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Modelling Market Environment Changes in the Horticulture Sector – A Review.

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Summary

The European horticultural sector faces changes in its market environment, such as changes in trade regulations, concentration in the chain-, and environmental concerns. These issues may individually affect the future economic and environmental performance of horticulture. The objective of the present paper is to review partial equilibrium models in terms of their ability to cope with the aforementioned aspects of the horticultural sector. We found that changes in trade regulations are already modelled in a detailed way in horticultural partial equilibrium models. However, chain concentration and environmental concerns are addressed to a much lesser extent in the currently available models.

Key words. partial equilibrium – trade regulations – market concentration – environmental issues – economic models – greenhouse sector

Introduction

The horticultural sector is of great economic importance in the European Union (EU), because of its large value added and many employment opportunities it provides (Bogers 2007). Nowadays, the European greenhouse industry faces many important challenges. These challenges are related to important changes occurring in market conditions, such as reforms in trade policies, the enlargement of the EU, and the increased demand for environmentally friendly and sustainable production. The changes in the market can be categorized into three types: (1) increased international competition arising from a growing global market due to new players and changes in trade regulations; (2) a high level of concentration among retailers and discount chains creating market power and an imperfectly competitive market; and (3) a growing public demand for sustainability and environmental regulations and standards which complicate the production environment for farmers.

Collectively, the three types of changes may individually affect supply, demand and trade patterns in the market. To assess these impacts quantitatively, economic models are important tools. The most commonly used approaches for market level models are based on partial equilibrium (PE), and general equilibrium (GE) methodologies. On the one hand, PE models are used to assess impacts on particular subsections of the economy by assuming that changes affect only certain sectors of the economy. On the other hand, GE models attempt to describe and analyse the entire economic system, capturing not only the direct impact of a policy shock on the relevant market, but also the impact on other parts of the economy and feedback effects from these to the original market (O'Toole and Matthews 2002). In this review, we focus on a small part of the total economy, the horticultural sector.

Although PE models do not account for as many linkages between product groups as GE models do, they can provide a transparent and focused analysis of how a limited number of products are affected by policies or changes in the market. PE models can analyse a wide variety of policies and are an appropriate tool for analysing the effect of the three categories of change facing the horticultural sector. In past decades, modelling economic issues in the horticultural sector resulted in a huge amount of articles. A review of the present state of PE models in the agricultural sector has already been performed (Conforti 2001; Tongeren et al. 2001; Anania 2006; Balkhausen et al. 2008; Pérez Domínguez et al. 2008). However, to our knowledge, a review of the present state of PE models in the horticultural sector has not been made. Therefore, this article attempts to review and summarise the models and approaches to develop a PE horticulture model which is able to cope with the three categories of changes in horticultural markets.

The paper is organized as follows. The next section describes in more detail the three types of change in horticultural markets. This is followed by a review of current PE models which analyse these issues in the horticultural sector or the agricultural sector. The review looks at the assumptions taken, the methodology, and the possible improvements for horticultural PE models. The paper ends with a conclusion and discussion.

Overview of Recent Market Changes in European Horticulture

Trade regulations

The volume and variety of fruit and vegetables traded globally has grown since the 1990s, at an average annual growth rate of 4 % for both imports and exports. This growth is due to a rise in welfare, EU enlargement, improved technology, seasonal variation in production, and the consumer's demand for quality fruits and vegetables (Wu Huang 2004). Fruit and vegetable trade has also grown as a result of trade liberalization and is expected to be fostered even further when an agreement is concluded in the Doha Round. The Doha Round, established by the World Trade Organisation (WTO), set limits on European and national policy freedom in the areas of market access, domestic support and export support. As part of the Doha Round, the EU has offered to reduce tariffs and trade distorting farm subsidies by 60 % and 80 % respectively, and export subsidies will be eliminated altogether (Huige et al. 2010).

Trade policies, regulations and protocols developed at the global level and at the EU level, are applied among other things to protect domestic production. Growing regional and international trade agreements, an increase in negotiated bilateral free trade agreements, and further liberalization has led to lower barriers to trade (Wu Huang 2004). For EU horticulture, the most important (trade) policy and framework is the CAP (Common Agriculture Policy) and its accompanying reformed CMO (Common Market Organisation) for fruit and vegetables. The CAP is an integrated system of measures which combines direct subsidy payments for crops and land. The CAP includes price support mechanisms such as import levies for specified goods imported into the EU, import quotas, 'set-aside' payments, enlarged tariff rate quotas (TRQs), entry price system (EPS), a Single Payment Scheme (SPS), and an internal intervention price. The reformed CMO aims to encourage producers to be more market-oriented. Main CMO trade instruments are the inclusion of fruit and vegetables in the SPS, and including export refunds and EU-financed withdrawals (except for free distribution) (Cec 2007). Trade of fruits, vegetables and ornamentals is further regulated in the Agreement on Sanitary and Phytosanitary Measures (WTO-SPS). This agreement aims to prevent disproportional import criteria and allow the right of every WTO member to set up (temporary) import requirements (Huige et al. 2010).

Concentration among farmers, retailers and discount chains

The food processing and retail industries have become increasingly concentrated in recent years (Sexton and Lavoie 2001; Anders 2005; Wijnands et al. 2006). At the national level of the EU Member States, the four largest food retailers together hold domestic market shares of between 60–80 % (Bunte and Dijkxhoorn 2009). Concentration tends to be higher on the buying side rather than the selling side. The leverage that the retail food industry has over their suppliers has increased through the growth of private labels, their multiproduct nature and their control over shelf space. Moreover, food retailers have integrated backwards in the food supply chain by setting up distribution centres and by selecting fewer suppliers. The food processing industry may be concentrated as well. However, in general, fruit and vegetables processing is less concentrated. Policy makers and industry representatives are increasingly worried that food retailers will use their size to set consumer prices above competitive levels and supplier prices below competitive levels (Murphy 2006). Market power abuse may increase the wedge between grower and consumer prices and lead to a fall in consumer demand and production.

Environmental concerns

The horticulture sector is concerned about global warming and the need to reduce carbon dioxide (CO_2) emissions. Both governments and food retailers have put more stringent requirements on horticultural production. EU and national governments have introduced new regulations and directives, notably with respect to greenhouse gases (GHG) and renewable energy sources. Food retailers have laid down standards such as GLOBALGAP.

Based on agreements reached in Kyoto and the EU, the European Commission has an EU energy policy that seeks a unilateral 30 % reduction of GHG emissions by 2020 (Cec 2009). As part of the EU climate policy, the EU Emission Trading System (EU ETS) was established. The EU ETS is a cap-and-trade system: the cap guarantees the necessary emission reductions, while trading in allowances ensures that the least-cost abatement options are realized. Under the EU ETS, large emitters of CO_2 within the EU must monitor and annually report their CO_2 emissions. Each Member State has its own national registry containing accounts which will hold the allowances traded in the EU ETS. These registries are linked with the European Commission Community transaction log, which record and check every transaction. The EU ETS applies to a limited number of (large) greenhouse horticulture firms.

The EU CAP stimulates the production of renewable energy, and focuses on environmental standards such as biodiversity, nutrients, pesticides, water management and climate change. Environmental concerns have received more attention in the CAP. With cross-compliance in the current Single Payment Scheme, environmental objectives have attracted more attention. Both the CAP and CMO for fruit and vegetables embrace a cross compliance mechanism. Cross-compliance includes statutory management requirements (e.g. standards in the field of environment, food safety, animal and plant health) and good agricultural and environmental conditions (e.g. standards related to soil protection, maintenance of soil organic matter and structure, and water management). Under the WTO, SPS measures are imposed to protect plant health against plant pests, to facilitate more sustainable production, and the sale and use of pesticides are monitored.

EU regulations and directives to diffuse water pollution are the EU's Nitrate Directive and the Water Framework Directive. The Nitrate Directive aims to reduce water pollution from nitrates from agricultural sources, and to prevent further pollution. Under the Nitrate Directive, EU Member States must monitor water quality, establish measures of good agricultural practice, as well as measures to limit the application of any nitrogenous fertilisers (Brouwer and Silvis 2010). The Water Frame-

work Directive (WFD) aims that each Member State prevents and reduces pollution, promotes sustainable water use, protects the aquatic environment and mitigates the effects of floods and droughts (Brouwer and Silvis 2010).

In addition to EU regulations, at the firm level, several private standards exist such as GLOBALGAP and the British Retail Consortium (BRC) Standards (Fulponi 2007). The GLOBALGAP standard is designed to maintain consumer confidence in food quality and food safety. Other important goals are to minimize detrimental environmental impacts of farming operations, optimize the use of inputs and to ensure a responsible approach to worker health and safety. The BRC standards are designed to assess retail suppliers.

Review PE models

This section reviews how the impact of the three main issues on production and trade in horticulture (i.e. trade regulations, concentration within the chain, and environmental issues) are currently modelled in PE models. To identify windows for improvement, horticultural PE models are compared with agricultural PE models. A PE analysis is defined as an analysis that analyses how demand and supply in each market determine the equilibrium price and quantity in that market, independently of other markets (Salvatore 1991). A PE model describes the market as a sum of individual demand and supply functions, a set of aggregate behaviour of both consumers and producers, and includes a set of identities which model the relationships between activities (Conforti 2001). In a PE model, assumptions refer to the competitive nature of the market, the homogeneity of products, bilateral trade versus pooled trade relations, and static versus dynamic demand and supply relations. Bilateral relations are a set of interactions between each buyer and seller of the commodity. A comparative PE model can be either static or dynamic. Comparative static models compare two different outcomes (before and after a change), while a dynamic PE model studies the changes over time, which shows the long-run impacts of various policy measures. Comparative static models give more detailed outcomes of the impacts in the short-run.

Trade regulations

Twenty-one PE models were found to consider trade regulations (Table 1). Ten PE models focused on products in the horticultural sector and the other eleven PE models focused on the agricultural sector. Parameters and impacts of trade measures for fruit and vegetables such as entry prices and tariff quotas are product-specific. For this reason, most analyses of trade policies for fruit and vegetables refer to one product. The choice of a single product model is legitimate, given the fact that trade policies are product-specific. However, product-specific models do not account of substitution or complementarity between products, an aspect which is taken into account in multi-product models. The agricultural PE models reviewed in this study, deal with multiple products. However, only four out of ten horticultural PE models can be characterised as multi-product models (Málaga et al. 2001; Kavallari and Schmitz 2007; Agrosynergie 2008; Bunte and Kuiper 2008). Bananas and tomatoes are the products that were most frequently considered in horticultural PE models. These products are characterised by a high consumer demand and are subject to specific trade regulations (i.e. former CMO for bananas and US-Mexico trade (NAFTA)).

EU trade policy affects imports and exports of all its Member States, which may influence the comparative advantage of the individual countries. For this reason, analyses of EU trade policies should include the EU as scope of region and differentiate for each Member State. All reviewed horticultural PE models dealt with a multi-country specification, whereas most of the agricultural PE models had a limited country range. Only two of the eleven agricultural PE models included a multi-country specification (Chantreuil et al. 2005; Von Ledebur et al. 2005). Multi-country PE models allow for a more detailed representation of trade by including bilateral trade relations. According to Anania (2001), bilateral relations improve the realism, accuracy and detail of trade policy. Five horticultural PE models considered bilateral relations (Guyomard and Le Mouël 2003; Vanzetti et al. 2005; Anania 2006; Rickard and Sumner 2006; Garcia-Alvarez Coque et al. 2009), whereas only two agricultural PE models included these relations (Ali 2008; Nolte 2008).

Models distinguishing bilateral trade may recognize product heterogeneity, product as imperfect substitutes, with respect to the country-of-origin. Of the five horticultural PE models which included bilateral trade relations, four horticultural PE models specified a product from different countries as imperfect substitutes (Vanzetti et al. 2005; Rickard and Sumner 2006, 2008; Bunte and Kuiper 2008; Garcia-Alvarez Coque et al. 2009). Using the assumption of imperfect substitutes, a country can act both as an importer and exporter of products. This approach yields more detailed and realistic results rather than assuming homogeneity of products. The appropriateness of the assumption of static rather than dynamic modelling depends on the time horizon of the policy. Dynamic modelling was applied by only one horticultural PE model (Málaga et al. 2001). This is different from the agricultural PE models, where eight of the eleven models considered dynamics. However, the modelling issues (i.e. CAP Reform, liberalization and access) of these models may have asked for results in the long term.

PE models can use econometrically estimated or calibrated parameters. Econometrically estimated parameters are based on observations, while calibrated parameters are based on benchmark data and theory. Econometric estimation of key behavioural parameters is preferred because it uses a larger amount of data. Given the lack of horticultural data (and over time), this is generally not feasible. From the ten horticultural PE models, two models used econometrically estimated parameters (Padilla-Bernal and Thilmany 2000; Málaga et al. 2001), whereas seven out of the eleven agricultural PE models included econometrically estimated parameters (Mizzi 1993; Chantreuil et al. 2005; Von Ledebur et al. 2005; Gravilescu et al. 2006; Gracia et al. 2008; Nolte 2008; Tabeau and Van Leeuwen 2008).

In summary, current horticultural PE models are well developed in modelling policy specific details of trade regulations such as tariff reduction and quotas, as well as the enlargement of the EU. Shortcomings of the current

Table 1. PE reviewed models dealing with trade regulations.

Product[1)]	Modelling issue	Assumption[2)]				Scope of region[3)]	Source
Horticultural sector							
Bananas	Quotas and tariff levels (old/new banana regime)	ni	C	B		EU25, ACP, L-America, ROW	Guyomard and Le Mouël (2003)
Tomatoes	TRQs, MFN, entry prices, tariff reduction	I	C	B		EU, Morocco, ROW	Garcia-Alvarez Coque et al. (2009)
Bananas	Tariff reduction	I	C	B		Twenty regions; e.g. EU, ACP	Vanzetti et al. (2005)
Processed tomato	Tariff reduction & EU domestic support	I	ni	B		EU, US and ROW	Rickard and Sumner (2006; 2008)
Fresh tomatoes	Tariff Reduction	ni			E	US and Mexico	Padilla-Bernal and Thilmany (2000)
Bananas	EU enlargement, different exchange rate (WTO)	H	ni	B		EU27, USA, ACP, ROW	Anania (2006)
Tomato, cucumber, pepper, squad, onion	Trade liberalization: change in exchange rates	H	D		E	US and Mexico	Málaga et al. (2001)
Grape, cucumber, tomato, clementine	CMO (EPS)	H	C			EU25	Agrosynergie (2008)
Floriculture	VAT	I	C			EU12	Bunte and Kuiper (2008)
Agricultural sector							
	CAP reform (quota, SPS, reduction payments)	H	D		E	Netherlands	Tabeau and Van Leeuwen (2008)
	CAP reform (intervention price, reduction payment)	H	D		E	EU15	Chantreuil et al. (2005)
	CAP Reform	ni	D		E	Spain	Casado and Gracia (2005)
Arable crop	CAP (SPS)	ni	D		E	Spain	Gracia et al. (2008)
Wheat, barley, sunflower, maize	CAP (SPS)	H	D		E	Romania	Gravilescu et al. (2006)
16 commodities (e.g fruit, wheat)	EU enlargement, unilateral + multilateral liberalization	H	C			EU Member States	Kavallari and Schmitz (2007)
Beef dairy	WTO restrictions	H	D			Ireland	Binfield et al. (2009)
8 products (e.g fruit, meat, dairy)	EU enlargement, participation CAP	H	C		E	Malta	Mizzi (1993)
Sugar	Free access tariff reduction, EU liberalizations	H	D	B	E	EU27 + >100 regions	Nolte (2008)
Feed, livestock	EU-Accession	H	C			Macedonia	Pelling (2007)
Dairy, meat	Tariff reduction and WTO	H	D	B		Switserland	Ali (2008)
Beef, dairy	Intervention price	H	C		E	EU	Von Ledebur et al. (2005)

[1)]If other than agricultural sector
[2)]H=homogeneous goods; I=imperfect substitutes; D=dynamic model; C=comparative static model; E=econometric model; B=bilateral relations; ni=no information
[3)]ROW=rest of the world; ACP=Africa, Caribbean and Pacific regions

horticultural PE models are the multi-product range, commodities as imperfect substitutes and the use of bilateral trade flows and econometric parameters.

Concentration among farmers, retailers and discount chains

In this review, nine PE models were found to consider concentration among farmers and especially among food retailers (Table 2). Four PE models focused on products in the horticultural sector and the other five PE models focused on the agricultural sector. Agricultural commodities are traded worldwide, but due to differences in consumer preferences with respect to taste, packaging and consumer characteristics in terms of culture and language, final consumer products differ between national markets. Most current PE analyses rightly involve only one country, whereas only two agricultural PE models include a multi-country specification (Sckokai and Soregaroli 2008; Song et al. 2009).

When assessing retail market power, it is important to decide upon the number of products to include in the analysis. Retailers do not sell tomatoes or fruit, but sell a wide variety of groceries. Analyses focusing on one or a

Table 2. PE reviewed models dealing with different market structures.

Product	Level[1)]	Modelling issue	Assumption[2)]			Scope of region	Source
Horticultural sector							
Fresh tomato	R	Oligopoly/oligopsony	I	C		France	Réquillart et al. (2008)
Fresh tomato	P/R	Monopoly and monopsony	H	D	E	Israel	Melnick and Shalit (1985)
Processed tomato	P	Monopsony and oligopsony	H		E	California	Just and Chern (1980)
Banana	R	Oligopoly and perfect competition	H		E	Turkey	Hatirli et al. (2003)
Agricultural sector							
Cereal	R	Monopoly, perfect competition	H/I	D	E	fictive 2 countries	Sckokai and Soregaroli (2008)
Beef and dairy	P/R	Oligopsony slaughtering firms, retailer oligopoly	H/I*			Italy	Moro et al. (2002)
food industry	F/R	retailer oligopoly, manufacturer oligopsony	H			fictive single country	Sexton and Zhang (2001)
soybean	F/R	Monopsony/oligopoly	H	D		US & China	Song et al. (2009)
Dairy, meat, other	R/W	Oligopoly/oligopsony	H		E	France	Gohin and Guyomard (2000)

1)P=farm/processing level; W=wholesale level; R=retail level
2)H=homogeneous goods; I=imperfect substitutes; D=dynamic model; C=comparative static model; E=econometric model; H/I homogeneous assumption beef, imperfect substitutes dairy;
* homogeneous assumption domestic farms, imperfect substitute's trade

limited number of products may be misleading. The literature provided both single-product (Just and Chern 1980; Melnick and Shalit 1985; Sckokai and Soregaroli 2008; Réquillart et al. 2008; Song et al. 2009) and multi-product specifications (Gohin and Guyomard 2000; Sexton and Zhang 2001; Moro et al. 2002).

Related to product choice is the question on how to deal with product differentiation. Retail pricing takes differences in consumer willingness to pay (and price elasticities) into account when deciding upon prices and on which varieties to obtain retail margins. One horticultural PE model dealt with a product as an imperfect substitute (Réquillart et al. 2008). Two of the agricultural PE models considered products as homogeneous and as imperfect substitutes (Moro et al. 2002; Sckokai and Soregaroli 2008).

When analysing the effect of market power a comparative static model is more appropriate (Réquillart et al. 2008). One is interested in the difference between the situation with and without market power. To estimate structural price relations, one may take into account price dynamics in their model, like Melnick and Shalit (1985); Sckokai and Soregaroli (2008); and Song et al. (2009).

In summary, current horticultural PE models are relatively well-suited for modelling concentration in the food retail sector. However, in the horticulture sector competition mainly occurs at the retail level or at wholesale level. The latter is not analyzed yet in any current horticultural PE models. Other shortcomings in these current horticultural PE models are the multi-region and multi-product specifications.

Environmental concerns

Although energy use and its related CO_2 emissions are among the most important environmental concerns related to horticulture, only one current European (Dutch) PE model for horticulture dealt with energy (Bunte and Van Galen 2005; Table 3).

The other two horticultural PE models dealt with fertilizer use in the US (Roosen 2001) and pest invasion in the Netherlands (Surkov et al. 2009). They do not analyze major environmental issues such as emissions of GHGs and the more environmentally friendly use of pesticides, water and nutrients. On the other hand, there were several agricultural PE models considering environmental issues, such as renewable energy sources and greenhouse gas emissions. However, in the horticultural sector, biofuels are used for heating greenhouses. In the agricultural sector, biofuel is mainly used as an economic alternative to other energy sources. As a consequence, agricultural PE models focused mainly on differences in subsidies and prices, and transport usage. Other environmental effects such as the use of water and pesticides are not modelled yet in the current PE models.

Changes in the prices of energy and CO_2 not only affect the international competitiveness of the Dutch greenhouse industry with respect to countries outside Europe, but also with respect to the Southern Member States (e.g. Spain). A shift of production to Southern Europe and developing countries outside Europe could reduce global CO_2 emissions and increase the efficiency of production (Bunte and Dijkxhoorn 2009). As a result, energy policy will promote Mediterranean horticultural production to the detriment of North-European products. Due to the fact that environmental policy may have an impact on the comparative advantage of countries with respect to horticultural production, PE models should consider a multi-country specification. Two horticultural PE models (Bunte and Van Galen 2005; Surkov et al. 2009) include a multi-country range but focus in their analysis on one country (i.e. Netherlands). The role and importance of the geographical region is further underrepresented in the current horticultural PE models

Table 3. PE reviewed models dealing with sustainability and environment.

Product[1)]	Modelling issue	Assumption[2)]			Scope of region[3)]	Source
Horticultural sector						
Fruit, vegetables, ornamentals	Energy prices	H	C	B	EU25, Morocco, Turkey, ROW	Bunte and Van Galen (2005)
Apples	Fertilizer use	H	D		US	Roosen (2001)
Chrysanthemum	Pest damage	H	D	ni	Netherlands, ROW	Surkov et al. (2009)
Agricultural sector						
	Biomass subsidy, electricity & carbon tax	H	C		Poland	Ignaciuk et al. (2006)
Grains, oilseeds, livestock, dairy	Biofuels	H	D		EU	Binfield et al. (2008)
Potato	Quarantine diseases	H	C	P	EU, ROW	Breukers et al. (2008)
	Energy prices	H	C	P	EU27	Kempen and Kraenzlein (2008)
Dairy	GHG	I	C	B	18 countries; e.g Australia, EU, US, New Zealand	Saunders and Wreford (2005)
Food and bioenergy	Biofuels	I	C	B	EU, Saharan Africa, ROW	Schneider et al. (2008)
	GHG	H	D		Ireland	Donnelan et al. (2009)
	Biofuels	H	D		US	Hayes et al. (2009)
	Biofuels	H	D	P	13 regions e.g. US, EU, Brazil, ROW	Peters et al. (2009)

[1)]If other than agricultural sector
[2)]H=homogeneous goods; I=imperfect substitutes; D=dynamic model; C=comparative static model; B=bilateral market; P=pooled market; ni=no information
[3)]ROW=Rest of the World (aggregated group)

(Roosen 2001). Five agricultural PE models analysed different countries. Two of these (Saunders and Wreford 2005; Schneider et al. 2008) considered bilateral relations, where the other three models (Breukers et al. 2008; Kempen and Kraenzlein 2008; Peters et al. 2009) considered the relations as a pooled group. One of the horticultural PE models dealt with bilateral relations (Bunte and Van Galen 2005), in line with their regional scope.

An important characteristic of the Dutch greenhouse industry is the fact that firms are both energy producers and consumers. This characteristic calls for modelling products of countries as imperfect substitutes rather than assuming homogeneity. From the current PE models, two agricultural PE models (Saunders and Wreford 2005; Schneider et al. 2008) considered products as imperfect substitutes.

Conclusion and Discussion

This paper reviewed existing horticultural PE models which analyze trade regulations, concentration in the chain and environmental concerns. Our review provided insight in their strengths and weaknesses and identified gaps in currently available models requiring further research. It appeared that horticultural PE models which focus on trade regulations are better represented than models focusing on market concentration and environmental concerns.

Trade regulations

Trade regulations and the enlargement of the EU were more widely considered by the horticultural PE models rather than by agricultural PE models. The current policy environment requires PE models to be sensitive to changes in policies at the European level and therefore cover a wide range of countries. The currently available horticultural PE models satisfy this requirement. However, most of the currently available horticultural PE models are product-specific and do not pay attention to substitution or complementarity with other horticultural or agricultural products. Both from a welfare, economic and policy perspective, however, including multiple products is important. The analysis of EU enlargement and trade regulations also depends on the assumptions of commodities as imperfect substitutes, the use of econometric estimations and the use of bilateral trade flows. The use of econometric estimated parameters is underrepresented in currently available horticultural PE models, while this improves the realism, accuracy and detail of the representation of a trade policy. Given the prospect of upcoming trade negotiations, modelling bilateral flows should account for bilateral measures and tariff quotas. Moreover, a PE model which analyses trade regulations should account for seasonality of supply and demand. Nowadays, consumers' demand for year-round fresh fruit and vegetables is increasing. This means that horticultural products may be traded all year-round, resulting in differences in the input demand and output supply throughout the year.

Concentration within the chain

In a market-oriented environment, such as the Dutch greenhouse sector, any intervention at firm level will be transmitted to final consumers, and a complete picture of a policy change, therefore, calls for modelling multiple levels of the chain. Likewise, changes in consumer demand and retailers' buying and marketing policies impact production and trade in horticulture. In principle, both aspects can be dealt with in an one-product, one-country model. This kind of model, however, neglect cross-subsidies and do not correctly represent product substitution and competition between countries. Both retailers and consumers are interested in a variety of products. Modelling multiple products in a multi-country setting is therefore desirable. Currently available horticultural PE models do not satisfy the multi-country and multi-product criterion. Another major shortcoming in the currently available PE models is that they estimate the gap between prices and marginal costs, but do not relate the profit margin to such explanatory variables as market concentration. A specific issue in modelling imperfections in supply chain pricing, is the occurrence of asymmetric price adjustment. Asymmetric adjustment refers to the fact that increases in costs are transferred to the final consumers more rapidly, than input price declines at farm level. The magnitude of adjustments to market shocks may cause policy implications, such as price support policies. Future PE models may incorporate this prospect.

Environmental concerns

Incorporating environmental issues is a white spot in horticultural PE models. These models may play a role in meeting future demand for quantitative impact assessments. In Northern Europe, and more specifically the Dutch greenhouse industry, environmental (energy) policies affect horticulture's competitiveness. Southern Europe is likely to face more stringent demands with respect to the use of water and pesticides. To reflect the differential impacts of environmental policies, future horticulture PE models should be region-specific. Incorporating environmental issues in PE models requires a respecification of supply and demand relations through: (1) a multi-regional range; (2) the use of bilateral trade flows; and (3) the consideration of goods as imperfect substitutes. For example, trade in CO_2 emission rights following from the implementation of the ETS requires a specification of bilateral trade flows. Allowing for imperfect substitution is important where countries supply and consume energy.

In summary, modelling environmental concerns received the least attention in currently available horticultural PE models (Table 4) and yet, these concerns are subject today to new regulations and public demand. Concentration within the chain is only weakly reflected in current PE models. Accounting for market concentration is important as the perceived increasing market power of food retailers is a major concern for actors in the chain and public bodies. Trade regulations are well represented in the current horticultural PE models, as the horticultural sector has been subject to trade regulations for more than fifteen years.

As a result, future horticultural PE models should be developed in such a way that they can be used for modelling market changes for multiple horticultural commodities, provided that the data are adapted to the particular commodity. An improved model of the impact of trade policy changes and EU enlargement, concentration within the chain and environmental concerns, calls for the development of multi-product models in multiple countries that consider products as imperfect substitutes and uses bilateral trade flows and econometric estimations. A multi-country multi-product PE model is a PE model extended vertically or horizontally to include other markets. Multi-market models offer more accurate ex ante impact analysis than single-market models by including possibly indirect effects such as substitution and complementarity between commodities.

Future PE models would benefit from explicitly addressing seasonality. However, a limitation in addressing the discussed issues in future horticultural PE models is the availability of quantitative data from actors throughout the whole chain.

Table 4. Current state and desirable future specifications of horticultural PE models.

	Trade regulations		Market concentration		Environmental issues	
Specifications	Current[1)]	Future[2)]	Current	Future	Current	Future
Multi product	+/−	P1[3]	−	P1	+/−	x
Imperfect substitutes	+/−	P3	+/−	P3	−	P3
Dynamics	+/−	ni	+/−	ni	+/−	ni
Bilateral trade flows	+	x	np	ni	−	P2
Econometric estimation	+/−	P2	+	x	ni	x
Multi country	+	x	−	P2	+/−	P1
More levels of the chain			+/−	x		

[1)]The current state of the specification: −=not included in current horticultural PE models; +/−=underrepresented in current horticultural PE models; +=represented in majority of current horticultural PE models; np=not present in current horticultural PE models

[2)]The desirable future specifications: x=desirable to include in future horticultural PE model; ni=no information if this assumption is more desirable in future horticultural PE models

[3)]Priority specifications to include in future horticultural PE models; P1=first priority; P2=second priority; P3=third priority

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