the farm will receive 80% of the entitled direct payment; if it is below 70% it will receive the same percentage of the entitlement. However, the financial incentive is large enough (around 11 600 €/ha) to ensure that farms find it profitable to produce the minimum volume of bananas needed for them to claim the full amount of the payments. A similar support mechanism applies in Spain where, in order to receive their full entitlement of support payments, farms have to produce at least 70% of what they produced, on average, in the reference period. In this case too the financial incentive (around 11 800 €/ha) is large enough for farms to find it profitable to produce the minimum volume of bananas which enables them to claim their full entitlement of direct payments. In Portugal a fully "coupled" fixed production subsidy is in place. The amount of the per unit subsidy in the model is 455.2 €/t. The subsidy expenditure cannot exceed Portugal's financial allocation (€8.7 million); if production is such that expenditure would exceed the maximum allowed, then the per unit subsidy is cut *pro rata* so that the expenditure equals the budget allocation.

considering different degrees of imperfect competition. Exporters and importers are assumed to have no market power.

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):

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

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

subject to a set of constraints, where: i is an index for exporting countries and for sources of domestic supply in the EU; j is an index for importing countries; e is an index for EU15 and EU12; n is an index for non-EU importing countries; $p^d_j(m)$ is country j's inverse import demand function; $p^s_i(r)$ is country i's inverse export supply function; q^d_j are country j's total imports; q^s_i are country i's total exports; 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 (it applies to imports from MFN importers and on out-of-quota imports from 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.

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 the EU Commission's (2008) detection of the existence of a stable cartel of banana traders in Northern European Union countries. The literature on cartels suggests that this 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 more 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.[12] 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 banana exporters and monopoly power with respect to importers. This market structure is modeled by maximizing traders' total profits,

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[12] For instance, in the EU vitamin case, these have been found to be among the major factors explaining the sustainability of the cartel (Belleflamme and Peitz, 2010).

given by total revenues across all importing countries minus international transaction costs, banana acquisition costs and tariff expenditure:

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

$$- \sum_i \sum_n (x_{in}\,T_{in})\ .^{13} \tag{2}$$

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:

$$k = \frac{p - c}{c} \tag{3}$$

where p is the selling price and c is the marginal cost. According to the conjectural variation approach, different mark-up values may be seen as corresponding, everything else being equal, to different values of the conjectural variation parameter. 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, it can be shown that (Shapiro, 1992):

$$k = \frac{s_i}{\varepsilon}(1 + \lambda_i) \tag{4}$$

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

Under Cournot behavior the conjectural parameter is equal to 0 and equation (4) reduces to the usual Cournot equation $k = \frac{s_i}{\varepsilon}$. When firms are price takers the conjectural parameter is equal to -1 and the mark-up is zero. Hence, the lower the market share of each firm (i.e, the higher the number of firms with respect to the size of the market), the closer the behavior to perfect competition, and the lower the mark-up. Conversely, mark-up increases with the market share of each firm and their behavior approaches Cournot.[14]

Under a cartel equation (4) reduces to the usual monopoly equation $k = \frac{1}{\varepsilon}$.

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[13] 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 because regions are modeled either as exporters or as importers (they cannot export and import at the same time).

[14] One frequent critique of the use of the conjectural variation is its lack of theoretical foundation (Vives, 2001). If conjectures are different from zero firms react to rivals' moves; this implicitly calls for a dynamic setting for firms' behaviors, while the conjectural variation approach is based on a single-period maximization problem. Model (5) below does not include the conjectural variation parameter, rather the mark-up value.

We model firm oligopolistic/oligopsonist behaviors by considering different percentages of mark-up. To provide the reader with an idea of the implications in terms of market structure of the assumptions we shall make 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. The table reports the values of the mark-up for two different values of the demand elasticity (assuming firms sell bananas on one market only) and under different market structures. We believe that, among those considered in table 2, only those 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 (assumed in table 2 to be identical), 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. Mark-up higher 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:

$$\text{Max } W\,(x_{in}\,,\,xq_{ie}\,,\,xmfn_{ie}\,) \;\;=\;\; \sum_j \int_0^{q^d_j} p^d_j(m)\,\mathrm{d}m \;\;-\;\; \sum_i \int_0^{q^s_i} p^s_i(r)\,\mathrm{d}r \;\;- \qquad\qquad (5)$$

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

where MU_{ij} is the 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).[15]

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, Suzuki and Kaiser (1997) and Yang, Hwang and Sohng (2002). Our model

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[15] 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.

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 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 exporters (and importers) have no market power. Kawaguchi, Suzuki and Kaiser (1997) analyze interregional exchanges of milk in Japan assuming that regional marketing boards maximize producers sale revenues net of transportation costs and only one agent handles milk produced in each of the regions. They propose a modified Takayama and Judge model which explicitly includes conjectural variation parameters; however, they assume these parameters to 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 parameters for each importing country, and making explicit assumptions about the number and symmetry of firms. Yang, Hwang and Sohng (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 (like those assumed here), while they suggest the standard Takayama and Judge (1971) spatial modeling framework when a common demand function and constant marginal cost 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. Although some contributions have analyzed how these may influence the stability of a cartel, their findings are rather controversial as they depend upon which non-cooperative behavior is assumed to replace the cartel (Bertrand *versus* Cournot) and upon which kind of sanction is assumed (Helpmann and Krugman, 1989; Rotemberg and Saloner, 1989; Lommerud and Sorgard, 2001). As for non-cooperative behaviors in the banana trading industry, Deodhar and Sheldon (1996) have found that the introduction of the TRQs by the EU in 1993 has not significantly affected the behavior of banana traders, while Scoppola (2008) concluded that after the 2006 tariffication of the TRQ on EU banana imports from non-ACP countries, traders behaved more competitively. Although there are good reasons to believe that the competitive environment may change because of a significant change in the trade policy, the assumption made here is that the simulated policy shocks do not influence the stability of the cartel, nor the nature of the non-cooperative behavior of firms. Further extensions could include the assumption that the EU MFN tariff reduction and/or the elimination of the TRQ on EU imports from ACP countries may imply a change in the degree of competition and in market structure.

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, Drogué and Anania (2010) 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 international transaction costs which, once corrected, make the model perfectly calibrate observed country net trade positions.[16] In the first step the model is augmented by a set of constraints imposing predicted bilateral trade flows to equal observed ones.[17] The values of the dual variables associated in the solution to these constraints are then used in step two 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, Drogué and Anania, 2010).

To explain how the calibration procedure works in the modeling of the three market structures considered in the paper 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

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

[17] Net trade positions and the matrices of trade flows obtained from the Comtrade data base are inconsistent. This is so for several, well known, reasons, including the fact that information obtained using the exporters as reporters differs from the same information obtained using the importers as reporters (because of inconsistencies in the timing of the declarations by the exporting and the importing countries, as well as reporting errors), and that net trade positions are given for each country by the difference between its exports and imports, while trade flow matrices consider all trade. In order to calibrate the model, consistent net trade positions and trade flows are needed (i.e. net trade positions have to equal the marginal distributions of the trade flows matrix); thus a two step reconciliation procedure has been used. In the first step net trade positions have been adjusted to make total net exports across all countries equal total net imports (for each country its own reported data has been used, which makes the sum of net imports differ from the sum of net exports); reconciliation has been obtained by keeping all net trade positions but one unchanged, and adjusting only that of the aggregate "Rest of the world net importers" (table 1). In the second step a minimum least square procedure has been used to obtain trade flows consistent with net trade positions and as close as possible to those obtained by using importers as reporters (these declarations are generally believed to be more accurate than those by exporters). In the least square procedure (a) observed trade flows (different from EU domestic ones) smaller than 15,000 t have been set at zero and (b) in the solution trade flows have been constrained to equal zero if observed ones were equal zero.

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 makes the import price equal to the export price augmented by the per unit transaction cost); the solution generated by the model differs from observed traded quantity, and import and export prices.[18] The calibration procedure enables the model to reproduce the observed market equilibrium by correcting the per unit transaction cost (figure 2); in this case by increasing it by an amount equal to λ^*_{ij}.[19] Figures 3 and 4 are analogous to figures 1 and 2 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 3 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 in point B. Figure 4 shows what happens when the calibration procedure is applied. In this case 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. In figure 5 point C represents the equilibrium quantity 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 to 4). 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 (figure 6). An adjustment of transaction costs to make them negative is needed for the model to reproduce the observed market equilibrium (figure 7); 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 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 world market for bananas 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 being driven by measurement errors of import and export prices, including those

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

[19] In this as well as in the other cases discussed below, the correction of the transaction cost needed to calibrate the model can, in general, be either positive or negative.

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 is 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 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). 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 food processors or retailers, exert oligopsony and/or oligopoly power and, hence, in assessing the impact of a trade liberalization 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 hold market power, our results may no longer hold true.

4. Results

All the simulations have been generated with reference to 2019, the earliest 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.[20] 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;[21] 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.[22]

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 being 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 its 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 other crucial parameters as well. In particular, they differ in the per unit transaction costs, because of the differences in the results of the calibration procedure for the five models; in fact, corrected transaction

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[20] The FAOSTAT data base is the source used for production in 2007. Information on banana consumption in 2007 for all countries does not exist; the FAOSTAT data base has been used to calculate apparent consumption (domestic production + imports − exports).

[21] 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.

[22] 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 FAOSTAT database. Negative rates have been set equal zero; rates larger than 5 have been set equal to 5. In Anania (2010) only the annual rate of change in yields was considered. The dollar/euro exchange rate in 2019 has been assumed to be 1.4 (in the 2007 base model it was 1.371).

costs - $tc_{ij} + \lambda^*_{ij}$ in figures 2 and 4 - become smaller and smaller as we move from perfect competition to increasing degrees of market power.[23]

The simulation results obtained under the five market structures appear fairly close (table 3). 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. However, differences in the results obtained under the various market structures become more remarkable when percentage changes are considered (table 4).

Under all market structures the implementation of the EPAs is expected to generate 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. 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.[24] The most significant differences in trade 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.

The increases in the degree of market power switches the sign of the expected change for some crucial variables. This is the case for 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

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[23] 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 change if the market structure were an oligopoly/oligopsony represented through a 6% mark-up instead of a perfectly competitive one", because it actually provides "the predicted change 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.

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

being larger than MFN ones, and per unit profits on ACP exports being larger than those on MFN exports, pushes EU import price for bananas upward. When this effect, which increases the larger the percentage of mark-up, overcomes the effect in the opposite direction of the partial liberalization of banana imports, the EU price increases. This leads us to conclude that, 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.

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.

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 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, although by 2% only, because of the lower volume of ACP exports, which are more profitable for the traders than MFN ones; in 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, as explained above, makes only production in Greece, Portugal and Cyprus (which jointly account for a very small share of EU banana production) react to market signals. For the reasons discussed above, the magnitude of percentage changes in market equilibrium increases with the percentage of mark-up and firms' market power.

The overall 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: 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 their relevant tariff , 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.

5. Conclusions

The goal of this paper was to address the importance of the assumptions made about market structure and firm behaviors in empirical trade policy analysis with respect to recent changes in the EU import regime for bananas. 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 investigate the degree of market power in international markets and applies it to banana trade and, finally, it assesses how the effects of the most recent EU import regimes for bananas are affected by the assumptions made on prevailing market structure.

The paper develops two modified versions of the Takayama and Judge (1971) spatial trade model. The first model includes a profit maximizing cartel of the firms which handle 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 each firm's conjectural variation parameters, which would imply making explicit assumptions about the number and symmetry of the relevant firms in each importing market. The percentage of mark-up provides a representation of the degree of market power without making too restrictive assumptions about the nature of competition.

The two step calibration procedure used to make the model replicate observed country net trade positions provided insights on a relevant issue, that is: what is the degree of market power in the world market for bananas? Indeed, the result of the analysis presented in the paper is that some of the market structures hypothesized turn out to be unfeasible, being largely inconsistent with observed 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 of the values of demand elasticities and market shares here considered. 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 being 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 bananas, the most important of which are that: bananas are a homogeneous product; banana traders do not extend their activities downstream into importing and ripening, or upstream into producing and exporting bananas; actors different from the firms operating in international trading (importers and, even more important, retailers) 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 skew the results reached in this paper; however, this would imply the use of a completely different modeling framework and data needs which would be difficult to satisfy.

In conclusion, notwithstanding its limitations, we believe this paper does provide useful insights for the empirical analysis of trade policy effects in imperfectly competitive markets.

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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).

[2]: For France average production in 2005-2007, to smooth the effects of hurricane Dean (August 2007). No data available for Cameroon and Suriname as reporting exporters in Comtrade; Foastat data have been used instead.

[3]: average (05-07/95-97) annual percent change in yields (negative rates have been set equal to zero) + 1/3 of the average (05-07/95-97) annual percent change in harvested area (negative rates have been set equal to zero). For country aggregates, weighted average with share of production in 2007 as weights. Resulting percent annual changes larger than 5 have been set equal to 5.

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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

Table 3 - Simulation results.

	2007 base	Perfect competition			Mark-up 3%			Mark-up 6%			Mark-up 9%			Mark-up 12%		
		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 2009 Agreement	2019 base	EPA only	EPA + Dec 2009 Agreement
EU production (000 t)	626	575	574	572	574	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	6.572	6.451	6.790
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	571,9	593,7	529,7
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	5.998	5.877	6.217
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	864	2.335	1.970
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	5.134	2.188	4.247
EU imports from LDC (000 t)	0	1.443	1.340	0	0	1.344	0	0	1.347	0	0	1.351	0	0	1.354	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	4.466	4.490	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	8.051	8.108	7.991
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	1.275	2.335	1.970
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	15.802	14.786	15.320
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	1.437	1.354	1.371
ACP export revenue (mill US$)	331,1	489,5	1.449,0	1.066,7	474,0	1.419,9	1.042,0	458,7	1.392,7	1.019,1	443,1	1.367,4	997,8	444,4	1.343,7	977,9
MFN export revenue (mill US$)	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	3.918,9	3.485,0	3.709,8
LDC export revenue (mill US$)	16,9	289,4	256,2	261,2	274,7	257,4	262,5	276,6	258,5	263,8	278,6	259,6	265,0	287,7	260,6	266,2
Traders' profits (mill US$)		0,0	0,0	0,0	250,1	289,1	282,6	484,1	561,6	548,6	703,6	819,0	799,5	693,0	1.062,4	1.036,4

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 (000 t)	-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 (000 t)	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 (euro)	-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 (000 t)	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 (000 t)	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 (000 t)	-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 (000 t)	-7,1	...	...	...	...	-100,0	-100,0	-100,0	-100,0	-100,0	-100,0	...	...	...	...
USA imports (000 t)	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 (000 t)	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 (000 t)	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 (000 t)	-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 (000 t)	-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 (mill US$)	196,0	199,6	203,6	208,6	202,4	-26,4	-26,6	-26,8	-27,0	-27,2	117,9	119,8	122,2	125,2	120,0
MFN export revenue (mill US$)	-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 (mill US$)	-11,5	-6,3	-6,5	-6,8	-9,4	2,0	2,0	2,1	2,1	2,1	-9,7	-4,4	-4,6	-4,9	-7,5
Traders' profits (mill US$)		15,6	16,0	16,4	53,3		-2,2	-2,3	-2,4	-2,4		13,0	13,3	13,6	49,6
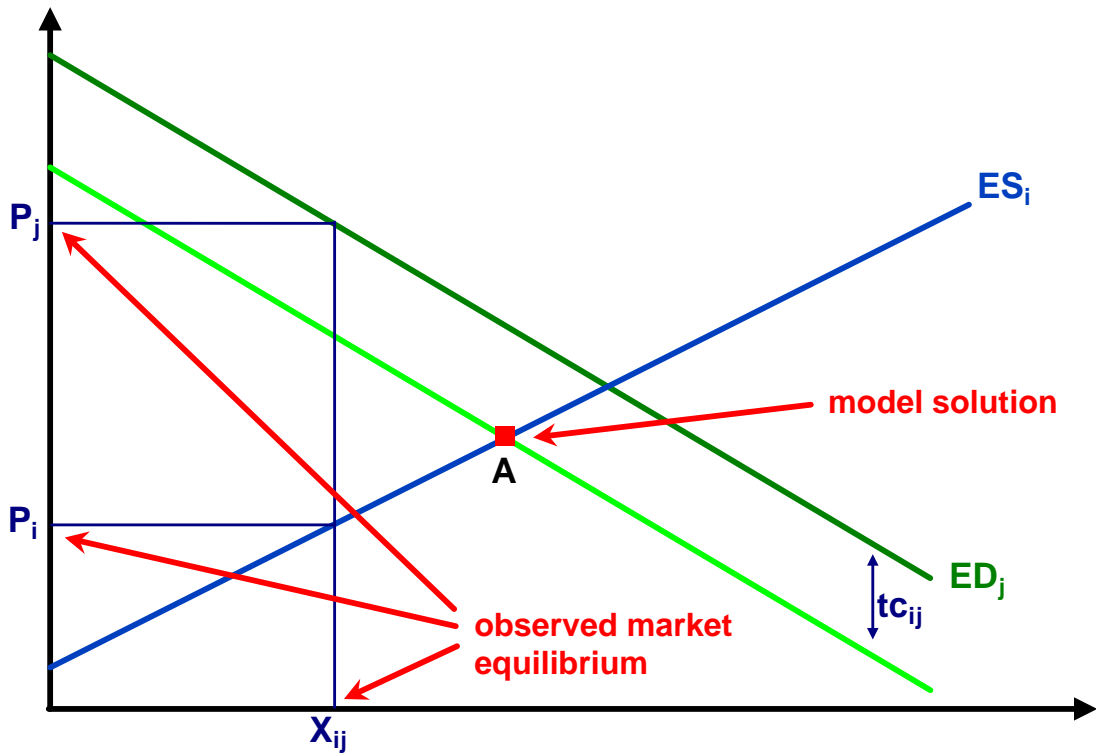
Figure 1 Perfect competition. Observed market equilibrium and uncalibrated model solution.
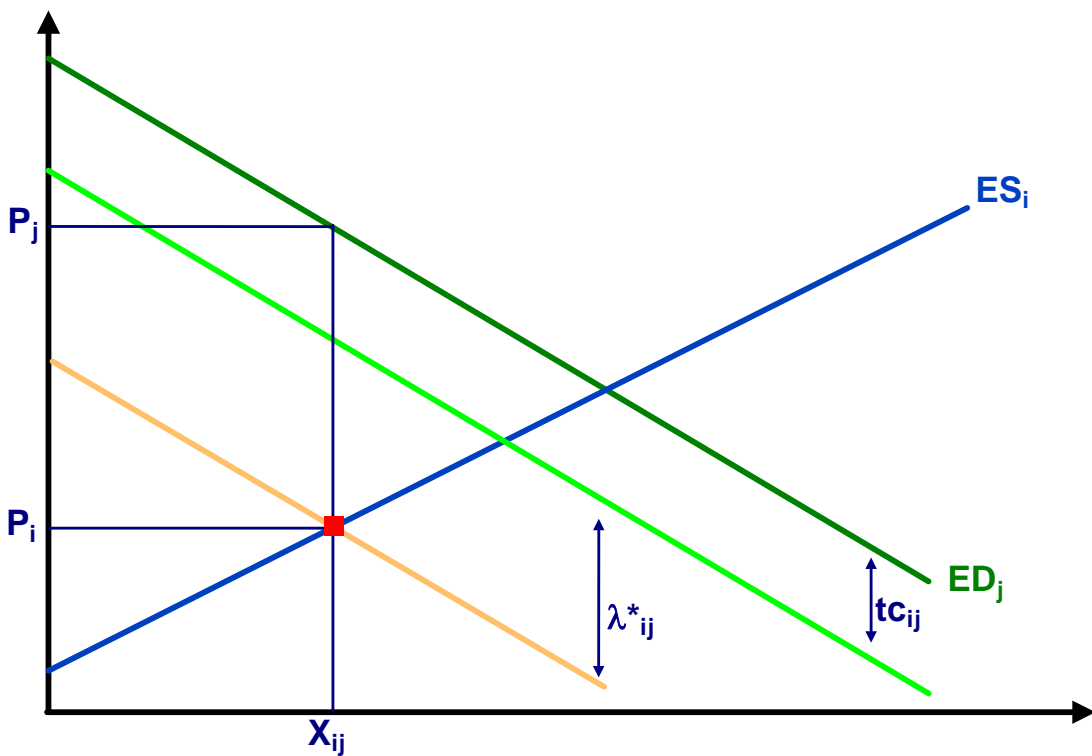

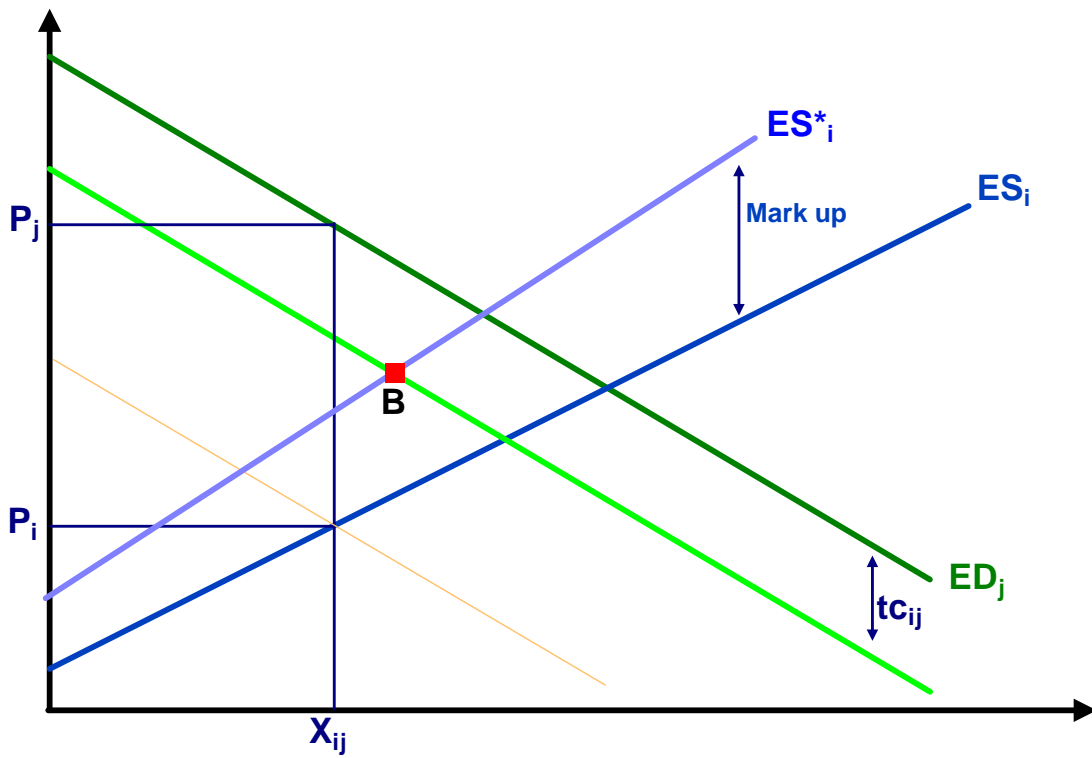Figure 2 Perfect competition. Calibrated model solution.

Figure 3 Imperfect competition, mark-up. Observed market equilibrium and uncalibrated model solution.
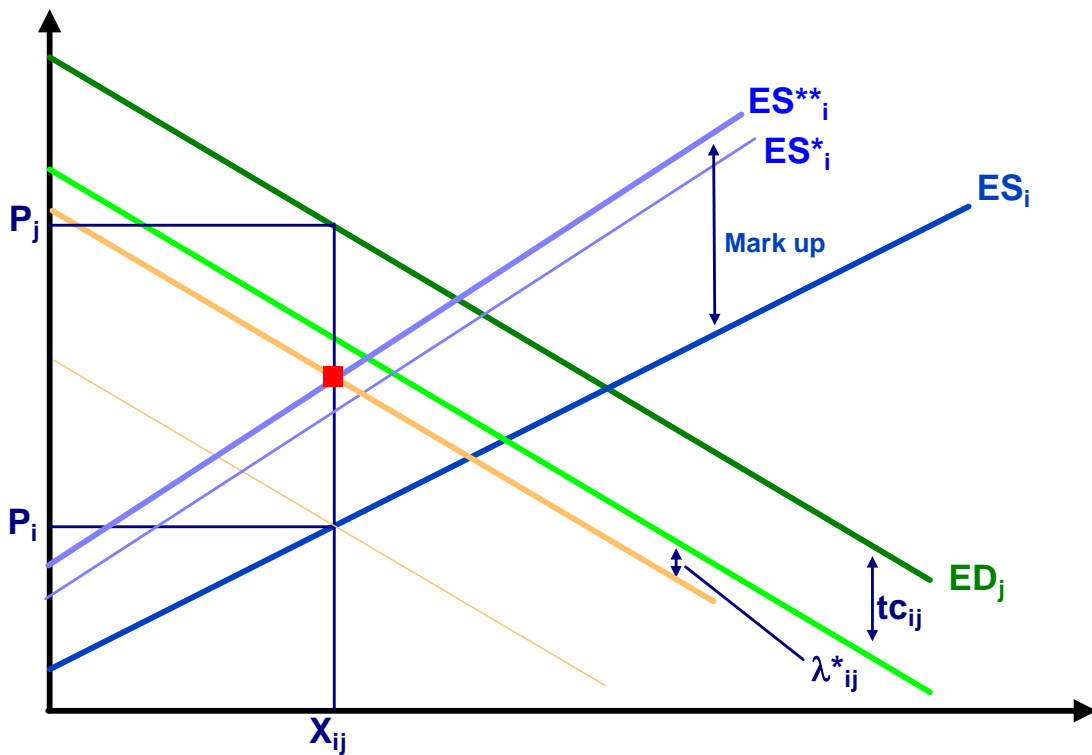

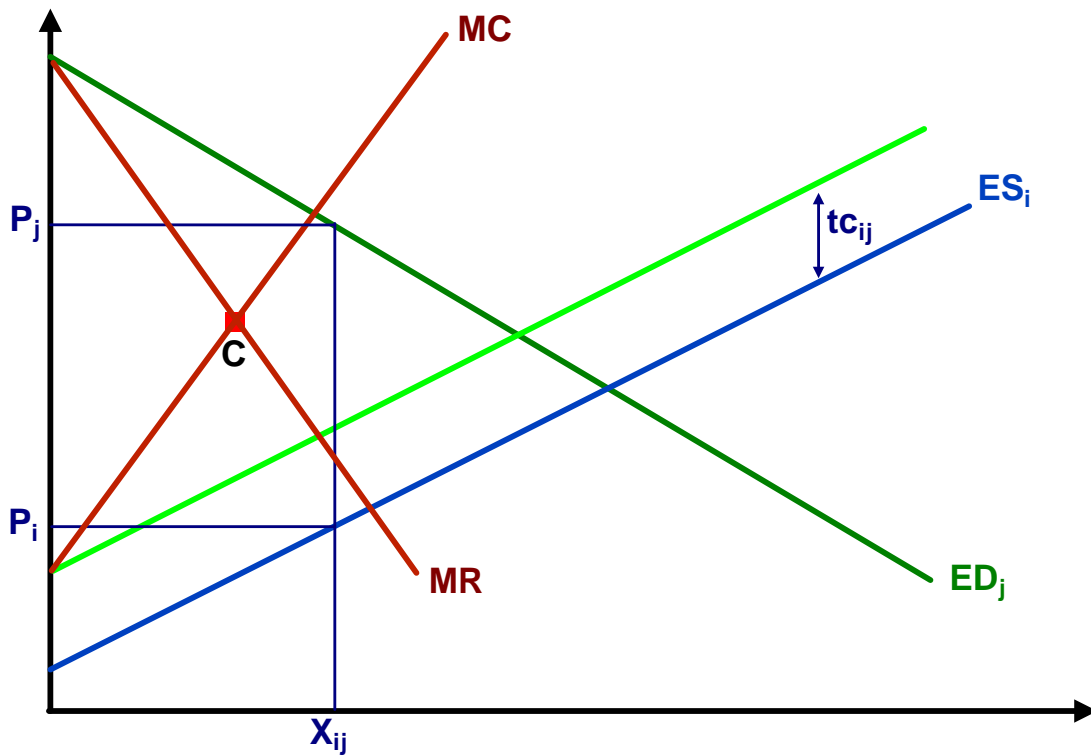Figure 4 Imperfect competition, mark-up. Calibrated model solution.

Figure 5 Imperfect competition, cartel. Observed market equilibrium
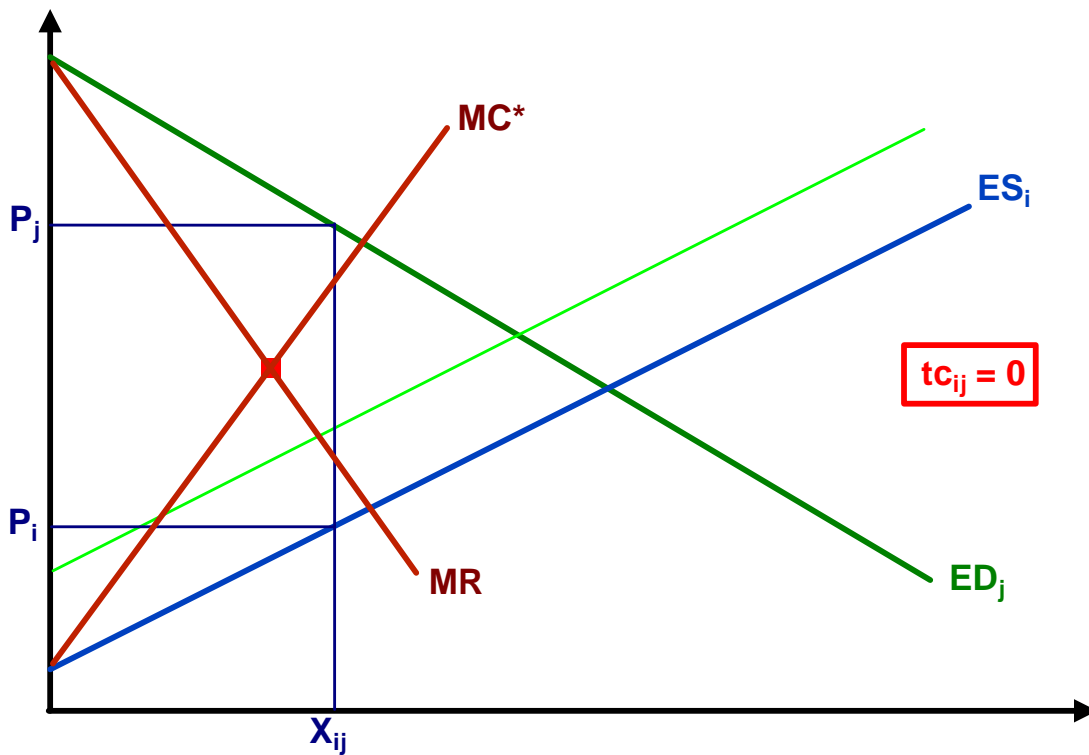and uncalibrated model solution.

Figure 6 Imperfect competition, cartel. Observed market equilibrium and uncalibrated
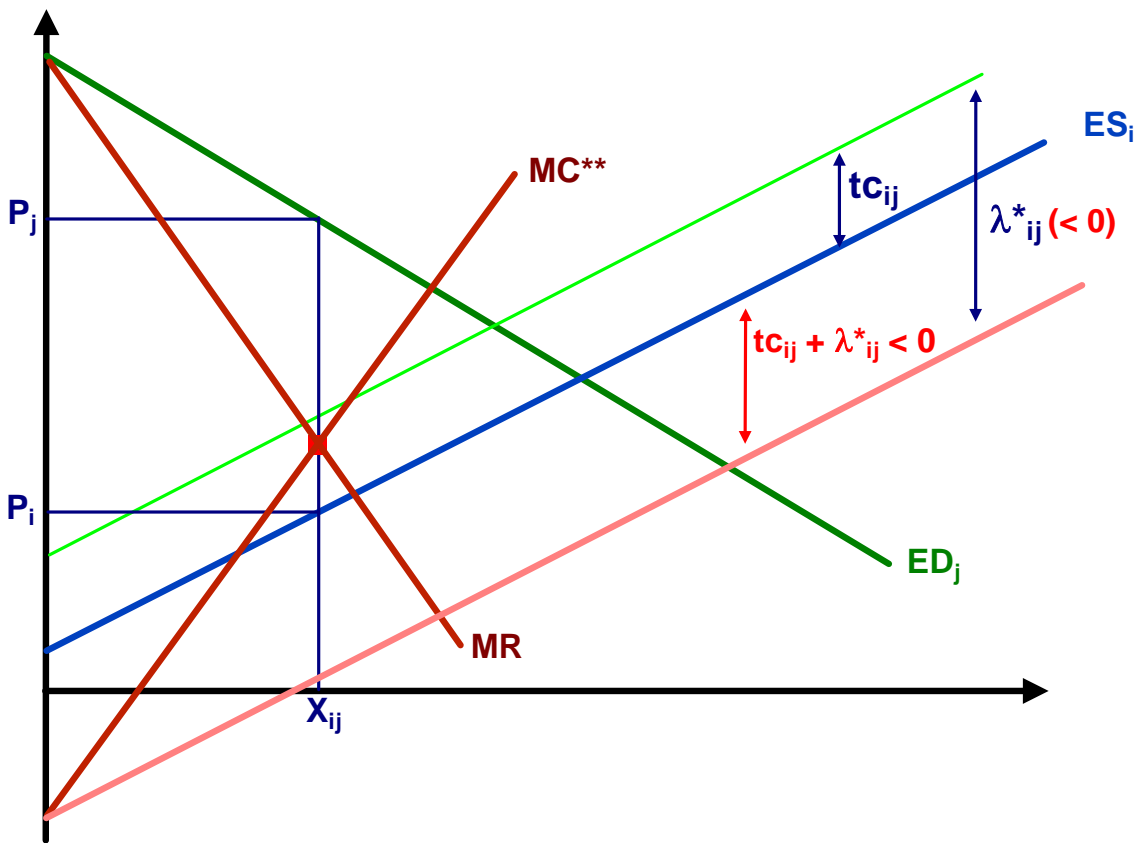model solution with the per unit transaction cost set equal zero.

Figure 7 Imperfect competition, cartel. Calibrated model solution
(the corrected per unit transaction cost calibrating the model is negative).