Peeling tomato paste subsidies

The impact of a revision of the CMO for processing tomatoes on European horticulture

Frank Bunte
Pim Roza

Project code 4044900

January 2007

Report 6.07.01

LEI, The Hague

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Peeling tomato paste subsidies; The impact of a revision of the CMO for processing tomatoes on European horticulture
Bunte, F. and P. Roza
The Hague, LEI, 2007
Report 6.07.01; ISBN/EAN: 978-90-8615-124-0
Price €14 (including 6% VAT)
50 pp., fig., tab., app.

This report evaluates the effects of a possible reform of the Common Market Organisation for processing tomatoes on production and trade of fruits and vegetables in Europe. The report describes the processing tomato supply chain and EU policy since 1978 and analyses the effects of possible reforms of EU policy using the HORTUS simulation model.

Orders:
Phone: 31.70.3358330
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Preface

The Common Market Organisation for fruits and vegetables is currently under review. In the fruit and vegetables sector, crops for the processing industry are heavily subsidised. This also holds for processing tomatoes for which the subsidies amount to 50% of the production value. In the framework of the current evaluation, the European Commission considers reducing and decoupling the subsidies for processing tomatoes. This report may give a contribution to the discussion by considering two scenarios for reform: abolishing the production subsidy and replacing the subsidy by area payments.

The Dutch Ministry of Agriculture, Nature Management and Food Quality requested LEI to perform the research on which this report is based. This report has been made by Frank Bunte and Pim Roza using LEI's simulation model for fruits and vegetables HORTUS. The researchers are grateful to Gerrit Meester and Raymond Tans (Ministry of Agriculture) for their comments. They are also grateful to professor Gabriele Canali (University of Cremona, Italy) who commented on an earlier version of this report.

Dr. J.C. Blom
Director General LEI B.V.

Summary

The Common Market Organisation (CMO) for processed fruit and vegetable products is currently evaluated by the European Commission. The evaluation may lead to a reform of the CMO. Within the framework of the evaluation and the possible reform by the European Union, the Dutch Ministry of Agriculture, Nature Management and Food Quality called upon LEI to evaluate the CMO for processing tomatoes. Currently, the production of processing tomatoes is subsidised with a 34.50 euro subsidy per tonne. The Ministry of Agriculture is interested in the impact the reform of the production subsidy may have on production and trade patterns of fresh and processing tomatoes as well as other fruits and vegetables. The CMO for processing tomatoes is laid down in EC Regulation nr 2201/96. In 2001 the regulation was adapted for the last time.

The processing tomato supply chain is a large sector in the Mediterranean countries and to a lesser extent in new member economies such as Poland and Hungary. The European tomato processing industry processed more than 11,000,000 tonnes of raw tomatoes in 2004. Italy is by far the most important producer of processed tomatoes in Europe with a 53% share of European production followed by Spain (22%) and Portugal and Greece (10% each). The production of processing tomatoes still grows fast, notably in Spain and Italy. Processing tomatoes are produced on relatively large farms specialised in extensive production of arable crops and vegetables.

The CMO for processing tomatoes goes back to 1978 and has been reformed in 2001. Under the 1978 regime, growers were subsidised through the processing industry. From 2001 onwards, growers are subsidised directly. The subsidies involved in the support of the processing tomato supply chain are substantial: a budget of 300 million euro amounting to 50% of producer turnover. Both the 1978 and the 2001 subsidy schemes are associated with substantial overproduction. Actual expenses in 2005/06 and 2006/07 (380 and 360 million euro respectively) exceed the EU budget by far. The 2001 subsidy regime spurred concentration at the processing level except for Italy.

This report analyses two possible reforms of the processing tomato supply chain: (I) the abolishment of the production subsidy for processing tomatoes; and (II) the abolishment of the production subsidy plus the introduction of a compensating area payment. The area payments are assumed to prescribe the allocation of some land to processing tomatoes in order to prevent unfair competition with growers of other vegetables, fruits and arable crops. Scenario I comes to the following conclusions:

- the reduction in the production subsidy is likely to be passed through into higher input prices for tomato processors. Input prices may rise with almost fifty percent. Grower prices will decrease to some extent (0-2%);
- production of European processing tomatoes will fall by 15% in Greece, Portugal and Spain and by 36.5% in export-oriented Italy given the price elasticities chosen. The fall in production may be compensated by the current growth in the demand for processing tomatoes;

- Mediterranean farmers will switch from processing tomatoes and other extensively produced crops towards fruits and fruit vegetables. Note that this result contrasts and complements the agronomic perspective posited above;
- in North-European markets, Mediterranean fruit exporters crowd out domestic producers and other exporters. As a result, North European growers switch from fruit to vegetables production. This also holds for the Netherlands.

If the abolishment of the production subsidy is compensated by area payments, the above results change into the following results:

- grower prices fall substantially. Area payments create a divergence between land and output developments in the Mediterranean. Demand for and - as a result - supply of processing tomatoes fall more sharply than land allocated to processing tomatoes. The area allocated to processing tomatoes decreases by 10-15%; production of processing tomatoes diminishes by 12-20%. Growers of processing tomatoes produce more extensively and thereby reduce capital and labour input. Grower prices fall with production costs due to sharp price competition;
- mediterranean growers switch to vegetables in the open (and probably also to arable crops). They also switch to some extent to fruits and fruit vegetables. North European production is hardly influenced.

1. Introduction

The Common Market Organisation (CMO) for fruit and vegetable products is currently evaluated by the European Commission. The evaluation may lead to a reform of the CMO, among other things in order to meet (future) WTO[1] requirements. The CMO for fruits and vegetables makes a distinction between fresh and processed fruits and vegetables. For fresh fruits and vegetables, the European Union actively reduces its role with respect to market withdrawals of temporary oversupply and actively supports producer organisations to set up market driven and environmentally friendly supply chains. For processed fruits and vegetables, the European Union actively supports European production through production subsidies for tomatoes, peaches, pears and citrus. There is also an active support programme for fresh bananas and citrus.

Within the framework of the evaluation and the possible reform by the European Union, the Dutch Ministry of Agriculture, Nature Management and Food Quality called upon LEI to evaluate the CMO for processing tomatoes. More in particular, the Ministry of Agriculture is interested in the impact the reform of the production subsidy for processing tomatoes may have on production and trade patterns of fruits and vegetables in Europe. For the Netherlands, this interest refers primarily to the impact on fresh tomatoes. The CMO for processing tomatoes is laid down in EC Regulation nr 2201/96. In 2001 the regulation was adapted for the last time. In December 2006, the European Commission is expected to lay down the evaluation of current policy for the processing tomato supply chain and the possible reform of this policy.

This report evaluates the current CMO for processing tomatoes as well as the effects of the following changes in the CMO: the abolishment of the production subsidy and the introduction of area payments (decoupling). The analysis of the effects of changes in the subsidy scheme focuses on the impact the reform may have on the production and trade pattern of fruits and vegetables in Europe. The effects are analysed using HORTUS: LEI's partial equilibrium model for the European fruits and vegetables sector. In the simulations carried out, HORTUS analyses whether Mediterranean growers switch from processing tomatoes to other crops and what effect the increase in Mediterranean production of these other crops may have on North European production of fruits and vegetables.

This report is constructed as follows. Chapter 2 describes the tomato processing supply chain and evaluates the current CMO for processing tomatoes. Chapter 3 estimates the substitution elasticities employed in the simulation analysis. Chapter 4 presents the results of the simulation analysis. Chapter 5 concludes.

[1] World Trade Organisation.

2. The European processing tomato sector

The European Union pursues an active policy for the processing tomato supply chain since 1978. From 1978 to 2000, the EU subsidised the tomato processing industry through a quota system provided the industry paid minimum prices to growers. Since 2000, the EU pays production subsidies directly to producer organisations of processing tomatoes. This Chapter describes and evaluates the European processing tomato sector (section 2.1); and the past and current CMO for processing tomatoes (section 2.2).

2.1 The European supply chain

The European tomato processing industry processed 11,380,100 tonnes of raw tomatoes in 2004. Italy is by far the most important producer of processed tomatoes in Europe with a 53% share of European production followed by Spain (22%) and Portugal and Greece (10% each). Other minor producers include France and some of the new member countries, in particular Hungary and Poland. The main products of the tomato processing industry are tomato paste (65%) and canned whole peeled tomatoes (27%). Canned tomatoes are almost exclusively produced in South Italy.

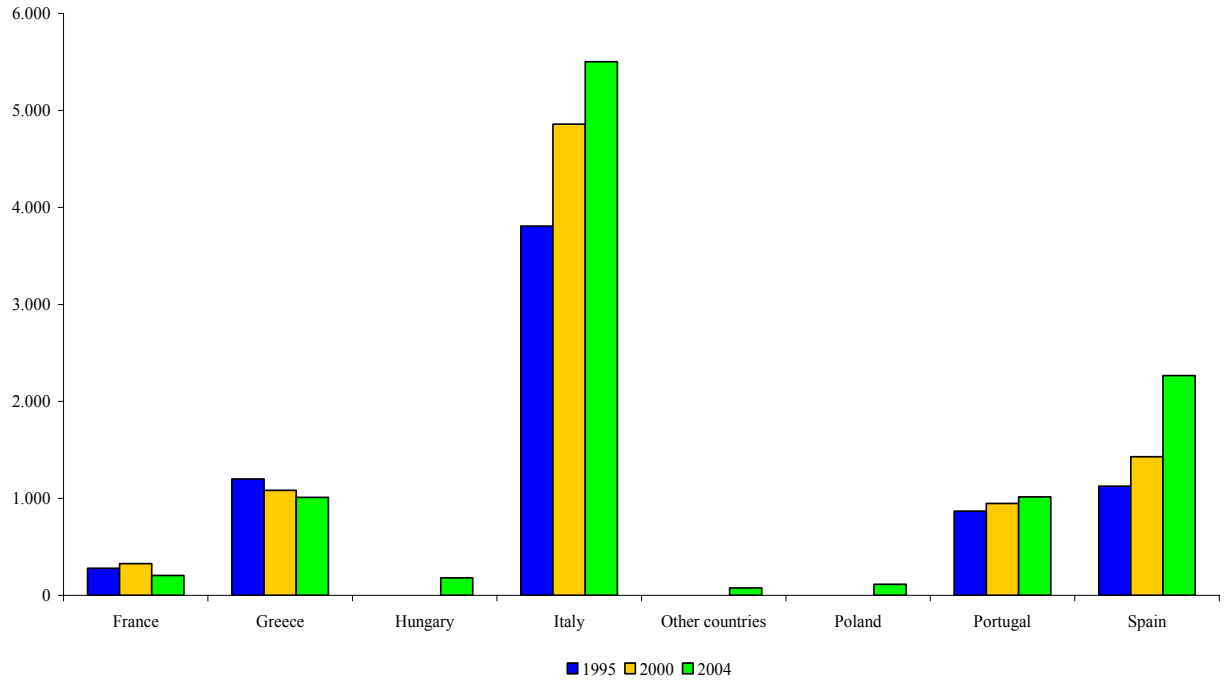

Figure 2.1 European processing tomato output by product and country (1995-2004, 1,000 tonnes, raw product equivalent, 3 year average)

Source: Amitom.

European production has grown over the 1995-2004 period (average annual growth of 2.3%), in particular in Spain (5.1% growth). Tomato production also increased in Portugal and Italy (1.1 and 2.7% growth, respectively), but decreased in Greece and France (-1.2 and -2.2% growth, respectively).

Production and processing is concentrated in a limited number of regions. Due to transport costs, production and processing can be found in the same or at least neighbouring regions. Figure 2.2 shows the areas in South Europe where tomatoes for processing are grown.

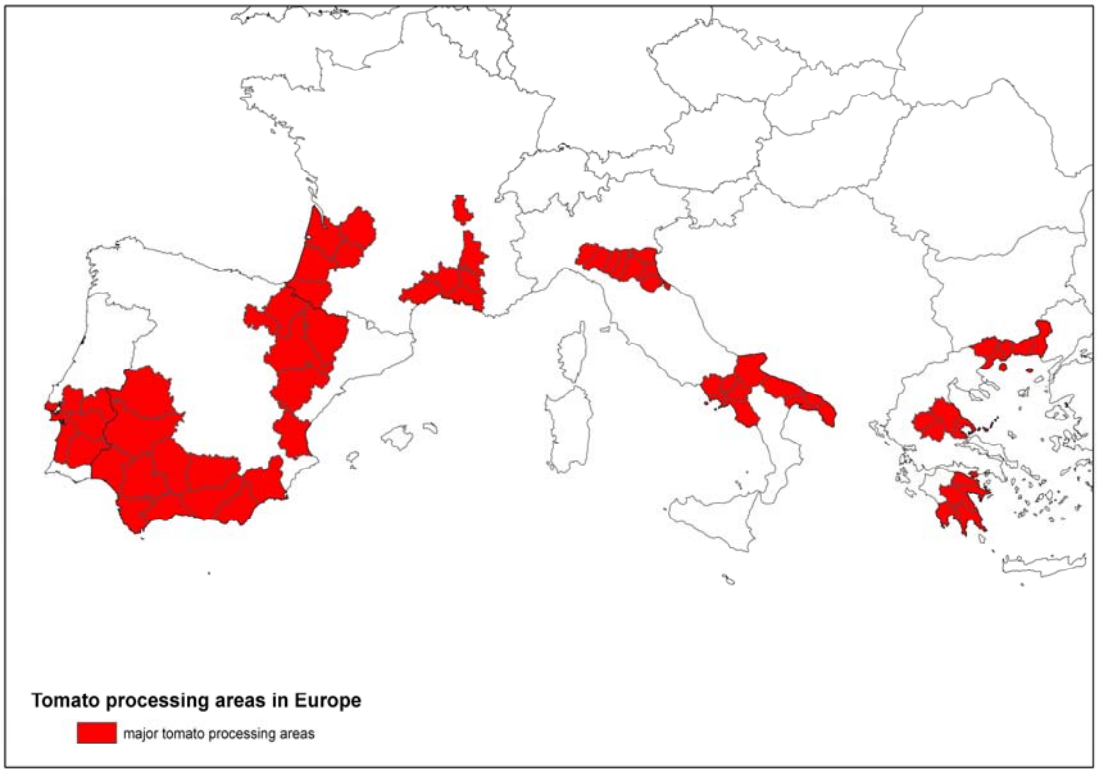

Figure 2.2 Tomato processing areas in South Europe

Italy

Italy has two main producing regions. The tomato paste production is concentrated in Emilia-Romagna, more in particular in the area around Parma and Piacenza. Emilia-Romagna accounts for 32% of Italian production of processing tomatoes and for 35% of processing activities. Tomatoes for the canning industry are primarily produced in Puglia and Campania. Puglia accounts for 37% of Italian production of processing tomatoes and Campania for 5-6%. Processing takes place in Campania (Naples and Salerno). Recent production growth took place in North rather than South Italy, among other things because the northern supply chain is characterised by economies of scale while the southern supply chain specialises in niche markets. The average size of the tomato farming area in the

North is larger (16-20 ha) than in the South (less than 8 ha). In the North, mechanisation is more widespread and producer organisations are more effective. This gives the North a comparative advantage over the South. Moreover, while in the North there are only about twenty processing factories, in the South there are more than 120 factories which, of course, are smaller.

Table 2.1 EU quota/threshold (from 2001 onwards) and production (1,000 tonnes)

	Quota/threshold	Production
1995	6,561	6,691
1996	6,561	7,868
1997	6,836	6,896
1998	6,836	8,068
1999	6,837	9,123
2000	6,866	8,410
2001	8,251	8,449
2002	8,251	7,817
2003	8,251	9,153
2004	8,251	11,380
2005	8,653	n.a.

n.a. = not available.
Source: Amitom.

Spain
Spanish production of tomato paste is concentrated in Extremadura. About 75% of Spanish processing tomato production takes place in Extremadura. Other important production areas are Andalusia (around Sevilla; 10% and rapidly growing) and the Ebro Valley (12%). Harvesting takes place from mid July till end October, the longest harvesting season in Europe. The production of tomato paste is concentrated in 15 large enterprises in Extremadura. They supply 95% of Spanish tomato paste.

Greece
Greek production is geographically more dispersed. Production takes place in Macedonia-Thracia (25%), in Thessalia-Boetia (60%) and on the Peleponnesos (15%). There are twenty processors in Greece, four of which supply 60% of Greek production.

Portugal
Portuguese production of tomato paste is concentrated in the Tajo valley in the Ribatejo region (80% of Portuguese production) and in the Alentejo region (10%). About 10% of Portuguese production is shipped to Spain for processing. Portugal has about ten tomato processors with an average production scale which exceeds production scale in other European countries.

France
French production is concentrated in the southern part of the Rhone Valley (Provence-Languedoc-Rousillon) and around the Lot and Garonne rivers (Aquitaine-Midi Pyrennées). In the Lot-Garonne region, processing tomato production competes with cereal production.

New Member States

In the new member countries, Hungary and Poland process a limited amount of tomatoes. Hungary processes 180,000 tonnes - which is comparable to the production in France - and Poland 115,000 tonnes.

Processing tomatoes are grown on large, specialised, mechanised arable farms. Typically, producers of processing tomatoes produce tomatoes alongside arable crops such as cereals, oil seeds, sugar beets, olives, grapes and vegetables in the open. This is illustrated by Table 2.2 which is based on a FADN sample. The table shows that growers of processing tomato tend to be large and have arable crops as substitutes in supply. The average size of the farms is relatively large compared to the average size of typical horticultural enterprises in the Netherlands and the Mediterranean. Average size ranges from 20 ha (Puglia) to 185 ha (Emilia-Romagna). Average size allocated to processing tomatoes ranges from 4.4 hectares in Puglia to 12.9 hectares in Emilia. Note that the numbers are based on the FADN sample and that actual numbers may differ a little.[1] Growers of processing tomatoes grow a range of products most of which are arable crops including extensive vegetables. Cereals are the most important crop processing tomato growers produce. 'Protected vegetables' are typically not produced by producers of processing tomatoes.

A possible reduction in the subsidy of processing tomatoes is likely to lead to a shift to substitute products. From an agronomic perspective, current substitutes in production are the most likely candidates. This implies that current growers of processing tomatoes are likely to switch to arable crops and extensive vegetables production. In current cropping plans, 'protected vegetables' such as fresh tomatoes, cucumbers and sweet peppers are no substitutes in supply for processing tomatoes. From an agronomic perspective, there is no immediate threat for the Dutch greenhouse vegetable sector as a result of the upcoming reform. Vegetables in the open, however, are part of current cropping plans of processing tomato growers, especially in Puglia and Ribatejo e Oeste. Since the major part of current cropping plans refers to arable crops, one may expect supply substitution between processing tomatoes and arable crops as a result of which the total area devoted to fruits and vegetables production may fall after the reform of the CMO.

[1] According to our Italian consultant, land allocated to processing tomatoes is actually higher in Emilia: 16-20 ha.

Table 2.2 Cropping plans of processed tomato growers (%)

		Sample	Total hectares	Tomatoes for processing	Vegetables in the open	Protected vegetables	Cereals	Sugar beets and oil seeds	Olives and wineyards	Other crops
Italy	Emilia-Romagna	60	186.43	6.9	2.2	0.0	46.8	15.8	0.5	27.8
Italy	Puglia	51	19.38	22.7	14.9	0.2	32.6	0.6	22.3	6.7
Spain	Extremadura	11	47.66	14.5	0.0	0.0	41.0	0.3	2.0	42.1
Portugal	Ribatejo e Oeste	56	25.85	45.6	7.6	0.1	23.2	5.3	4.9	13.3
Portugal	Alentejo e do Algarve	7	93.07	7.2	1.4	0.1	54.8	10.6	5.3	20.6

Source: FADN.

2.2 The Common Market Organisation for processing tomatoes

The European CMO for processed fruit and vegetable products has five aims:
1. maintain 'specialised' productions (actually traditional);
2. maintain the level of producers' income;
3. maintain regular supplies to the processing industry;
4. strengthen the role of producer organisations (POs);
5. market oriented relations between POs and processors.

As part of the CMO for processed fruit and vegetable products, the CMO for processing tomatoes was established in 1978 in order to protect European producers from world market competition, in particular Californian competition. World market prices were considered too low to allow a reasonable standard of living to European producers (Pritchard and Burch, 2003). However, the proposed CMO was initially contested by North European nations (mainly importers of processed tomato products), which feared that the CMO would have a price-increasing effect. This fear was recognised and the CMO was built around domestic support payments, which would have a price-depressing effect.

In 1996 the European Union came up with a new CMO for processed fruit and vegetable products, but it took until 2001 when the CMO for processed tomatoes was amended in order to meet WTO requirements, to curtail expenses on the tomato processing supply chain and to address some anomalies in the old regulation. In this section, we briefly, address the 1978 regulation before describing the 2001 regulation.

The CMO for processing tomatoes is made up of three elements:
- *import tariffs on imported processing tomato products*. The European tomato processing industry is protected from imports from outside the European Union by import tariffs on processed tomato products. The *ad valorem* import tariff has been gradually reduced from 18 per cent in 1995 to 11 per cent in 2004. Details may be found in Box 2.1;
- *export restitutions for exported processing tomato products*. Export subsidies make up the difference between European and world market prices in order to foster European exports. Details may be found in Box 2.1;
- *support for domestic (European) production*. This is by far the most important element of the CMO. This part involves 300 million euro (2000) and will be elaborated below.

Import tariffs and export refunds

Import tariffs

Imports of processed tomato products into the EU may be subject to presentation of an import license (Article 11 (1) of Regulation 2201/1996). Furthermore an import tariff is applied to processes tomato imports, according to the Common Customs Tariff, whereby the applied tariff is equal to the bound tariff (see table 2.3). Before 2001 a minimum import price had to be fixed, but along with the amendments in 2001 the minimum import price for processed tomato products was withdrawn.

Import tariffs for processed tomato products

	Product	bound tariff %	applied tariff MFN %	applied tariff GSP %
200210	Peeled tomatoes, prepared/preserved	14.4	14.4	0
200290	Unpeeled tomatoes, prepared/preserved	14.4	14.4	0
200950	Tomato juice not fermented or spirited	16.4	16.0	0
210320	Tomato sauces with a basis of tomato puree	10.2	10.2	7.1/0

Source: WTO, UNCTAD Trade Analysis and Information System (TRAINS).

Export refunds

Export refunds may be paid on the basis of the difference between European Union and third country prices, to enable processed tomato products to be exported competitively to third countries. However, there is no European reference price for processed tomato products, like for sugar. Therefore the fixation of the export refunds is based on several criteria (see Article 178 of Regulation 2201/1996). The refunds shall be granted only on application and on presentation of an export license, and are also applicable to re-exports. In 2000, export refunds were € 45-50 per tonne or 8.5% of the free-on-board price for a maximum of 135,000 tonnes, and therewith the sum of export refunds for processed tomato products amounted € 6.3 million (Pritchard and Burch, 2003). In 2006 the export refund for peeled tomatoes amounted € 45 per tonne. According the annual commitments of the European Union with regard to the Uruguay Round Agreement, the volume of subsidised exports of processed fruit and vegetables should not be higher than 143,000 tonnes, while the maximal budget is € 8.3 million. These figures show that processed tomato products are responsible for most export refunds in the processed fruit and vegetables sector. Nevertheless, export refunds have only a relatively small impact on the European processed tomato industry. The above mentioned 135,000 tonnes of exported products constituted only 1.6% of total processed tomato production.

Box 2.1 Import tariffs and export refunds

2.2.1 The 1978 Regulation

From 1978 onwards, the European Community (EC) supported tomato growers by establishing minimum prices for tomato growers. Minimum prices were to be paid to the growers by tomato processors who received financial aid by the EC in return. Processor aid and grower minimum prices were confined to quotas. In brief, the 1978 regulation was based on three elements which were amenable by the EC:

- commodity, national and factory based quota. Financial aid to the processing tomato supply chain was attended with a quota system which was supposed to control European production and the EC's financial obligations. Factories received aid based on their quotas. If a factory had a quota for 20,000 tonnes of raw tomatoes to be used in canning, it received quota payments for this amount. Quotas were not transferable, but confined to a particular processor. However, quotas were adjustable. If the factory would process above-quota tonnage *and* purchase the additional tonnage from growers at minimum prices, its quota might be increased in future years. Production exceeded national quota systematically. National quotas were adapted in 1984, 1990 and 1992. For 1999-2000, quotas were based on average production quantities in the

two previous years. In that year, production would exceed quota levels by 33 per cent;

- processor aid per tonne of quota. The EC could influence its expenses and the supply chains' incentive to produce through the processor aid per tonne. Processor aid per tonne fell steadily from 1978 onwards. However, in percentage of output prices, aid remained constant till 1997 (Pritchard and Burch, 2003). Since 1997, processor aid has been reduced substantially, both in euro and in percentage of output prices;
- minimum prices for growers for in-quota tomatoes. Tomato processors paid minimum prices to tomato growers for in-quota tomatoes. Out-of-quota prices were the outcome of market forces. Growers received a weighted average of in-quota minimum prices and out-of-quota market prices. Minimum prices were reduced throughout the 1978-2000 period and finally abolished in 2001.

The 1978 support regime was attended with the following anomalies:

- processors had an incentive to process above-quota supplies and even to buy them at minimum prices in order to protect their future quota. The tendency to overproduce led to adjustments of the national quota in several years (see above);
- because quotas were not transferable, (small) inefficient processors were protected from competition by (large) efficient processors. There has been little economic restructuring in the European tomato processing industry in the 1990s (Pritchard and Burch, 2003). The number of processors hardly fell and the production scale remains low. In 2000, sixty per cent of all tomato factories have quota of less than 10,000 tonnes and twenty per cent quota less than 1,000 tonnes. In California, plants with a capacity of over 1,000,000 tonnes exist;
- the 1978 arrangements were associated with problems of transparency and accountability, especially in South Italy (Pritchard and Burch, 2003). The existence of ghost stocks was common knowledge. However, the amount of fraud remained unclear. Fraud was also encouraged by the need to protect future quota.

2.2.2 The 2001 Regulation

In 2001, the 1978 arrangement was amended by a new arrangement. In 1996 the common market organisation of processed fruit and vegetables was already reformed through Council Regulation (EC) No 2201/96, when a new regulation on processed tomatoes (2699/2000) was adopted in December 2000. The main change was the replacement of the quota and the minimum price arrangements by a production threshold regime. Furthermore the subsidies are now paid to tomato growers (via producer organisations) instead of tomato processors and minimum prices do no longer apply. The new arrangement depends on two elements.

- *grower subsidies (aid for processing).* Growers receive a subsidy per tonne of tomato produced. Subsidies do no longer depend on the products made out of raw tomatoes (box 2.2). The subsidy equals € 34.50 per tonne and is fixed in perpetuity at this rate. Subsidies are granted to producer organisations. These producer organisations also negotiate grower prices (of raw tomatoes for processing) with the tomato processing industry, which in principle reflect market prices. These prices as well as the

negotiated quantities are laid down in contracts between producer organisations and processors;

- *European and national thresholds*. The processing aids are confined to tomatoes produced under the national thresholds. The national thresholds are not converted into individual thresholds for producer organisations. Instead, the producer organisations have to submit applications for processing aid to the responsible national authorities. When the application is approved, the quantity applied for shall count against the Member State's threshold. Therefore it goes: 'First come, first served'. The producer organisations are therefore compelled to submit their applications as soon as possible. Possibly, growers and grower associations face a Prisonner's Dilemma with regard to their production decisions. Their individual production decisions do not influence market prices, but their collective decisions do.

  If a country exceeds its threshold, the payments per tonne are reduced proportionately in the following years. Therefore any financial gains to growers in one year from increased production are offset by reduced payments in the following year. As stated in Article 5(2) of the CMO:

  > 'Whenever a Community processing threshold is overrun, the aid fixed for the product in question in accordance with Article 4(2) shall be reduced in all the Member States in which the corresponding threshold has been overrun. For the purposes of applying the first subparagraph, threshold overruns shall be calculated by comparing the threshold with the average quantity processed with aid under this Regulation over the three marketing years preceding that for which aid must be set. However, to calculate the overrun of the thresholds fixed for each Member State, any quantities still available below the threshold of a Member State but not processed shall be allocated to the other Member States, in proportion to their respective thresholds. The reduction in aid shall be proportional to the volume of overrun relative to the relevant threshold.'

The new system will probably be more costly, since the number of tonnes eligible for subsidies increased significantly together with the reform: the EU threshold in 2001 for processing subsidies amounted 8.251 million tonnes, i.e. 20.7% more than the quota of 6.685 million tonnes in 2000. In marketing year 2005/06 the threshold was raised to 8.653 million tonnes, as a result of the accession of ten new Member States in May 2004. Table 2.4 shows the present national thresholds. As from marketing year 2003/04, Spain has sub-divided its national thresholds into two separate thresholds. According Article 5(4) of Council Regulation (EC) No 2201/96 Member States can divide their national thresholds into two sub-thresholds, one for whole peeled tomatoes, and one for other tomato products.

Table 2.4 EU and national thresholds

Member State	Threshold	National share in EU-threshold
Italy	4,350,000	50.3%
Spain	1,238,606	14.3%
canned whole peeled tomatoes	*116,612*	
other tomato products	*1,126,994*	
Greece	1,211,241	14.0%
Portugal	1,050,000	12.1%
France	401,608	4.6%
Poland	194,639	2.2%
Hungary	130,790	1.5%
Slovak Republic	29,500	0.3%
Malta	27,000	0.3%
Czech Republic	12,000	0.1%
Cyprus	7,944	0.1%
Total EU threshold	*8,653,328*	100%

Source: EU Regulation 2201/1996.

The new arrangement is expected to have the following advantages over the 1978 arrangement:

- *Inefficient processors are no longer protected.* Subsidies and quota are granted to growers rather than processors. Because growers may switch processors, a dramatic reorganisation of the tomato processing industry may be expected. Growers will contract efficient processors because they are able to pay higher prices to the producers than their inefficient counterparts. Inefficient processors may therefore be expected to exit the industry. The exit of these high-cost processors benefits both consumers and growers because processor gross margins will fall.
- *Prices may be expected to decrease.* Producer aid is no longer attended with minimum prices. Prices at all levels in the supply chain may be expected to fall, because price formation is free. There is no longer a floor in the supply chain's price.
- *There is more transparency and less fraud.* Subsidies are given directly to producers. This reduces the risk that processors appropriate part of the subsidies, let alone the risks associated with fraud (paper tomatoes).
- *European overproduction will fall.* According to Pritchard and Burch (2003) the new arrangement limits the incentives to overproduce. Under the previous arrangement, production exceeded national quota by far.
- *Rent seeking behaviour*. Under the previous system the processors showed rent seeking behaviour, by focusing on protecting or increasing their quotas, instead of increasing the efficiency of their production. The abolition of individual quotas for processors should avoid this.

The CMO for processed tomatoes is applied to a range of processed tomato products:
- peeled tomatoes, whole or in pieces, frozen (CN 0710 80 70)
- tomato flakes (CN 0712 90 30)
- peeled tomatoes, whole or in pieces (CN 2002 10 10)
- unpeeled tomatoes, whole or in pieces (CN 2002 10 90)
- tomato juice (including passata) (CN 2002 90 11 and 19)
- tomato concentrate (CN 2002 90 31, 39, 91 and 99)
- tomato juice (CN 2009 50)

Box 2.2 Products from the tomato processing industry

2.2.3 The domestic support regime at work

In this subsection, we describe the performance of the threshold mechanism over the 2002-2006 period and the implications for EU expenditures.

As indicated above, production aid equals € 34.50 per tonne of raw tomatoes, irrespective of the finished product. In principle the aid is eligible for the total production of a Member State, but in case the Community threshold is overrun, the aid for the following marketing year is reduced in the Member States that overran their national threshold in proportion to the overrun. Table 2.5 shows that Italy, but especially Spain has overrun its threshold in 2005/06, which has lead to a 12% reduction in aid for Italy and even a 32% reduction for Spain (other tomato products) in 2006/07.

Table 2.5 Aid for processing tomatoes

		2003/04	2004/05	2005/06	2006/07
Italy		€ 34.50	€ 34.50	€ 34.50	*€ 30.43*
Spain	whole canned tomatoes	€ 34.50	€ 34.50	€ 34.50	€ 34.50
	other tomato products	€ 34.50	*€ 29.36*	*€ 31.29*	*€ 23.35*
Greece, Portugal, France		€ 34.50	€ 34.50	€ 34.50	€ 34.50
Hungary, Poland, Slovakia, Czech Republic, Malta		n.a.	€ 25.88 a)	€ 34.50	€ 34.50

a) 75% of € 34.50 in first year after accession; n.a. = not available.
Source: European Commission.

As regard the total amount of aid for processing, the European Commission has set a theoretical budget of € 300 million, based on the new threshold (see table 2.4) and the aid per tonne (= € 298.5 million). However, the overrun in 2003/04 and 2004/05 (by Spain) and in 2005/06 (by Spain and Italy) has led to an enormous increase of expenditure, with total spending rising to € 380 million in 2005 (see figure 2.3). Total expenditure is expected to decline with the expected decline in Spanish and Italian production. Total expenditure in the year 2006/07 has decreased to 362.2 million euro due to the decrease of the aid per tonne shown in table 2.5.

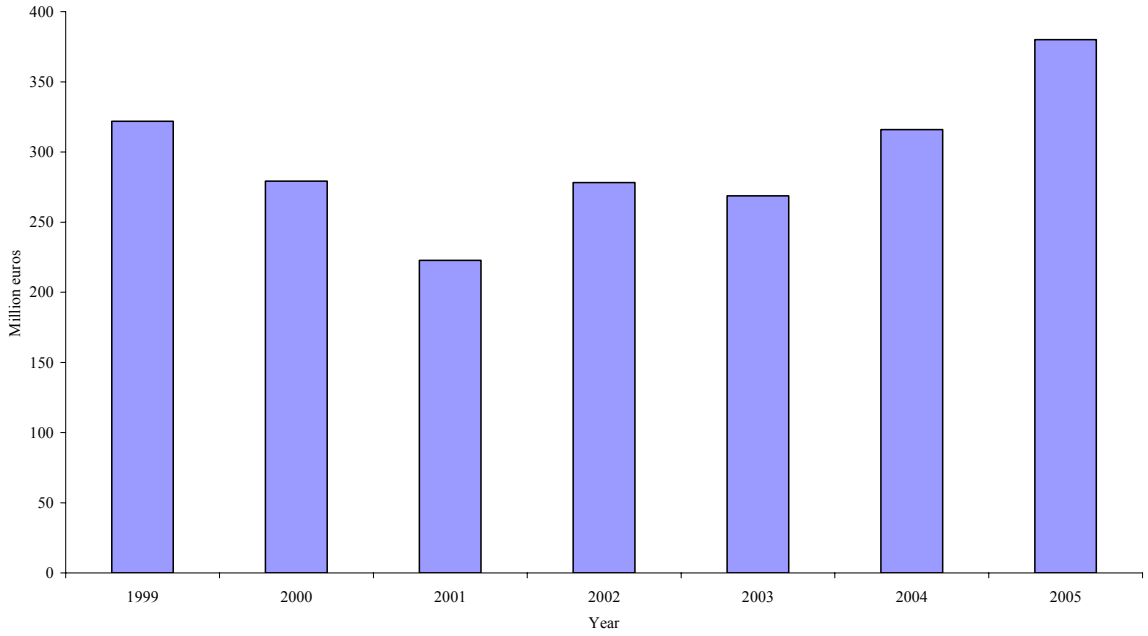

Figure 2.3 Aid for processing tomatoes, 1999-2005 (million euros)
Source: European Commission.

At the end of section 2.2 some hypotheses with respect to the impact of the new domestic support arrangement were laid down. The validity of these hypotheses is discussed below.

The number of tomato processors may be expected to fall
The number of tomato processors has fallen sharply since 2000, as shown by Table 2.6. Hereby the fall in the number of processors between 2000 and 2004 is more pronounced than the fall between 1994 and 2000 (with the exception of France). Note that the number of tomato processors remains large and falls relatively slowly in Italy, where the number of factories is still large. The figures seem to support the notion that the number of processors will decrease as a result of the domestic support regime introduced in 2001 and that the most efficient processors will be left over. The reduction of the number of processors over the four year period 2000-2004 (101) exceeds the reduction over the six year period 1994-2000 (34) by far. The producer organisations will look for the processor with the best offer.

Prices at all levels of the supply chain may be expected to decrease.
Figure 2.4 shows the development of the producer prices of tomatoes for processing in four countries in the last decade. Until the amendments of 2001 a minimum price was kept, which explains the lack of variance in prices between the countries. However, with the start of the 2001/02 season the prices in the four countries start to diverge. Prices in Italy and Portugal behave according to the hypothesis: they decrease in the 2002/03 and

2003/04. In the last two seasons the prices show some signs of recovery. Contrary to Italy and Portugal the producer prices in Spain and France show an upward trend. With the exception of 2001/02 (Spain) and 2002/03 (France), prices have been rising since the reform. This has lead to a gap between Italy and Portugal on the one hand and Spain and France on the other hand; prices in the last two countries are two times higher.

Table 2.6 Number of tomato processing factories and number of producer organisations

	Number of factories			Producer Organisations
	1994	2000	2004	2004
France	28	13	9	7
Greece	42	36	20	?
Italy	231	232	200	69
Portugal	18	16	11	35
Spain	135	123	79	70
Total	454	420	319	181

Source: Pritchard and Burch (2003); EU-MED AgPol (Deliverable D11).

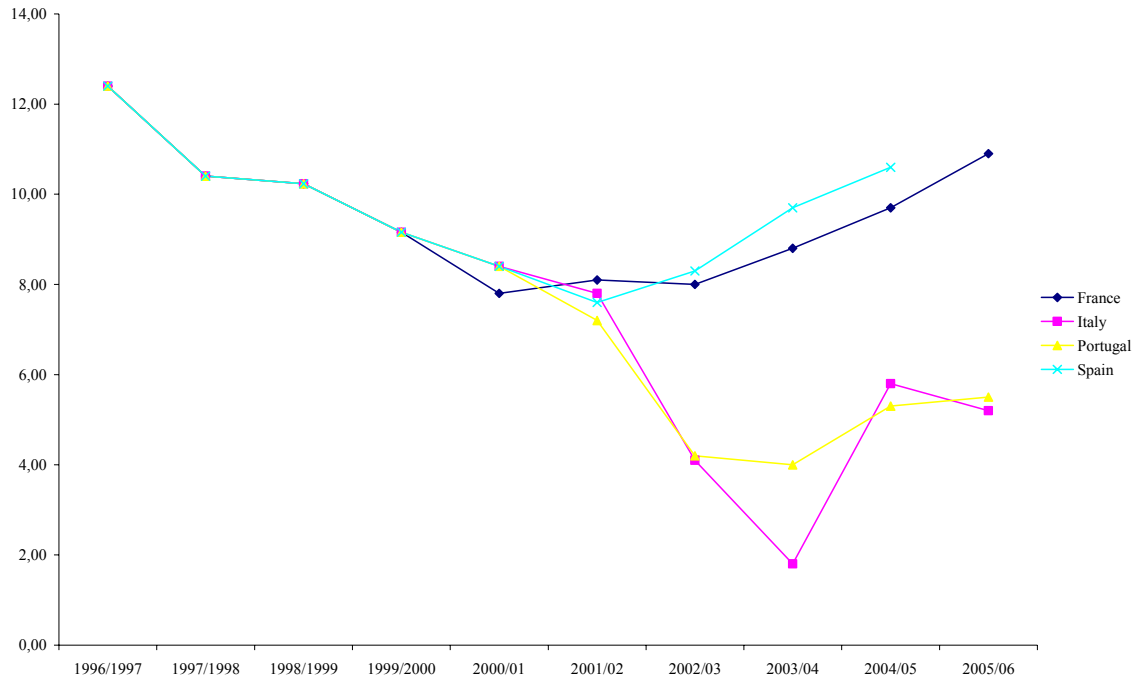

Figure 2.4 Producer prices in France, Italy, Portugal and Spain, 1996/1997-2005/06 (US$/100 kg)
Source: Amitom.

There is more transparency and less fraud

The current system is simpler than the system before 2001. There are two types of thresholds, at EU and at national level. No individual quota or thresholds do exist anymore. Furthermore, processors cannot receive aid for so-called 'paper tomatoes', since the aids are

paid to the growers. Furthermore the producer organisations and processors have to prove the fulfilment of the contracts to the competent national authorities. All together the 2001 reform has created more transparency and reduced the chances of fraud.

European overproduction will fall

In a certain sense, European producers still overproduce. European production exceeds the quotas by far (Pritchard and Burch, 2003). In this respect, the new support arrangement is not more successful than the 1978 support mechanism. Production and processing have grown substantially in Italy and Spain. This issue is discussed in the Management Committee of 14 March 2006. Italy and Spain raised ongoing problems they were facing in the tomato sector and they pushed the Commission for action. The Commission said it was aware of the problems, but would not be altering the arrangements ahead of reform of the regime. Basically, overproduction is only 'punished' by a lower level of processing aid in the next year. But growers and producer organisations may be looking at the marginal cost of producing additional amounts of tomatoes against somewhat lower processing aids.

Rickard (2003) argues that the regime change in 2001 may be expected to lead to production growth. Rickard distinguishes inefficient from efficient farms. Before 2001, the inefficient farms produced at high costs below the (implicit) quota allocated to them. The efficient farms produced at low costs at or above the (implicit) quota allocated to them. With the abandonment of the individualised quota regime, the inefficient farms may be expected to decline is size and to exit and the efficient farms may be expected to grow. With the quota regime and the associated rents vanishing, effective grower prices may be expected to rise, effective processor input prices may be expected to fall and as a result production may rise.

Rent seeking behaviour

There are clear signs that rent seeking activity played an important role in the functioning of the 1978 domestic support mechanism. Tomato processors processed above-quota quantities in order to increase their quota (and to protect their current quota). Outright fraud was also used to protect and increase quota allotments (Pritchard and Burch, 2003). The domestic support mechanism introduced in 2001 no longer applies to processors. Processors probably have lost an instrument to engage in rent seeking. Tomato producers may now engage in rent seeking, but they do not have individual quotas, so they are dependent on their producer organisation, which competes with other producer organisations for a share in the national threshold. On the other hand, producer organisations may now engage, to some extent, in rent seeking activities; the more supply they control, the more aid they get (and pay to growers).

2.3 World context

The EU accounts for one third of world output of processing tomatoes. Major production regions outside Europe include: California (US), Turkey, China and Thailand (Pritchard and Burch, 2003). California is historically the most important competitive threat for the European supply chain. However, this threat may be less important than supposed due to

differences in product differentiation: (1) there is a difference between the brixes (varieties) supplied in California and demanded in Europe; and (2) the European GMO-policy protects European production. Heinz e.g. prefers European production over American exports. The most imminent threat for European production probably is Turkish production. Turkey has a vast production potential and faces low transport costs. China's production of processing tomatoes is likely to rise. This may give a spur to Chinese exports, but also to Chinese consumption.

2.4 Reform of the CMO for processed fruit and vegetable products

Currently the European Commission is preparing to reform the CMO for fresh and processed fruit and vegetable products. In a consultation document published in May 2006 the Commission has presented several arguments for this reform (European Commission, 2006). In the case of processed tomatoes the most important argument relates to the WTO reduction commitments for domestic aid. It is to be expected that the current processing aid of € 34.50 will have to be reduced as a result of the WTO commitments. Furthermore, the Commission intends to extend the decoupling of support to the fruit and vegetable sector. A last argument relates to the market conformity of policy in the fruit and vegetable sector: the CMO should better anticipate to changing market conditions.

A proposal for a reform of both the fresh and processed fruit and vegetable sectors will be submitted at the end of 2006. This reform will have serious consequences for the processed tomato sector in the EU, as the (growers') aid for processing tomatoes will probably be radically altered. The key reform options are: (1) to maintain the status quo; (2) to introduce full or partial decoupling; (3) to convert the current (production based) subsidy regime into an area-related subsidy. The second option of (partial) subsidy decoupling is most popular with the tomato growers. In this case the producers of tomatoes for processing are integrated into the decoupled payment regime, on the basis of historical references. The new market organisation will come to effect in marketing year 2008/09.

The growers of tomatoes for processing as well as the processors have expressed their concerns over the reform. 'The Spanish government has defended an anticipation of the reform in order to minimize farmer losses due to subsidy cuts associated to over-production in recent years' (USDA-FAS, 2006).

2.5 Conclusion

The processing tomato supply chain is a large sector in the Mediterranean countries and to a lesser extent in new member economies such as Poland and Hungary. The production of processing tomatoes still grows fast, notably in Spain and Italy. Processing tomatoes are produced on relatively large farms specialised in extensive production of arable crops and vegetables. The subsidies involved in support of the processing tomato supply chain are substantial: a budget of 300 million euro amounting to 50% of producer turnover. Both the 1978 and the 2001 subsidy schemes are associated with substantial overproduction. Actual expenses in 2005/06 and 2006/07 (380 and 360 million euro respectively) exceed the EU

budget by far. The 1978 regime did not promote supply chain concentration: production and processing remained small-scale. The 2001 regime, on the other hand, led to concentration at the processing level except for Italy.

3. Substitution elasticities horticulture

In this section, we determine the price elasticities of supply and the substitution elasticities that we will use in the simulation studies analysed in the next section. Section 3.1 gives a brief literature review. Section 3.2 presents the results of the estimations of the land equations modeled in HORTUS. Section 3.3 gives the results of the estimations of a more general system of land equations for Italy. Section 3.4 concludes.

3.1 Literature review

For agriculture (arable farming), substitution elasticities have been calculated in a number of studies in the mid-1990s in order to determine the effects of decoupling (see among others Guyomard, Baudry and Carpentier (1996); Oude Lansink and Peerlings (1996) and Moro and Schokai (1999)). These studies use production (duality) theory to determine the substitution elasticities. Guyomard et al. (1996), for instance, find own price elasticities of land allocation between 0.20% (sunflowers) and 1.27% (maize). If the prize of maize rises with 1%, maize (sunflower) acreage rises with 1.27% (0.20%). The studies also report cross price elasticities of land allocation.

These studies also investigate to what extent decoupled payments still exert production effects. In general, these studies conclude that decoupling is not perfect. Area payments still have production effects.

Oude Lansink (2001) is (about) the only study available for vegetables production. Table 3.1 presents the own and cross price elasticties of supply estimated by Oude Lansink (2001). Tomatoes, cucumbers and peppers are complements, whereas other vegetables are substitutes for tomatoes, cucumbers and peppers. This implies that a rise in the tomato price leads to more supply of tomatoes, cucumbers and peppers at the detrimental of all other vegetables in greenhouse horticulture (and all other output). The price elasticities of supply found are small and comparable with the ones found for arable farming: 0.26-0.91%.

Table 3.1 Price elasticities of supply for Dutch greenhouse horticulture

	Tomatoes	Cucumbers	Peppers	Other vegetables	Other Outputs
Tomatoes	0.28	0.04	0.04	-0.16	-0.28
Cucumbers	0.13	0.91	0.14	-0.24	-0.04
Peppers	0.14	0.16	0.26	-0.24	0.13
Other vegetables	-0.29	-0.14	-0.14	0.47	0.36
Other outputs	-6.85	-0.34	0.92	4.68	6.79

Source: Oude Lansink (2001).

3.2 Estimating substitution elasticities for HORTUS

Calculating price elasticities of supply on basis of production theory is labour and data intensive. Since we derived specific supply equations in HORTUS (Bunte and Van Galen 2005), we restricted ourselves to estimating these equations (see Appendix A).

For this purpose, we collected data on production, acreage and grower prices from Eurostat for the Netherlands and Italy. The demand for land has been estimated using Seemingly Unrelated Regressions (SURE). The equations do not model cross price elasticities in detail, but model acreage allocation as a function of the development of the own price versus the development of a price index for a relevant group: fruits, protected crops, et cetera. Table 3.2 gives the results for the Netherlands. The substitution elasticity for protected crops is 0.30%. This implies that if the tomato price rises 1% above the group index, tomato acreage will rise by 0.30% (and as result cucumber and pepper acreage will fall).[1] Supply substitution between apples and pears and between carrots and beans is more common than in intensive vegetables production. Supply substitution may be low in intensive vegetables production, because production knowledge and climate and soil conditions and requirements may be very product specific. The substitution elasticity between the four product groups equals 0.24 (see Appendix 1). This elasticity is lower than the within-group substitution elasticities except for vegetables from intensive vegetable production in the open. Intergroup substitution elasticities may be expected to be lower than intragroup substitution elasticities. It is easier to change from cucumber to pepper production than to apple production. This characteristic is assumed and required in models based on the Armington-relation such as GTAP.

Table 3.2 Substitution elasticities for the Netherlands

Product group	Products	Elasticity
Fruit	Apples, Pears	0.88
Protected crops	Tomatoes, Cucumbers, Peppers	0.30
Intensive vegetables production in the open - Horticulture	Asparagus, Cabbage, Cauliflower, Lettuce, Strawberries	0.18
Extensive vegetables production in the open - Arable farming	Beans, Carrots	0.98

Table 3.3 shows the results for Italy for three product categories. We did not estimate the substitution elasticity for protected crops due to data limitations.

- *Fruits*
  The substitution elasticity for fruits for Italy is lower (0.37) than the one for the Netherlands (0.88). This result may be due to the fact that in Italy fruit refers to a more heterogeneous product group, including citrus and dessert grapes;

[1] In HORTUS, tomatoes, cucumbers and peppers are substitutes rather than complements by definition (see and compare Oude Lansink 2001). Within a group of products, at least two products are substitutes in production. Because, we do not identity other protected vegetables and other protected output in HORTUS, tomatoes, cucumbers and peppers are also bound to be substitutes in production (see Oude Lansink, 2001).

- *Horticulture*
  The substitution elasticity for intensive vegetables production (0.08) is somewhat smaller than it is in the Netherlands (0.18);
- *Arable farming*
  The substitution elasticity for extensive vegetables production (0.12) is substantial lower than it is in the Dutch case, among other things due to the fact that the group includes more products for Italy. Inclusion of tomatoes in this group did not give satisfactory results. The substitution elasticity became negative. In the next section, we discuss results for (processing) tomatoes.

The substitution elasticity between the three product groups equals 0.12 (see Appendix 1). This elasticity is lower than the within-group substitution elasticities for fruits, equal to the one for vegetables from arable farming and again higher than the one for vegetables from horticulture.

Table 3.3 Substitution elasticities for Italy

Product group	Products	Elasticity
Fruit	Apples, cherries, citrus, grapes, pears	0.37
Intensive vegetables production in the open - Horticulture	Asparagus, cauliflower, cucumbers, lettuce, strawberries	0.08
Extensive vegetables production in the open - Arable farming	Beans, carrots, onions, potatoes	0.12

3.3 Price elasticities in more general land allocation systems

Table 3.4 gives the (cross) price elasticities of land for a more general system of land allocation. Table 3.4 refers to vegetables and arable products, the closest substitutes in production of tomatoes. Unfortunately, we do not have a subdivision of fresh and processing tomatoes. The own price elasticity of land - the diagonal in the table - equals 0.03-0.25% and is fairly small. The cross price elasticities suggest that cereals and tomatoes are complementary products.[1] A rise in the cereal price with 1% leads to a rise in tomato acreage of 0.07%; a rise in the tomato price leads to a rise in cereal acreage of 0.03%. Intensive vegetables production, on the other hand, is a substitute of tomato production.[2] The table illustrates that (fresh) tomatoes and crops from intensive horticultural production (asparagus, cauliflower, cucumbers, lettuce and strawberries) are substitutes in supply. However, the table also suggests that (processing) tomatoes are complementary to some arable crops and substitutable to others. A rise in the tomato price of 1% leads to a fall of 0.09% of the area allocated to extensive vegetables production (beans, carrots, onions and potatoes), of 0.10% of the area allocated to intensive vegetables production (asparagus, cauliflower, cucumbers, lettuce and strawberries) and of 0.28% of the area allocated to other industrial crops (oil seeds, sugar beets and tobacco). Note that a reduction in the production subsidy

[1] The sign is positive.
[2] The sign is negative.

will lead to a *fall* in tomato prices and to a *rise* in the area allocated to vegetables and other industrial crops.

Table 3.4 Own and cross price elasticities for land use of selected crops for Italy

Demand for land for:	Price of:				
	Cereals	Tomatoes	Vegetables - Arable	Vegetables - Horticulture	Other crops
Cereals	0,04	0,03	0,01	*-0,08*	-0,01
Tomatoes	0,07	*0,25*	0,07	-0,17	0,02
Vegetables - Arable	*0,38*	-0,09	*0,16*	*-0,36*	-0,03
Vegetables - Horticulture	*-0,08*	*-0,10*	*-0,04*	0,03	0,03
Other crops	-0,27	-0,28	*-0,12*	*0,69*	0,06

Numbers in italics refer to significance at the 5% level.

3.4 Conclusion

This section shows that there is important supply substitution between tomatoes on the one hand and both vegetables and arable crops on the other hand. This result again underlines that it is important to consider possible supply substitution from processing tomatoes towards extensive vegetables production and arable crops.

This section also finds small substitution elasticities within product groups - the elasticities in table 3.2 and 3.3 - and even smaller substitution elasticities between product groups: 0.24 for the Netherlands and 0.12 for Italy. The elasticities found will be used in the simulations discussed in the next section.

4. Simulation analysis

In this section we illustrate what the likely impact of a change in the subsidy for processing tomatoes will be on production and trade in fruits and vegetables in the European Union. The report analyses two possible reforms: (I) a reduction or even an abolishment of the production subsidy per tonne; and (II) the introduction of area payments (decoupling). We present the results of the simulation analysis carried out using HORTUS: LEI's supply and demand model for production and trade in fruits and vegetables in the European Union. In section 4.1 we discuss the assumptions made in defining the scenarios analysed. In section 4.2 we present the results of the simulation analysis for scenario I: reduction of production subsidies. In Section 4.3 we present the results for scenario II: replacement of production subsidies by area payments. Section 4.4 concludes.

4.1 Assumptions

In the framework of the evaluation of the CMO for fruits and vegetables, the European Union considers amending the subsidy regime for processing tomatoes. The production subsidy will be reduced and possibly replaced by an area, a lump sum or an equivalent payment. Payments to processing tomato growers will be decoupled. In this context, we will analyse the following scenarios:

I. the abolishment of the production subsidy without a compensation in terms of an area, lump sum or any equivalent payment;
II the abolishment of the production subsidy with partial compensation in terms of an area, lump sum or any equivalent payment. The area payment is assumed to prescribe the allocation of some land to the production of processing tomatoes in order to prevent unfair competition for growers of other vegetables, fruit and arable crops.

Other scenarios are possible as well. However, we think that these two scenarios give a good first impression of the likely effects of a subsidy reduction and decoupling. It is relatively straightforward to consider other magnitudes in the changes applied to the policy variables, because HORTUS is made up of linear relations. For this reason, we stick to two scenarios. By the way, scenario (II) only makes sense when decoupling is imperfect. If decoupling is perfect, i.e. if there is no relation between current production and government payments, scenario (II) coincides with scenario (I).

In terms of parameters, there are four main assumptions to be made in the simulation analysis to be carried out:

1. how big is the grower subsidy for processing tomatoes in percentage terms?
2. how price elastic is the demand for European processed tomatoes? And how price elastic is the supply of European fruits and vegetables?

3. given the fact that processing tomatoes are primarily grown on arable farms, what implications does the change in the CMO have for the total area cultivated with fruits and vegetables?
4. to what extent does the future CMO decouple the relation between subsidies and production?

Grower subsidies

In 2001-2003, the average grower price for processing tomatoes was approximately 67 euro per tonne (FADN). The subsidy amounts to 34.50 euro per tonne. This implies that the subsidy equals roughly fifty percent of the grower price. We assume that the subsidy equals fifty percent of the grower price. This accords with estimations made in the literature.

Demand and supply substitution

We assume that the price elasticity of the demand for processed tomatoes is low. This is a fairly reasonable assumption. In general, the price elasticity of the demand for food is low. In general, the price elasticity of intermediates with a low cost share is low as well. A price elasticity of demand of -0.1% or -0.2% seems reasonable. The estimations are based on a price elasticity of -0.2% implying that if consumer prices rise with 1% demand falls with 0.2%. European production is sheltered from international competition due to transportation costs, differences in standards and attitudes towards genetically modified raw inputs (Pritchard and Burch, 2003). Rickard (2003) argues that there are three geographical markets in the world for processing tomatoes: the Americas, Europe and the Mediterranean, and the Far East. Turkey (and to some extent) China are the only serious competitors for the European tomato processing industry. Our Italian consultant, on the other hand, indicates that Italian representatives of producer organisations and the processing industry expect imports from non-EU countries to rise substantially in the long run. In the short run, Spain is likely to expand its market share. For the moment, we assume that the substitution elasticity between processing tomatoes from the various countries of origin (exporters) is low (1.25%). A substitution elasticity of 1.25% implies that if prices of imports from Italy grow with 1% above the overall import price index, imports from Italy fall with 1.25%.

On basis of the analysis in the previous section, the following assumptions are made with respect to the substitution elasticities between the crops identified in HORTUS. The substitution elasticity between the three main products - fruits, protected vegetables and vegetables in the open - is low (0.10). A substitution elasticity of 0.10% implies that if grower prices for e.g. fruit grow with 1% above the overall grower price index, the fruit area will grow with 0.10%. The within group elasticity is substantially higher. For fruits, we assume that the within group substitution elasticity is higher in North Europe than in the Mediterranean, in accordance with the results obtained in the previous section, because North European fruit production depends on a few close substitutes (apples, pears, cherries, plums, et cetera) while Mediterranean fruit production is more diversified. Fruit production in the Mediterranean includes citrus, peaches and dessert grapes. For vegetables, we assume that the substitution elasticity equals 0.30 for protected crops as established for the Netherlands and 0.60 for vegetables in the open which is approximately the average of the values found for Italy and the Netherlands.

Table 4.1 Supply substitution elasticities employed

Region	Countries	Substitution Elasticity		
		Fruit	Protected crops	Crops in the open
North Europe	Baltic states, Belgium, Ireland, Netherlands, Scandinavia, UK	0.9	0.3	0.6
Central Europe	Austria, Czech Republic, France, Germany, Hungary, Poland, Slovak Republic	0.6	0.3	0.6
Mediterranean and Rest of the world	Cyprus, Greece, Italy, Malta, Morocco, Portugal, Slovenia, Spain, Turkey, Rest of the World	0.3	0.3	0.6

Total land employed in fruits and vegetables production

Processing tomatoes are grown on arable farms in rotation with crops like cereals, oil seeds and other industrial crops. A reduction in the subsidy for processing tomatoes is likely to have a first order effect on the land allocated to cereals, oil seeds, and other industrial crops. In Italy, 100,000 hectares are allocated to processing tomatoes and 2,000,000 hectares to all fruits and vegetables.[1] A shift of land from processing tomatoes of say 10,000 hectares to cereals, oil seeds and other industrial crops implies a decrease in the total area employed in fruits and vegetables production of 0.5%. For reasons of simplicity, one might neglect such a reduction, certainly in the light of the results to be presented below.

Decoupling

Decoupling policies eliminate the relation between the subsidy and current production. However, in reality, decoupling may be imperfect and promote production as such - simply by granting subsidies - or favour particular crops.

In the empirical literature, there is an intense debate with respect to the question to what extent decoupled government payments really are decoupled (Guyomard et al., 1996; Oude Lansink and Peerlings, 1996; Moro and Sckokai, 1999; Gohin and Guyomard, 2000 and Gullstrand, 2003). To what extent do these payments promote agricultural production as such? To what extent do they promote the production of particular crops? This discussion is among other things due to the fact that there are two definitions of decoupling (Andersson, 2004):

1. the *ex ante* definition examines whether policies fulfil the WTO decoupling criteria and classifies policies meeting this criteria as being decoupled. The subsidy criteria should be clearly defined and apply to a well-defined base period. Payments are not to be based on the size of any variable - in particular input, output and prices - in any other year than the base year. Production should not be obligatory;

[1] Including all fruits and vegetables for the food processing industry (grapes for wine production, olives for olive oil production, et cetera).

2. the *ex post* definition examines (empirically) whether policies exert production effects and classifies policies as being decoupled on basis of (empirical) measurements. In theory, area payments imply decoupling. However, area payments may promote agricultural production as such by discouraging farm exit. Moreover, the conditions to be met in order to receive the area payments, may favour the production of one crop over another. Area payments may exclude the choice of certain crops.

The empirical literature indicates that area payments which are decoupled according to definition 1 may not be decoupled according to definition 2 (Moro and Sckokai, 1999; Gohin and Guyomard, 2000; Gullstrand, 2003 and Andersson, 2004). There are several reasons why WTO-proof area payments may have production effects. Area payments give a minimum income to farmers. This may reduce farmers' risk perceptions and increase banks' willingness to grant loans, et cetera. Both aspects may influence decisions to invest and to stay in business, for instance.

In order to assess the effects of possible decoupling initiatives with respect to processing tomatoes, one should take into account that even decoupled subsidies may be associated with production incentives. We assume this to be the case. If not, scenario II would coincide with scenario I.

4.2 The impact of a reduction in the production subsidy

This section presents the impact of abolishing the production subsidy for processing tomatoes. The results have been obtained from HORTUS: a partial equilibrium model for fruit and vegetables production, consumption and trade in the EU25 (Bunte et al., 2005). HORTUS is a static model. The model indicates that production, consumption and trade at time T are at point A - the base year - and will be in point B at some time T+X in the future. The model does not give information about the dynamics of the changes, about how the sector gets from point A at time T to point B at time T+X. The model also does not say anything about any possible underlying trends (developments) in production, consumption and trade. The model gives information about a *shift* from one trend to another trend without indicating anything about the possible trends themselves.

The abolishment of the production subsidy causes an upward shift of the supply function of processing tomatoes. Growers of processing tomatoes will shift their acreage to other crops in their cropping plan. They will grow processing tomatoes less often provided scale economies allows them to produce at lower prices. Mechanisation of harvesting activities, for example, may play a relevant role in lowering costs and may make the difference between continuing the production of processing tomatoes or not. Assuming more or less constant returns to scale in agriculture and a price inelastic demand for processing tomatoes, the abolishment of the production subsidy will be met by an increase in the prices the processors pay for processing tomatoes (Table 4.2).[1] [2] Grower prices fall slightly.

[1] In the model, grower prices rise (fall) if output rises (falls) much faster than the area employed does. However, in this case, the area used for the production of processing tomatoes falls with production.

[2] Tomato growers and processors are price takers. The price of final products is fixed due to market competition among producers and processors, both national and international, between processors and retail chains,

Given the elasticities chosen, the demand for (European) processing tomatoes and thus the output of the tomato processing industry will fall by approximately 15% in Greece, Portugal and Spain and by more than 30% in Cyprus and Italy. For France, Hungary, Malta and Poland, we find intermediate numbers for the production decrease. Turkey and the Rest of the World will be able to increase imports into the EU and as a result their production. European production will, of course, fall more sharply and non-European production will rise more substantially if higher elasticities of import substitution would be employed.

Table 4. 2 The impact of scenario I on the processing tomato supply chain (percentage changes)

	Input prices of processing industry	Grower prices	Hectares	Output / Industry demand
Cyprus	49.8	-0.2	-31.8	-31.8
France	49.9	-0.1	-18.5	-18.5
Greece	49.5	-0.5	-14.2	-14.2
Hungary	49.6	-0.4	-23.8	-23.8
Italy	48.6	-1.4	-36.5	-36.5
Malta	49.5	-0.5	-26.7	-26.7
Poland	49.8	-0.2	-24.3	-24.3
Portugal	49.6	-0.5	-15.7	-15.7
Spain	49.7	-0.3	-14.7	-14.7
Morocco	-	-0.1	0.7	0.7
Turkey	-	0.0	4.0	4.0
ROW	-	0.0	10.6	10.6

Table 4.2 suggests that Italy (and Cyprus) will face the largest drop in output of processing tomatoes. Italy is a large importer, exporter and re-exporter and will face a surge in imports from the Rest of the World in its home market. Italy is also by far the largest exporter to non-EU countries and faces a major decrease in its exports to these markets. For Greece, Portugal, Spain and to a lesser extent France, domestic demand is the most important driving factor. This shelters their domestic production to some extent.

What is even more important is the fact that agricultural production will lead to a production shift in the direction in which the Mediterranean countries have a comparative advantage: fruits and fruit vegetables (fresh tomatoes, cucumbers and sweet peppers). In Greece, Portugal and Spain, the area allocated to fruit and fruit vegetables grows moderately by 0.2-1.0%. In Italy, the area allocated to fruit and fruit vegetables grows by 1.6-1.8% (see Table 4.4). Because the demand for processing tomatoes falls and arable production in general becomes less attractive due to the fall in the grower price of one of its main crops (processing tomatoes), growers will switch from arable crops and extensive vegetables production to fruits and fruit vegetables. This makes a possible fall in the total area

and due to the low level of product differentiation. However, even though producers and processors are price takers, this does not imply that producers and processors are not able to pass on cost increases. Cost increases follow from entry and exit processes.

employed in fruits and vegetables production unlikely, on the contrary, and gives a spur to the general shift from arable to fruits and vegetables production in Europe (EC, 2004).

As a result of the growth in Mediterranean fruit production, North European countries will face fiercer competition in the production of fruits and fruit vegetables. The Mediterranean countries will crowd out North European fruit production. This will lead to a shift to vegetables production in North Europe. This also holds for the Netherlands.

Table 4.3 Import developments for processing tomatoes under scenario I (percentage changes)

Exporter:	Importer:					
	France	Germany	Netherlands	Poland	ROW	UK
Cyprus	-22.9	-25.5	-24.7	-32.1	-61.2	-34.0
France		-25.6	-24.8	-32.1	-61.3	-34.1
Greece	-22.5	-25.2	-24.4	-31.7	-60.8	-33.6
Hungary	-22.6	-25.3	-24.5	-31.8	-61.0	-33.8
Italy	-21.4	-24.0	-23.2	-30.5	-59.7	-32.5
Malta	-22.5	-25.2	-24.4	-31.7	-60.9	-33.7
Poland	-22.9	-25.6	-24.7		-61.2	-34.0
Portugal	-22.5	-25.2	-24.4	-31.7	-60.9	-33.7
Spain	-22.7	-25.4	-24.6	-31.9	-61.1	-33.9
Morocco	39.5	36.8	37.6	30.3	1.2	28.3
Turkey	39.4	36.7	37.6	30.2	1.1	28.3
ROW	39.4	36.7	37.5	30.2	1.0	28.2

Table 4.4 Area development in Europe under scenario 1 (percentage changes)

	Fruit	Vegetables in the open	Fruit vegetables
Mediterranean	*0.8*	*-3.7*	*1.2*
Greece	0.6	-2.7	0.5
Italy	1.6	-5.2	1.8
Portugal	0.4	-2.2	0.9
Spain	0.2	-1.3	0.4
Rest of Europe	*0.0*	*0.0*	*0.1*
Netherlands	-0.3	0.1	0.1
Rest of the world	*-0.1*	*0.1*	*0.0*

In terms of total acreage, the impact of a reduction in the subsidy for processing tomatoes on Dutch horticulture is limited. However, the market share of the Netherlands on its main export markets - Germany and the UK- will decrease. More in particular, we may observe the following changes in bilateral international trade patterns (see table 4.5).

- Italy will increase its exports of fresh fruits and vegetables to Germany and the UK substantially. This holds in particular for its exports of fruit vegetables to Germany and all its exports to the UK. This holds less so for its fruit exports to Germany;
- Greece, Spain, but also Portugal will experience minor increases of their exports of fresh vegetables to Germany and the UK. Their exports of fresh fruits to Germany decline somewhat;

- Dutch fresh fruit exports are relatively hard hit. Dutch exports of fresh vegetables to Germany - including fresh tomatoes - may also decrease somewhat. The Netherlands will lose market share in the German and British market because Italy and the other Mediterranean countries will increase their exports while Dutch exports will more or less remain constant.

Table 4.5 Changes in German and British imports by exporter under scenario I (percentage changes)

	Germany				UK			
	Greece	Italy	Netherlands	Spain	Greece	Italy	Netherlands	Spain
Apples	0.0	4.6	-1.5	-1.0	1.3	5.9	-0.2	0.4
Citrus	1.0	5.5		0.0	1.7	6.3		0.7
Grapes	-0.7	3.8		-1.7	1.6	6.1		0.6
Pears	-0.9	3.6	-2.4	-1.9	0.9	5.5	-0.6	-0.1
Cucumbers	1.6	6.1	0.0	0.6	1.6	6.1	0.1	0.6
Peppers	1.5	6.1	0.0	0.5	1.7	6.2	0.2	0.7
Tomatoes	1.2	5.7	-0.3	0.2	1.6	6.1	0.0	0.6
Onions	0.9	5.5	-0.6	-0.1	1.6	6.1	0.1	0.6
Other vegetables	0.9	5.4	-0.6	-0.1	1.7	6.2	0.2	0.7

To conclude, the reduction in the production of processing tomatoes is partly compensated by the increase in the production of other fruits and vegetables. Grower prices of processing tomatoes decrease somewhat (table 4.2). Grower prices of other fruit and vegetables also fall because there is more land available for their production. Land prices fall in all European countries implying that fruit and vegetables production becomes more extensive.

4.3 The impact of decoupling

In this section, we discuss the impact of a subsidy reduction plus the introduction of area payments. We assume that area payments prescribe the allocation of some land to processing tomatoes in order to prevent unfair competition with producers of other vegetables, fruits and arable crops. The impact of area payments is modelled by assuming that the land allocation in the countries producing processing tomatoes adjusts partially to the price incentives implied by the subsidy reduction.

Land allocation adjusts partially to the price incentives implied by the reduction in the production subsidy and the associated fall in demand. Because land allocation does not adjust fully to the price incentives a gap arises between area and output developments. Output falls much harder than land (table 4.6). Because land use for processing tomatoes becomes more extensive, growers of processing tomatoes will employ less labour and capital. The resulting reduction in capital and labour costs will lead to a fall in grower prices due to sharp product competition.

Table 4. 6 The impact of scenario II on the processing tomato supply chain (percentage changes)

	Input prices of processing industry	Grower prices	Hectares	Output / Industry demand
Cyprus	32.2	-17.8	-14.2	-17.7
France	35.2	-14.8	-11.8	-14.7
Greece	35.3	-14.7	-9.5	-12.5
Hungary	33.3	-16.7	-12.8	-16.2
Italy	27.5	-22.5	-15.0	-19.5
Malta	32.0	-18.0	-14.3	-17.9
Poland	33.4	-16.6	-13.1	-16.4
Portugal	34.8	-15.2	-10.4	-13.4
Spain	36.4	-13.6	-9.9	-12.6
Morocco	-	0.0	0.4	0.4
Turkey	-	0.0	2.5	2.5
ROW	-	0.0	6.0	6.0

The basic difference between scenario I and scenario II is that under scenario I, growers of tomato processors are able to shift the burden of the price reduction to the producers of other crops by switching crops. In scenario II, the burden of the fall in grower prices falls primarily upon the growers of processing tomatoes (table 4.7).

Table 4.7 Grower price under scenario I and II (percentage changes)

	Greece		Italy		Portugal		Spain	
Scenario	I	II	I	II	I	II	I	II
Apples	-0.5	-0.1	-1.4	-0.1	-0.5	0.0	-0.3	0.0
Bananas	-0.5	0.0	-1.4	-0.7	-0.5	0.0	-0.3	0.0
Citrus	-0.5	-0.1	-1.4	-0.1	-0.5	0.0	-0.3	0.0
Cucumbers	-0.5	-0.2	-1.4	-0.4	-0.5	-0.2	-0.3	-0.1
Grapes	-0.5	-0.1	-1.4	-0.3	-0.5	-0.2	-0.3	-0.1
Onions	-0.5	-1.1	-1.4	-1.3	-0.5	-0.9	-0.3	-0.4
Other fruits	-0.5	-0.1	-1.4	-0.1	-0.5	0.0	-0.3	0.0
Other vegetables	-0.5	-1.1	-1.4	-1.4	-0.5	-0.9	-0.3	-0.4
Pears	-0.5	-0.1	-1.4	-0.1	-0.5	0.0	-0.3	0.0
Peppers	-0.5	-0.3	-1.4	-0.4	-0.5	-0.2	-0.3	-0.1
Tomatoes fresh	-0.5	-0.3	-1.4	-0.4	-0.5	-0.1	-0.3	-0.1
Tomatoes processing	-0.5	-14.7	-1.4	-22.5	-0.5	-15.2	-0.3	-13.6

The partial adjustment in land allocation and the impact on grower prices have major consequences for growers' substitution behaviour in the Mediterranean area. Growers of processing tomatoes will switch to arable crops and extensive vegetables production rather than fruits and fruit vegetables. Growers of processing tomatoes remain stuck in the production of arable crops and extensive vegetables and within this category they switch to products like onions, carrots and potatoes, but probably also to cereals, sugar beets and oil

seeds.[1] As a result of this lack of substitution behaviour in the Mediterranean area, North Europe is hardly influenced at all (see table 4.8). If production in North Europe is influenced at all, this refers to vegetables in the open.

Table 4.8 Area development in Europe under scenario 1I (percentage changes)

	Fruit	Vegetables in the open	Processing tomatoes	Fruit vegetables
Mediterranean	*0.4*	*1.3*	*-13.0*	*0.4*
Greece	0.4	1.4	-9.5	0.3
Italy	0.7	2.0	-15.0	0.6
Portugal	0.3	1.1	-10.4	0.2
Spain	0.1	0.6	-9.9	0.1
Rest of Europe	*0.0*	*0.0*	*-12.4*	*0.0*
Netherlands	0.3	-0.1	0.0	0.2
Rest of the world	*0.0*	*0.0*	*5.7*	*0.0*

4.4 Conclusion

A reduction in the production subsidy for processing tomatoes is likely to lead to a rise in the price tomato processors pay for raw tomatoes. This is especially likely if there are no substantial returns to scale in tomato production, and if the price elasticity of demand for European processing tomatoes is low. The rise in the price of processing tomatoes will lead to a fall in the demand for European processing tomatoes of 15-35 per cent given the assumptions made with respect to the price elasticity of demand and the substitution elasticities between exporters. There is discussion on this point.

More importantly, the reduction in the production subsidy will lead to a shift in Mediterranean agriculture from extensive arable and vegetables production to fruits and fruit vegetables. Mediterranean production of fruits and fruits vegetables will crowd out (replace) North European production of fruits and fruit vegetables. As a result, North European producers will switch to the production of other vegetables. Dutch fruit exporters will lose market share on their export markets to their South European competitors. To a lesser extent this also holds for Dutch (fruit) vegetables exporters.

If the reduction in the production subsidy for processing tomatoes is replaced by area payments, land allocation in the Mediterranean will be stuck in processing tomatoes. As a result, grower prices for processing tomatoes will fall substantially and there will hardly be any substitution to other crops. In this case, Mediterranean growers are likely to substitute to arable crops and extensive vegetables. The impact on North European production will be minor.

[1] Note that arable crops are not included in the model.

5. Conclusion

In 2006-2007, the European Union evaluates and possibly amends the Common Market Organisation (CMO) for fruits and vegetables. One of the principal elements of the current CMO is a production subsidy for processing tomatoes. The European Union considers reducing and decoupling the subsidy for processing tomatoes. The Dutch Ministry of Agriculture requested LEI to evaluate what the likely impact is of these changes on production and trade patterns for fruits and vegetables in the EU.

The report comes to the following findings:

- processing tomatoes are primarily grown on arable farms in rotation with crops such as cereals, oil seeds and other industrial crops such as sugar beets. So, from an agronomic perspective, one may expect a reduction in the subsidy for processing tomatoes to lead to a shift to other crops on arable farms such as cereals;
- the subsidy on processing tomatoes amounts to fifty percent of the grower price. The price effects of a change in the subsidy regime may be large. This implies that the stakes for the Mediterranean processing tomato industry are substantial.

More specifically, the report comes to findings for two scenarios: (I) the abolishment of the production subsidy for processing tomatoes; and (II) the abolishment of the production subsidy plus the introduction of a compensating area payment. The area payments are assumed to prescribe the allocation of some land to processing tomatoes in order to prevent unfair competition with growers of other vegetables, fruits and arable crops. Scenario I comes to the following conclusions:

- the reduction in the production subsidy is likely to be passed through into higher input prices for tomato processors. Input prices may rise with fifty percent. Grower prices will decrease to some extent (0-2%);
- demand for European processing tomatoes will fall with 15% in Greece, Portugal and Spain and more than 35% in Italy. The fall in demand may be compensated by the current growth in the demand for processing tomatoes. Demand for European processing tomatoes may fall harder, if imports from non-European production areas rise faster. Rickard (2003) indicates that the European market is sheltered from international competition due to transport costs. Italian experts expect non-European producers to be able to expand their exports to the EU substantially in the long run;
- the subsidy reduction will make not only the production of processing tomatoes less attractive, but also the production of other arable crops. As a result, Mediterranean farmers will switch production from arable crops and extensive vegetables to fruits and fruit vegetables. This result contrasts and complements the agronomic perspective posited above. One qualification need to be made in this respect. Mediterranean farmers may, of course, at least in theory, also switch to products not in the model such as meat and dairy production;

- in North European fruit markets, Mediterranean exporters crowd out domestic producers and other exporters. As a result, North European growers switch from fruit to vegetables production. This also holds for the Netherlands.

If the abolishment of the production subsidy is compensated by area payments, the above results change into the following results:

- grower prices fall substantially. Even though demand for processing tomatoes will fall substantially, Mediterranean growers will not adjust their land allocation fully (in order to collect area payments). The area allocated to processing tomatoes will fall by only 10-15%. Production of processing tomatoes, however, will diminish by 12-20%. They will produce more extensively and reduce capital and labour input. Grower prices will fall sharply with production costs. The burden of falling producer prices falls on growers of processing tomatoes only and is not shared by other producers of other crops as is the case in scenario I;
- mediterranean growers switch to vegetables in the open (and probably also to arable crops). They also switch to some extent to fruits and fruit vegetables. North European production is hardly influenced.

Basically, the paper stresses that the Mediterranean countries have a comparative advantage in the production of fruits and fruit vegetables rather than arable crops among which processing tomatoes. A reduction in the production subsidy for processing tomatoes will lead to a shift in production in the Mediterranean towards this advantage. Possible reductions in possible subsidies related to fruit production may countervail this development to some extent. In policy terms, processing tomatoes are the Mediterranean's defensive interests and fruits and fruit vegetables the Mediterranean's offensive interests. The production loss in horticulture and food processing for processing tomatoes will be compensated by other products. Of course, some production regions may face important adaptation costs. Area payments with restrictions on land use countervail the development towards comparative advantage. Area payments lower the adjustment burden for growers of processing tomatoes but at the cost of lower grower prices.

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Appendix 1. Estimating substitution elasticities

The Appendix gives a more elaborate overview of the estimations carried out to estimate the substitution elasticities. The first part refers to estimation of the land equations derived in HORTUS. The second part refers to a more general system of input (land) demand equations.

The HORTUS model

HORTUS models acreage allocation as follows:

$$ha_j = HA + y_j - \mathbf{y} + \tau(p_j - \mathbf{p}) \qquad (1)$$

Where

ha_j = area used in production of crop j
y_j = production of crop j
p_j = price of crop j
HA = total acreage available for all crops j
y = index of production of all crops j
p = index of prices of all crops j

More generally, equation (1) can be written as:

$$ha_j = \alpha_0 + \alpha_1 HA + \alpha_2 y_j + \alpha_3 \mathbf{y} + \alpha_4 p_j + \alpha_5 \mathbf{p} + \varepsilon \qquad (2)$$

Where the α's represent parameters to be estimated. HORTUS derives theoretical expectations with respect to the parameters in term of their sign and even their size. The coefficients of HA, y and y_j are predetermined. Since estimation of equation (2) without prior restrictions is time consuming, we estimated equation (2) with the a priori restrictions implied by equation (1).

The acreage allocation equation is estimated using Seemingly Unrelated Regressions (SURE). The equations are corrected for auto-regression whenever appropriate.

The results of the estimations are given by Table A1.1.

In HORTUS, the coefficient equals the substitution elasticity. In terms of equation 1, the coefficient has the following interpretation. If the price of lettuce rises 1% faster than the price index for vegetables in the open, the lettuce area will increase with 0.88% (at the detriment of some of the other vegetables in the open). The results suggest that substitution is important between apples and pears; and between vegetables in the open cultivated in arable farming. Substitution between vegetables in the open cultivated on horticultural farms is less common due to the large variety of different crops produced (lettuce, strawberries, asparagus, cabbage). Production knowledge and differences in soil and climate re-

quirements and availability are probably more product specific than for the other sub-groups.

Table A1.1 Estimation results for the Netherlands: intragroup elasticities

		Coefficient: Substitution Elasticity	Standard Error	Rho	DW coefficient
Fruit	Apple	0.88	0.0304	n.a.	2.30
	Pear	0.88	0.0304	n.a.	2.23
Fruit vegetables	Cucumbers	0.30	0.0566	1.00	2.20
	Tomatoes	0.30	0.0566	1.00	2.12
Vegetables in the open I - Arable farming	Beans	0.98	0.0086	n.a.	1.80
	Carrots	0.98	0.0086	n.a.	1.92
Vegetables in the open II - Horticulture	Asparagus	0.18	0.0064	0.51	0.87
	Cabbage	0.18	0.0064	0.30	1.91
	Cauliflower	0.18	0.0064	0.33	1.35
	Lettuce	0.18	0.0064	0.02	2.10
	Strawberry	0.18	0.0064	0.21	1.81

n.a. = not applied.

Table A1.2 Estimation results for the Netherlands: intergroup elasticities

	Coefficient: Substitution Elasticity	Standard Error	Rho	DW coefficient
Fruit	0.24	0.0159	0.42	2.79
Protected vegetables	0.24	0.0159	0.46	1.90
Vegetables in the open (Arable farming)	0.24	0.0159	0.20	0.20
Vegetables in the open (Horticulture)	0.24	0.0159	0.45	1.95

Substitution between the sub-sectors is low (Table A1.2). The substitution elasticity is 0.24% implying that if fruit prices rise with 0.24% relative to the price index for fruits and vegetables, fruit acreage rises with 0.24%. Note that the performance of the estimation in terms of the error term is not optimal. The Durbin-Watson coefficient is particularly low for greenhouse vegetables. We tried to incorporate other arable products into our estimations, but so far the results have been disappointing.

Table A1.3 and A1.4 give the results for Italy. In general, the results for Italy are less convincing than they are for the Netherlands. Autocorrelation is a more serious problem for Italy. The substitution elasticities found for Italy are lower than the ones found for the Netherlands. For the intragroup elasticity for fruit, this result is reasonable, since the fruit composite group is far more heterogeneous in Italy than it is in the Netherlands. For arable crops, this argument is less convincing, as far as we know.

Table A1.3 Estimation results for Italy: intragroup elasticities

		Coefficient: Substitution Elasticity	Standard Error	Rho	DW coefficient
Fruit	Apple	0.37	0.0030	0.30	2.03
	Citrus	0.37	0.0030	0.30	1.94
	Cherries	0.37	0.0030	0.30	1.77
	Grapes	0.37	0.0030	0.30	2.13
	Pears	0.37	0.0030	0.30	1.79
Crops in the open I - Arable farming	Beans	0.12	0.0116	0.25	0.48
	Carrots	0.12	0.0116	0.26	1.46
	Onions	0.12	0.0116	0.07	0.42
	Potatoes	0.12	0.0116	0.33	1.63
Crops in the open II - Horticulture	Asparagus	0.08	0.0118	0.38	0.61
	Cauliflower	0.08	0.0118	0.38	1.89
	Cucumbers	0.08	0.0118	0.38	1.93
	Lettuce	0.08	0.0118	0.38	1.34
	Strawberry	0.08	0.0118	0.38	0.38

Table A1.4 Estimation results for Italy: intergroup elasticities

	Coefficient: Substitution Elasticity	Standard Error	Rho	DW coefficient
Fruit	0.12	0.01133	.29	.67
Vegetables from arable farming	0.12	0.01133	.42	1.39
Vegetables from horticulture	0.12	0.01133	.40	.36

A more general system of land equations

Demand for land for the respective crops is also estimated using the following log-linear system of (ad hoc) demand equations:

$$\ln ha_j = \alpha + \beta \ln HA + \sum_{j=1}^{J} \gamma_j \ln p_j + \varepsilon$$

This system has been estimated using SURE and correcting for autocorrelation. In theory, one may also estimate systems of net output equations and submit them to theoretical expectations with respect to the parameters (homogeneity, symmetry and sign of the Hessian). The corresponding data requirements are higher. The estimation process is more elaborate.

Table A1.5 gives the (cross) price elasticities of land for a more general system of derived demand equations for land. Table A1.5 refers to both vegetables and arable products, the closest supply substitutes of (processing) tomatoes. The own price elasticity of land allocation equals 0.03-0.24%. The cross price elasticities suggest that cereals and (processing) tomatoes are complements and that (processing) tomatoes and other industrial crops (fodder beans, oil seeds, sugar beets and tobacco) are substitutes of (processing) tomatoes. Note that tomatoes and vegetables from intensive horticultural production are substitutes as well.

Table A1.5 Own and cross price elasticities for the demand for land in Italy

	Constant	Area	Cereals	Toma-toes	Arable vegeta-bles	Other vegeta-bles	Other crops	R^2	DW
Cereals	0,26	*0,97*	0,04	0,03	0,01	*-0,08*	-0,01	95	1,93
Tomatoes	-0,17	0,71	0,07	*0,25*	0,07	-0,17	0,02	28	1,51
Arable vegetables	-0,34	*0,81*	*0,38*	-0,09	*0,16*	*-0,36*	-0,03	93	1,99
Other vegetables	*13,57*	-0,10	*-0,08*	*-0,10*	*-0,04*	0,03	0,03	87	1,83
Other crops	-4,15	1,10	-0,27	-0,28	*-0,12*	*0,69*	0,06	27	1,79

Appendix 2. Changes in hectare use (percentage changes)

	Austria	BelLux	Cyprus	Czech Rep	Den-mark	Estonia	Finland	France	Ger-many	Greece	Hun-gary	Ireland	Italy	Latvia
Apples	-0.3	-0.3	0.0	-0.3	0.0	-0.1	0.0	-0.2	-0.1	0.6	0.4	0.0	3.6	-0.1
Bananas										0.9				
Citrus			-0.1					0.1		0.8			2.2	
Cucumbers	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.6	0.4	0.0	2.0	0.1
Grapes	0.0	-0.2	0.0	0.0				0.0	0.0	0.3	0.1		0.9	
Onions	0.3	0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.0	0.5	0.4	0.0	2.0	0.1
Other fruits	0.0	0.1	0.2	0.0	-0.3		-0.2	-0.1	0.0	0.6	0.1	0.0	2.7	-0.1
Other vegetables	0.1	0.1	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.5	0.4	0.0	1.8	0.1
Pears	-0.3	-0.3	0.1	0.2	0.0			-0.1	-0.3	1.1	0.3	0.0	2.5	-0.1
Peppers	0.2	0.1	0.2	0.4				0.0		0.5	0.7		1.6	
Tomatoes fresh	0.1	0.0	0.2	0.2	0.0	0.1	0.1	0.1	0.1	0.5	0.4	0.0	1.8	0.1
Tomatoes processed			-31.8					-18.5		-14.2	-23.8		-36.5	

	Lithua-nia	Malta	Mo-rocco	Nether-lands	Poland	Portu-gal	ROW	Slovak Rep	Slove-nia	Spain	Sweden	Turkey	UK
Apples	-0.1	0.0	0.0	-0.4	0.0	0.6	-0.2	-0.2	0.0	0.3	-0.2	-0.1	-0.1
Bananas			0.1			1.1	0.0			0.5		0.1	
Citrus		0.6	-0.1			0.6	-0.1			0.3		-0.1	
Cucumbers	0.1	0.0	0.1	0.1	0.2	0.5	0.0	0.1	-0.1	0.5	0.1	0.0	0.0
Grapes		-0.2	0.1	0.1		0.1	-0.1	-0.3	0.1	0.1		-0.3	-0.1
Onions	0.1	0.0	0.1	0.3	0.2	0.5	0.0	0.2	0.0	0.3	0.1	0.0	0.0
Other fruits	0.0	0.0	0.0	0.1	-0.1	0.6	0.0	0.1	-0.3	0.1	-0.3	0.0	-0.2
Other vegetables	0.1	0.0	0.1	0.0	0.2	0.5	0.0	0.1	-0.1	0.3	0.1	0.0	0.0
Pears	-0.1	0.0	0.1	-0.3	0.1	0.6	-0.1	-0.1	0.1	0.2	-0.1	0.0	-0.2
Peppers		0.0	0.1	0.2		0.6	0.0	0.3		0.4		0.0	0.0
Tomatoes fresh	0.0	0.0	0.0	0.1	0.3	1.0	-0.1	0.1		0.4	0.1	0.0	0.0
Tomatoes processed		-26.7	0.7		-24.3	-15.7	10.6			-14.7		4.0	

Appendix 3. Changes in output (percentage changes)

	Austria	BelLux	Cyprus	Czech Rep	Den-mark	Estonia	Finland	France	Ger-many	Greece	Hun-gary	Ireland	Italy	Latvia
Apples	-0.3	-0.3	0.0	-0.3	0.0	-0.1	0.0	-0.2	-0.1	0.5	0.4	0.0	3.6	-0.1
Bananas										0.8				
Citrus			-0.1					0.1		0.8			2.2	
Cucumbers	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.6	0.4	0.0	2.0	0.1
Grapes	0.0	-0.2	0.0	0.0				0.0	0.0	0.3	0.1		0.9	
Onions	0.3	0.2	0.2	0.3	0.1	0.1	0.1	0.0	0.0	0.5	0.4	0.0	2.0	0.1
Other fruits	0.0	0.1	0.1	0.0	-0.3	0.0	-0.2	-0.1	-0.1	0.6	0.1	0.0	2.7	-0.1
Other vegetables	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.5	0.4	0.0	1.7	0.1
Pears	-0.3	-0.3	0.1	0.2	0.0			-0.1	-0.3	1.1	0.3		2.4	-0.1
Peppers	0.2	0.1	0.2	0.4				0.0		0.5	0.7		1.6	
Tomatoes fresh	0.1	0.0	0.2	0.2	0.0	0.1	0.1	0.1	0.1	0.5	0.4	0.0	1.8	0.1
Tomatoes processed			-31.8					-18.5		-14.2	-23.8		-36.5	

	Lithua-nia	Malta	Mo-rocco	Nether-lands	Poland	Portugal	ROW	Slovak Rep	Slove-nia	Spain	Sweden	Turkey	UK
Apples	-0.1	0.0	0.0	-0.4	0.0	0.6	-0.2	-0.2	0.0	0.3	-0.2	-0.1	-0.1
Bananas			0.1			1.1	0.0			0.5		0.1	
Citrus		0.5	-0.1			0.6	-0.1			0.3		-0.1	
Cucumbers	0.1	0.0	0.1	0.1	0.2	0.5	0.0	0.1	-0.1	0.5	0.1	0.0	0.0
Grapes		-0.3	0.1	0.1		0.1	-0.1	-0.3	0.0	0.0		-0.3	-0.1
Onions	0.1	0.0	0.1	0.3	0.2	0.5	0.0	0.2	0.0	0.3	0.1	0.0	0.0
Other fruits	-0.1	-0.1	0.0	0.1	-0.1	0.6	0.0	0.1	-0.3	0.1	-0.3	0.0	-0.2
Other vegetables	0.1	0.0	0.0	0.0	0.2	0.5	0.0	0.1	-0.1	0.3	0.1	0.0	0.0
Pears	-0.1	0.0	0.1	-0.3	0.1	0.6	-0.1	-0.1	0.1	0.2	-0.1	0.0	-0.2
Peppers		0.0	0.1	0.2	0.0	0.5	0.0	0.3		0.4		0.0	
Tomatoes fresh	0.0	0.0	0.0	0.1	0.3	1.0	-0.1	0.1		0.4	0.1	0.0	0.0
Tomatoes processed		-26.7	0.7		-24.3	-15.7	10.6			-14.7		4.0	