The Effects of Energy Price Increases on Dutch Horticulture

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Abstract
This paper elaborates on the effects of a rise in energy costs for Dutch glasshouse horticultural producers. The effects on production, bilateral trade and consumption in 25 European countries plus Morocco, Turkey and the Rest of the World, are estimated using a version of the HORTUS partial equilibrium supply and demand model. This model includes 11 sorts of fruit and vegetables, and two categories of ornamental plants and flowers. As energy, especially natural gas, is a major intermediate input in Dutch glasshouse horticulture, it has potentially large impacts on producers and trade. The results indicate that a 10 percent increase in energy prices could cause significant shifts in production and trade flows, as well as some changes in consumption patterns. The effects are larger for more export oriented products, and dependent on the nature of competition on foreign as well as domestic markets.

Keywords: energy costs; glasshouse vegetables and flowers; model of international trade.
JEL-classification: F15, F17, Q17

1 Introduction

Horticulture takes up a considerable share in agricultural output in the Netherlands. In 2003 horticultural output was 14 and 27 percent of total agricultural output, for vegetables and ornamentals respectively. Being relatively capital and labour intensive, instead of land intensive like dairy farming, horticulture seems to suit the Netherlands well, as land is not an abundant factor. An important intermediate input in glasshouse vegetables and flowers production is energy. Energy, mostly natural gas for heating glasshouses, represent about 37 percent of the costs of intermediate inputs. This energy intensive process may proof vulnerable to shocks in energy prices. Recently, energy prices have shown considerable increases.

This paper presents the results of model simulations of a rise in heating gas prices for Dutch glasshouse vegetables and ornamental flowers and plants producers. For our estimations we use the recently developed HORTUS model. This partial equilibrium model simulates supply and use of horticultural products in the EU-25 countries, plus Morocco, Turkey and the Rest of the World. The model distinguishes 11 kinds of fruit and vegetables and two kinds of ornamentals: ornamental (cut) flowers and nursery plants.

2 Cost structure of Dutch glasshouse horticulture

Table 1 shows an overview of costs of glasshouse vegetables and cut flowers producers in the Netherlands. This table makes clear that glasshouse vegetables and flowers have almost similar costs of production. There are, however, some apparent differences. Most flowers require relatively expensive nursery material (bulbs or slips and cuttings) and use more pesticides, in comparison with vegetables. The most interesting difference relates to the use of natural gas for heating. Glasshouse vegetables – primarily tomatoes, cucumbers and peppers – are produced more energy intensive than flowers.

Table 1. Division of total costs for Dutch glasshouse horticultural production, average 2001-2003.

	Vegetables	Cut flowers
Plant assets, pesticides, fertilizer, etc.	0.22	0.31
Energy	0.24	0.20
- *natural gas*	0.21	0.15
Labour costs	0.26	0.21
Capital costs	0.21	0.24
General/other costs	0.06	0.05
Total costs	1.00	1.00

Source: LEI Information net

Intermediate inputs taken together make up about 50 percent of production costs. Hereof, 46 and 29 percent goes to natural gas for heating, for vegetables and cut flowers respectively. Between 2000 and 2004 energy prices have risen with as much as 10 to 30 percent, dependent on the type of buyer. There are many reasons to believe that prices will continue to increase in the future, putting pressure on Dutch horticultural prices. Producers respond by agreeing long-term contracts with energy suppliers (in the newly liberalized Dutch energy market), or investing in energy preserving measures, such as heat screens, or total energy principles. Some producers have turned the tables around and produce their own electricity.

3 Economic structure

This section outlines the economic structure in HORTUS as well as the demand and supply relations.

3.1 Economic structure

HORTUS is based on a simple input-output structure constructed on basis of commodity balance information and additional cost information (see section 4). The output value of commodity j in region s at market prices is indicated by VOM(j,s). The output value equals the sum of all intermediary inputs used in industry j in region r VIFM(j,s) and value added in industry j in region s $\sum_{i=1}^{2} VEFM(i,j,s)$:

$$VOM(j,s) = VIFM(j,s) + \sum_{i=1}^{2} VEFM(i,j,s)\,. \qquad (1)$$

This equality simply says that output value equals the sum of all outlays on intermediary inputs and labour and the return to capital. The value of all outlays on intermediary inputs is identified for each commodity j and each region s. Value added is identified for both labour and capital for each commodity j and region s. At this moment, intermediary inputs are not subdivided into more specific categories such as expenses for energy, seed, pesticides, *et cetera*.

The available amount of commodities in a country VOIM(j,r) equals the sum of production and imports.

$$VOIM(j,s) = VOM(j,s) + \sum_{r=1}^{R} VIMS(j,r,s) \qquad (2)$$

Import value VIM(j,r,s) is identified for each commodity j, country of origin r and country of destination s.

There are two possible destinations for the supply available: domestic use and exports VXMD(j,r,s,). Domestic use is subdivided into human consumption VPM(j,s) and other uses VFM(j,s), predominantly food industry demand. Available supply in region s may thus be subdivided into:

$$VOIM(j,r)=VPM(j,r)+VFM(j,r)+\sum_{s=1}^{S} VXMD(j,r,s)\,. \tag{3}$$

Private consumption VPM(j,r) is identified for each commodity j and region r. Other uses VFM(j,r) are identified for each commodity j and region r. Finally, exports VXMD(j,r,s) are identified for each commodity j, country of origin r and country of destination s.

Private consumption is further subdivided into two categories: domestic origin (VDPM) and imports (VIPM)

$$VPM(j,r) = VDPM(j,r)+VIPM(j,r). \tag{4}$$

Likewise, other uses are subdivided into domestic origin and imports:

$$VFM(j,r) = VDFM(j,r)+VIFM(j,r). \tag{5}$$

Consumption and other uses are identified for each commodity j and source region r. Imports are aggregated for this purpose.

3.2 Price relations

HORTUS identifies a great number of prices: producer prices, market prices, export prices, import prices and consumer prices. Figure 1 relates the prices identified in HORTUS. The prices differ from each other due to taxes, subsidies, import and export taxes and subsidies, trade margins and transport costs. In this section, we follow the product from producer to consumer and distinguish all relevant price levels.

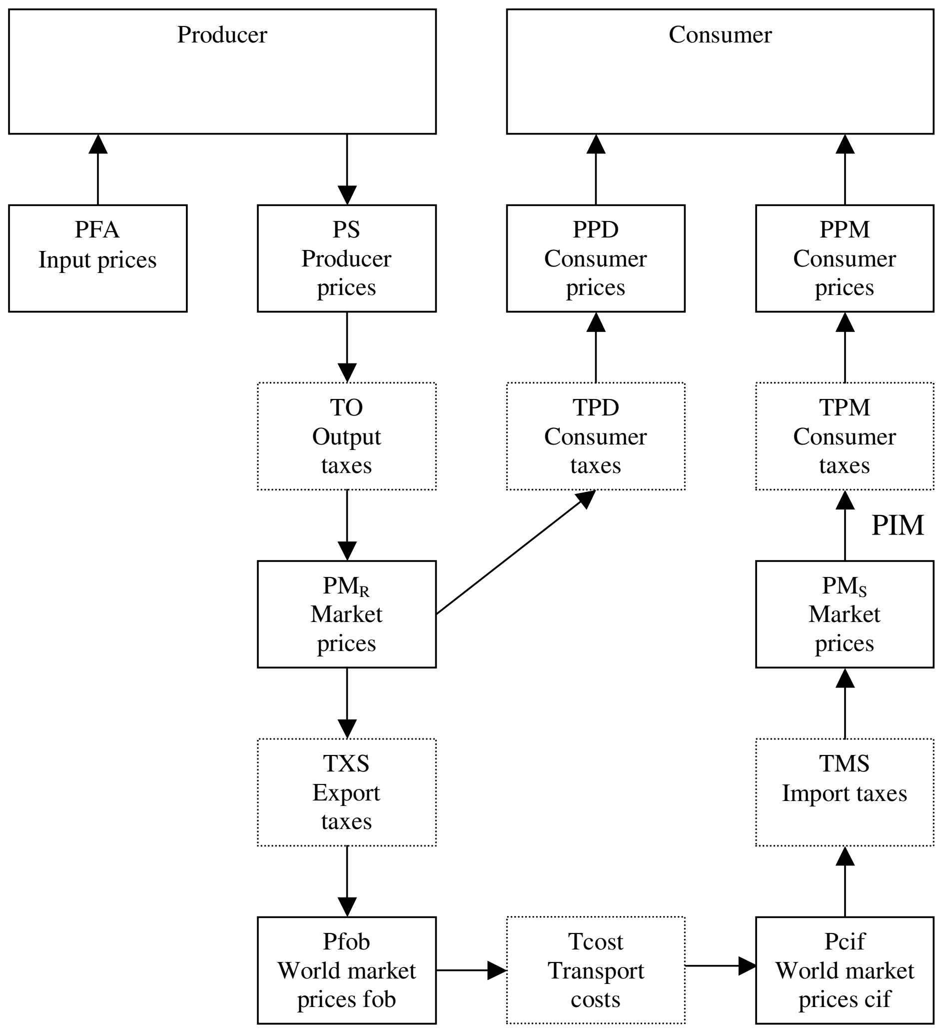

Figure 1. Price relations.

The producer receives producer price PS. If the product is taxed or subsidised, output tax TO creates a wedge between the producer price PS and the market price PM. The commodity is sold for domestic use or exports. Consumer tax and trade margins TPD create a wedge between the market price PM and the consumer price PPD. Commodities are exported at export price P_{fob}. The difference between the market price PM and the export price P_{fob} is equal to the export tax TXS. Import prices P_{cif} are obtained by adding transport costs T_{cost} to the free on board export prices P_{fob}. The market price of imported commodities PMS may be obtained by adding import taxes TMS to the import price P_{cif}. Again, for imported products consumer taxes TPM create a wedge between market prices PM and consumer prices PPM. The model also identifies the input prices the producers face as well as the taxes and subsidies on these inputs. These taxes may be used to model e.g. changes in energy policy.

3.3 Demand

Commodity demand depends on a nested CES structure (Figure 2). Demand for all commodities within the nest is determined as a function of the nest's budget share and the prices of all commodities within the nest. The prices of all other commodities only influence the demand of the commodities within the nest in as far as they determine the nest's budget share. The price of Spanish tomatoes determines the budget share of Spanish versus Dutch tomatoes in e.g. Germany and indirectly the budget share of imported versus domestic tomatoes in Germany and even more indirectly the budget share of tomatoes versus other vegetables. Demand substitution between fruits and vegetables on one hand and all other commodities on the other hand is not considered as yet. HORTUS distinguishes nests for fruits and vegetables; ornamentals; and processed fruits and vegetables.

Consumer demand is derived from the following CES function:

$$Y = A\left(\sum_{i=1}^{N} \delta_i y_i^{\alpha}\right)^{1/\alpha} \tag{6}$$

where Y represents the demand for the product group and y_i the demand for the individual commodities, where $Y = \sum y_i$. A, α and δ_i are parameters where $\sum \delta_i = 1$. Parameter α is related to the elasticity of substitution: σ = 1/(1-α).

The utility maximisation problem for a nest is defined as follows:

$$L = A\left(\sum_{i=1}^{N} \delta_i y_i^{\alpha}\right)^{1/\alpha} - \lambda\left(\sum_{i=1}^{N} p_i y_i - I\right) \tag{7}$$

where I indicates the budget and p_i commodity i's price. Maximising utility gives the following demand function:

$$y_i = \frac{\delta_i^{\sigma} I}{p_i^{\sigma} \boldsymbol{p}^{1-\sigma}} \tag{8}$$

where $\boldsymbol{p} = \left(\sum_{i=1}^{N} \delta_i^{\sigma} p_i^{1-\sigma}\right)^{1/(1-\sigma)}$ represents the price index of Y. Linearising equation (7) gives the following equation to be used in the simulation model:

$$\overline{y}_i = \overline{i} - \overline{\boldsymbol{p}} + \sigma\left(\overline{\boldsymbol{p}} - \overline{p}_i\right) \tag{9}$$

where the 'upper bar' denotes percentage changes.

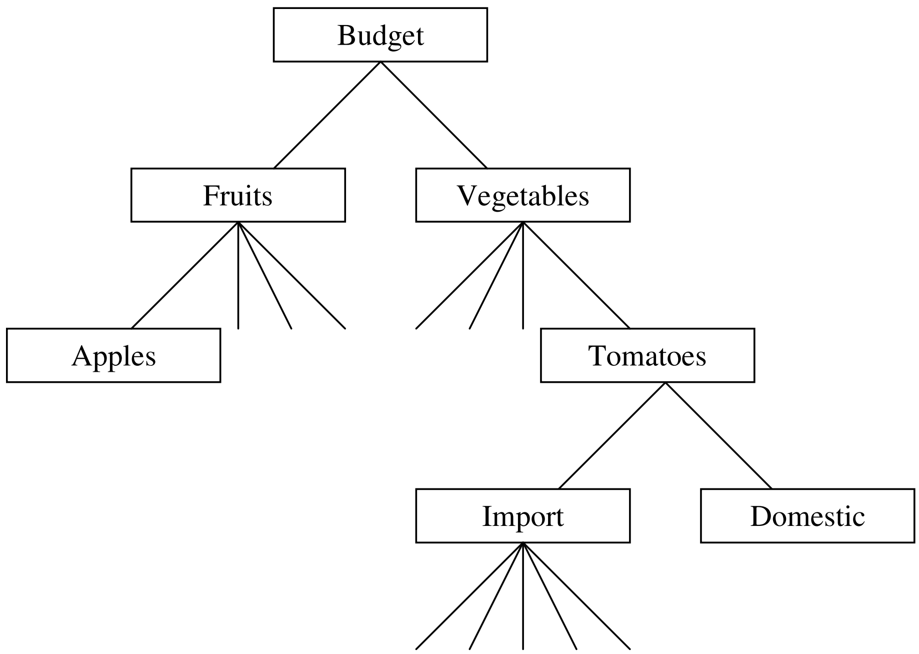

Figure 2. Demand structure.

3.4 Supply

The production of each commodity j depends on the input of land, labour, capital and intermediary inputs (Figure 3). Following GTAP, we assume a Leontief relation between intermediary inputs on one hand and land, labour and capital on the other hand. The Leontief relation assumes a linear relation between production and intermediary inputs. The relation between the three production factors and output is modelled using a CES production function. Land is more or less a fixed factor whose input is combined with the input of labour and capital. The CES function employed is the following:

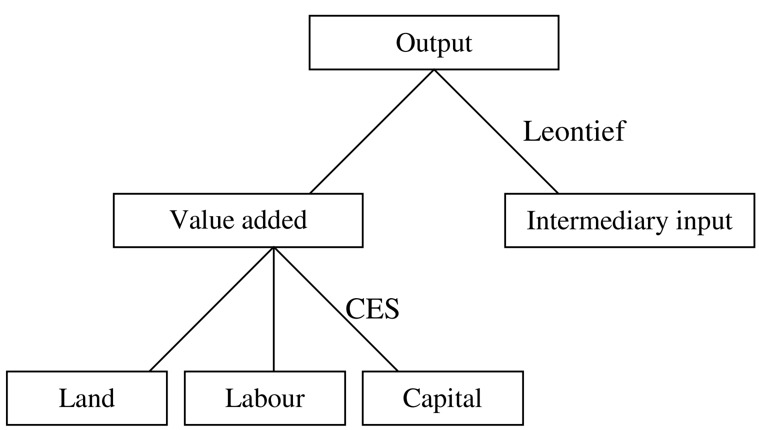

Figure 3. Supply structure.

$$y_j = \left(\gamma_{haj} ha_j^{\varphi} + \sum_{i=1}^{M} \gamma_{ij} x_{ij}^{\varphi}\right)^{1/\varphi} \qquad (10)$$

where y_j denotes output of commodity j, ha_j acreage employed in the production of commodity j; x_{ij} refers to the quantity of input i used in the production of commodity j; and γ_{ij} and φ are parameters. The elasticity of substitution τ is a function of φ: $\tau = 1/(1-\varphi)$. Acreage is modelled separately from the other inputs, because total acreage available for agricultural (horticultural) uses is more or less fixed and depends - among other things - on government decisions with respect to rural planning.

A representative producer decides on inputs and outputs using cost minimisation and profit maximisation objectives.

$$\max \Pi\left(y_j, ha_j, x_{ij}\right) = \sum_{j=1}^{M} p_j y_j - \sum_{j=1}^{M} \sum_{i=2}^{N} w_i x_{ij} - \mu\left(\sum_{j=1}^{M} ha_j - HA\right) \qquad (11)$$

Producer profits equal revenues: price times quantity (over j commodities) minus costs: input prices w times input quantities (over all j commodities and all i inputs). Finally profits depend on one physical constraint: the availability of land for horticultural uses. Profits may be maximised using a three step procedure: (1) deciding on non-land inputs by minimising costs; (2) deciding on output by maximising profits; and (3) deciding on acreage given short run output and price decisions.

Input demand
The cost minimisation problem is modelled as follows:

$$\min C\left(x_{ij}\right) = \sum_{j=1}^{M} \sum_{i=2}^{N} w_i x_{ij} - \lambda\left(\sum_{j=1}^{M}\left(\left(\gamma_{haj} ha_j^{\varphi} + \sum_{i=2}^{N} \gamma_{ij} x_{ij}^{\varphi}\right)^{1/\varphi} - y_j\right)\right) \qquad (12)$$

where C represents non-land production costs. Minimising costs with respect to x_{ij} gives the following expression for x_{ij} after some tedious substitution:

$$x_{ij} = y_j \left(\frac{\gamma_{ij} w_j}{w_i}\right)^{\tau} \left(1 - \frac{MP_{haj}}{AP_{haj}}\right)^{1/\varphi} \qquad (13)$$

where $\mathbf{w_j} = \left(\sum_{i=2}^{N} \gamma_{ij}^{\tau} w_i^{1-\tau}\right)^{1/(1-\tau)}$ represents the aggregate input price for commodity j. The demand for input i for the production of commodity j depends on the production of commodity j (y_j), the price of input i (w_i) versus the aggregate input price ($\mathbf{w_j}$) and the returns to non-land factor inputs $\frac{MP_{haj}}{AP_{haj}} = \gamma_{haj}\left(\frac{ha_j}{y_j}\right)^{\varphi}$, where MP_{haj} denotes the marginal product of land for commodity j and AP_{haj} the average product of land for commodity j, i.e. the yield for commodity j. In a linearised form the demand for factor inputs transforms to:

$$\overline{x_{ij}} = \overline{y_j} + \tau\left(\overline{\mathbf{w_j}} - \overline{w_i}\right) + \pi_j\left(\overline{y_j} - \overline{ha_j}\right). \qquad (14)$$

where $\pi_j = \left(\frac{MP_{haj}/AP_{haj}}{1 - MP_{haj}/AP_{haj}} \right)$. The last term on the right hand side models diminishing returns to labour and capital. If output is to increase more than acreage input $\left(\overline{y}_j > \overline{ha}_j\right)$, labour and capital input should increase with a factor $\left(\pi_j\left(\overline{y}_j - \overline{ha}_j\right)\right)$ above the output increase $\left(\overline{y}_j\right)$.

Supply

One may derive short-run output y_j (or equivalently short-run price p_j) as a function of equilibrium inputs x_{ij} by substituting x_{ij} into the profit function (equation (9)) and maximising this function towards y_j. The first order derivative equals

$$p_j = \mathbf{w_j} \left[1 - \frac{MP_{haj}}{AP_{haj}} \right]^{1/\varphi}. \tag{15}$$

The supply price p_j depends on aggregate input costs $\mathbf{w_j}$ and diminishing returns to capital and labour input given acreage. Linearising this function gives the short-run inverse supply function:

$$\overline{p}_j = \overline{\mathbf{w}_j} + \pi_j\left(\overline{y}_j - \overline{ha}_j\right) \tag{16}$$

Acreage

The last optimisation problem refers to acreage input: how does the producer divide available acreage over the respective commodities to be produced. Maximising profits towards ha_j give the following expression for ha_j after some tedious substitution:

$$ha_j = \frac{HA\, y_j \left(\gamma_{haj} p_j\right)^{1/(1-\varphi)}}{\left(\sum_{j=1}^{M}\left(y_j\left(\gamma_{haj} p_j\right)^{1/(1-\varphi)}\right)\right)}. \tag{17}$$

One may linearise this equation to the following equation:

$$\overline{ha}_j = \overline{HA} + \overline{y}_j + \tau\overline{p}_j - \sum_{k=1}^{M}\left(s_k\, \overline{y}_k\right) - \sum_{k=1}^{M}\left(\tau s_k\, \overline{p}_k\right) \tag{18}$$

where $s_j = ha_j/HA$ denotes the share of the land used for commodity j divided by all land available. Acreage available for commodity j depends positively on total acreage (HA) and the output and price of commodity j (y_j and p_j respectively) and the output and price of all other commodities k (y_k and p_k respectively).

4 Data

HORTUS models production, consumption and bilateral trade for 27 regions: the EU25 – Belgium and Luxemburg are one region – Morocco, Turkey and the Rest of the World. The model specifies thirteen product categories, six fruits, five vegetables and two ornamental flowers and plants (Table 2). The model distinguishes four inputs: land (areas), intermediary inputs, labour and capital (values). The model distinguishes human consumption and other uses, notably processing. We have data on processing for grapes, apples, citrus and tomatoes, the most processed fruits and vegetables.

Table 2. Product and country choice.

Vegetables	Fruit	Ornamentals	Countries	Inputs
Cucumbers	Apples	Flowers	EU-25	Land (area)
Onions	Bananas	Nursery plants	Morocco	Intermediary
Sweet peppers	Citrus		Turkey	inputs
Tomatoes	Grapes		Rest of the World	Labour
Other vegetables	Pears			Capital
	Other fruit			

The data structure contains four elements:

1. Commodity balances;
2. Bilateral trade data;
3. Price information;
4. Cost information.

These data have been collected as follows:

1. The commodity balances relate production and aggregate import (domestic supply) to aggregate exports and domestic use (domestic use). Domestic use is split in human consumption, processing and other uses. Commodity balance information is obtained from FAO and Eurostat. If commodity balance information was not available, we used FAO and Eurostat production and trade data to construct a commodity balance (Bunte and Van Galen, 2005). If we do so, all domestic use is human consumption, unless we have information otherwise.
2. Bilateral trade data are obtained from PCTAS and Eurostat Comext (peppers). Bilateral trade data are matched with aggregate import and exports data in the commodity balances using RAS techniques.
3. The model calculates export price data on basis of the original data on bilateral exports. All other prices have been set equal to these data.
4. RICA cost information has been used to break down production value in input shares. We used information on actual expenses on intermediary inputs and paid labour and capital. We calculated the opportunity costs of unpaid labour and capital. The difference between the production value and actual expenses have been allocated to unpaid labour and capital.

5 Results

This section presents the results of an increase in the price of energy in the Netherlands by 25 percent. This figures roughly relates to the increase in gas and electricity prices since 2000. Starting from the situation in the year 2000 (current version of the model) this increase leads to a new equilibrium regarding production volumes, land use, demand for input goods and production factors capital and labour, as well as new bilateral trade patterns and consumption. It leads to changes in the competitive position of the Netherlands vis-à-vis it's rival producers, most notably for the affected energy intensive products. We pay special attention to the difference between on the one hand vegetables and flowers, and on the other hand the different types of glasshouse vegetables (cucumbers, tomatoes and peppers).

In terms of domestic changes, the cost of production will increase by about 11 percent (0.46*25) for vegetables and 7.5 percent for flowers (0.30*25). For simplicity, we assume a general increase in intermediate input costs of 10 percent. For nursery plants we model a lower increase of only 5 percent , due to the fact that many plants and nursery stock are produced outside requiring little energy.

Producer prices
The rise in prices of intermediates increases producer prices in the Netherlands. Naturally, this increase is more pronounced for ornamental flowers and glasshouse vegetables than for nursery plants, as the increase was lower for the latter. For reasons beyond the scope of this article, the increase in producer prices of nursery plants is counterbalanced by an increase in the availability of land formerly occupied by the energy intensive glasshouses.

Table 3. Changes in producer prices in the Netherlands.

Apples	-0.40
Bananas	-0.40
Citrus	-0.40
Cucumbers	4.24
Grapes	-0.40
Nursery Plants	0.70
Onions	-0.27
Ornamental flowers	4.79
Other Fruits	-0.40
Other Vegetables	-0.27
Pears	-0.40
Peppers	4.24
Tomatoes	4.09

The change in producer prices is translated into export prices and consumption prices of domestic products. Substitution takes place between on the one hand domestic and foreign produce, and on the other hand particular products are substituted for other, less expensive, ones.

Land use
We notice that land used for the production of both glasshouse vegetables and ornamentals decreases considerably in the Netherlands. Expectedly, the burden falls more heavily on the vegetables, for which land use decreases even more than 10 percent. Ornamentals land use decreases less than 5 percent (in hectares) although the shock to input costs was the same 10 percent. Tomatoes are affected the most with a decrease of 12.9 percent in hectares in the Netherlands. On average the total area of horticultural products doesn't change much in the Netherlands or elsewhere. (See Table 4)

Table 4. Absolute changes in land use, hectares (% change between brackets).

	Netherlands	Spain	Rest EU-15	New EU members	Morocco	Turkey	Rest of the World
Apples	263 (2.05)	-29 (-0.06)	-215	-93	-3	-11	-943
Bananas	0	-4 (-0.05)	0	0	0	0	-417
Citrus	0	-526 (-0.09)	0	-1	-31	-18	-1298
Cucumbers	-69 (-10.51)	343 (4.83)	116	51	0	13	390
Grapes	0.3 (0.79)	-447 (-0.04)	-43	-16	0	-54	0
NursMat	115 (1.01)	-0.4 (-0.02)	-194	-8	0	-1	0
Onions	189 (1.43)	-14 (-0.06)	18	-28	0	-12	0
Ornamentals	-1189 (-4.52)	23 (0.42)	95	14	9	14	150
OthFruits	40 (0.79)	-215 (-0.08)	-262	-64	-12	-25	0
OthVegs	821 (1.47)	-107 (-0.05)	384	11	-9	0	0
Pears	121 (2.01)	-36 (-0.09)	-75	-7	0	-4	-139
Peppers	-144 (-11.98)	436 (1.88)	40	60	4	45	859
Tomatoes	-146 (-12.92)	512 (0.85)	160	82	34	68	1719

Sector output

Tables 5 to 7 present results on demand for labour and capital, demand for intermediate inputs, sector output, and household demand in all regions. These tables describe in detail what happens to production and consumption. Demand for intermediate inputs, including energy, has a one-to-one relation to output, via the Leontief function.

The results show that in terms production and intermediate input demand (energy among others) tomato producers are worse off than producers of ornamentals, and other glasshouse vegetables. This result might seem peculiar, because producer prices of tomatoes increase less than those of the other affected products.

We can explain this fact by looking at the economic structure of the model. First, why do vegetables' output decline more than ornamentals? Exporters of ornamental face less competition and are better able to pass on price increases. In other words, in vegetables markets there are more suppliers and consequently the increase in Dutch export prices is translated more strongly in the difference vis-à-vis average export prices of it's competitors. Elasticities of substitution between Dutch and e.g. Spanish tomatoes are significantly larger than for ornamentals.

Second, why are tomato producers in a less favourable position than cucumbers or pepper producers? This is partly explained by the fact that tomatoes are exported more than the other two products. However, the difference is small, 81 percent for tomatoes, against 78.5 and 75 percent for peppers and cucumbers. However, Dutch tomato producers face more competition from foreign producers, most notably Spain. Where Dutch exporters claim over 50 percent of the German cucumber import market, the share for tomatoes is less than one third.

Table 5. Changes in demand for labour and capital, % changes.

	Apples	Bananas	Citrus	Cucumbers	Grapes	Nurs. Mat	Onions	Ornamentals	Oth. Fruits	Oth. Vegs	Pears	Peppers	Tomatoes
Austria	-0.07	0.00	0.00	1.42	0.00	-0.37	-0.02	0.16	-0.02	0.04	-0.04	0.00	0.51
Belgium & Lux.	-0.15	0.00	0.00	2.99	0.00	-0.26	0.00	0.90	0.00	0.00	-0.21	2.64	2.28
Cyprus	-0.02	0.00	-0.02	0.03	-0.01	0.00	0.02	0.00	-0.02	0.02	-0.02	0.19	0.19
Czech Rep.	-0.07	0.00	0.00	0.14	-0.01	-0.28	0.02	0.04	-0.02	0.03	-0.02	0.22	0.26
Denmark	0.02	0.02	0.02	1.14	0.02	0.22	0.08	3.15	-0.12	0.08	-0.27	0.02	1.84
Estonia	-0.05	0.00	0.00	0.53	0.00	0.00	-0.04	0.00	0.00	0.04	0.00	0.00	0.92
Finland	-0.09	0.00	0.00	0.17	0.00	-0.16	0.02	0.02	-0.04	0.05	0.00	0.00	0.53
France	-0.07	0.00	0.00	0.54	0.00	-0.26	-0.02	0.08	-0.01	0.00	-0.07	0.00	0.40
Germany	-0.15	0.00	0.00	2.00	-0.04	-0.42	0.18	0.05	-0.11	0.22	-0.18	0.00	1.66
Greece	0.00	0.00	0.00	0.62	-0.02	-0.19	0.00	-0.06	-0.01	0.00	-0.05	0.18	0.00
Hungary	-0.02	0.00	0.00	0.19	0.00	-0.09	-0.01	0.26	-0.04	0.00	-0.02	0.81	0.22
Ireland	0.02	0.02	0.02	1.32	0.02	-0.19	0.02	0.63	-0.07	0.04	0.02	3.23	1.39
Italy	-0.09	0.00	0.00	0.39	0.00	0.05	-0.01	0.31	-0.02	0.00	-0.07	0.15	0.07
Latvia	-0.07	0.00	0.00	0.12	0.00	0.00	0.00	-0.39	-0.03	0.02	-0.12	0.00	0.63
Lithuania	-0.04	0.01	0.01	0.63	0.01	0.01	-0.01	0.01	-0.02	0.01	-0.09	0.01	2.24
Malta	-0.01	-0.01	-0.02	-0.01	-0.05	-0.01	-0.01	-0.01	-0.07	-0.01	-0.09	-0.01	-0.01
Morocco	0.00	0.00	-0.01	0.04	0.00	0.01	0.00	4.71	0.00	0.00	0.00	0.06	0.13
Netherlands	0.86	-0.40	-0.40	-11.00	-0.40	-2.73	0.62	-6.67	-0.40	0.65	0.82	-12.48	-12.96
Poland	-0.02	0.00	0.00	0.08	0.00	0.00	-0.07	0.61	-0.01	0.00	-0.02	0.00	0.17
Portugal	-0.01	0.00	0.00	0.01	0.00	-0.16	0.00	-0.03	0.00	0.00	-0.07	0.00	0.04
ROW	-0.02	-0.01	0.00	0.02	0.00	0.00	0.00	0.07	0.00	0.00	-0.01	0.06	0.05
Slovak Rep.	-0.02	0.01	0.01	0.25	-0.01	0.01	-0.03	0.09	0.00	-0.01	-0.03	0.25	0.15
Slovenia	-0.01	0.01	0.01	0.00	0.00	-0.70	-0.05	0.39	-0.02	-0.01	0.00	0.01	0.01
Spain	-0.03	-0.01	-0.05	4.87	0.00	0.01	-0.02	0.46	-0.05	-0.02	-0.05	1.91	0.89
Sweden	-0.24	0.04	0.04	1.44	0.04	-0.29	0.30	0.04	-0.17	0.27	-0.26	0.04	1.80
Turkey	0.00	0.00	0.00	0.03	-0.01	-0.34	0.00	3.95	0.00	0.00	-0.01	0.07	0.03
United Kingdom	-0.10	0.02	0.02	0.88	0.02	-0.56	0.11	0.22	-0.08	0.10	-0.19	1.96	0.47

Table 6. Changes in output and consequently demand for intermediate inputs, % changes.

	Apples	Bananas	Citrus	Cucumbers	Grapes	Nurs. Mat	Onions	Ornamentals	Oth. Fruits	Oth. Vegs	Pears	Peppers	Tomatoes
Austria	-0.07	0.00	0.00	1.42	0.00	-0.37	-0.01	0.16	-0.02	0.04	-0.04	0.00	0.51
Belgium & Lux.	-0.15	0.00	0.00	2.99	0.00	-0.26	0.00	0.90	0.00	0.00	-0.21	2.64	2.28
Cyprus	-0.02	0.00	-0.02	0.03	0.00	0.00	0.02	0.00	-0.01	0.02	-0.02	0.20	0.19
Czech Rep.	-0.07	0.00	0.00	0.15	0.00	-0.27	0.02	0.04	-0.01	0.03	-0.02	0.23	0.27
Denmark	0.00	0.00	0.00	1.11	0.00	0.20	0.06	3.13	-0.14	0.06	-0.29	0.00	1.82
Estonia	-0.05	0.00	0.00	0.53	0.00	0.00	-0.03	0.00	0.00	0.04	0.00	0.00	0.92
Finland	-0.09	0.00	0.00	0.17	0.00	-0.16	0.02	0.02	-0.04	0.05	0.00	0.00	0.53
France	-0.07	0.00	0.00	0.55	0.00	-0.26	-0.02	0.08	-0.01	0.01	-0.06	0.00	0.41
Germany	-0.15	0.00	0.00	2.01	-0.03	-0.42	0.18	0.06	-0.11	0.22	-0.17	0.00	1.66
Greece	0.00	0.00	0.00	0.63	-0.02	-0.18	0.00	-0.06	-0.01	0.00	-0.05	0.18	0.01
Hungary	-0.02	0.00	0.00	0.19	-0.01	-0.09	-0.02	0.26	-0.04	-0.01	-0.02	0.80	0.22
Ireland	0.00	0.00	0.00	1.31	0.00	-0.20	0.01	0.61	-0.08	0.02	0.00	3.21	1.38
Italy	-0.09	0.00	0.00	0.39	0.00	0.05	-0.01	0.31	-0.02	0.00	-0.07	0.15	0.07
Latvia	-0.06	0.00	0.00	0.12	0.00	0.00	0.00	-0.38	-0.03	0.03	-0.12	0.00	0.63
Lithuania	-0.05	0.00	0.00	0.62	0.00	0.00	-0.02	0.00	-0.03	0.00	-0.09	0.00	2.24
Malta	0.00	0.00	-0.02	0.00	-0.04	0.00	0.00	0.00	-0.06	0.00	-0.08	0.00	0.00
Morocco	0.00	0.00	-0.02	0.04	0.00	0.01	0.00	4.71	0.00	0.00	0.00	0.06	0.13
Netherlands	1.26	0.00	0.00	-10.84	0.00	-1.48	0.89	-5.95	0.00	0.92	1.22	-12.31	-12.95
Poland	-0.02	0.00	0.00	0.08	0.00	0.00	-0.07	0.61	-0.01	0.00	-0.02	0.00	0.17
Portugal	-0.01	0.00	0.00	0.01	0.00	-0.16	0.00	-0.03	0.00	0.00	-0.07	0.00	0.04
ROW	-0.02	-0.01	0.00	0.02	0.00	0.00	0.00	0.07	0.00	0.00	-0.01	0.06	0.05
Slovak Rep.	-0.03	0.00	0.00	0.24	-0.01	0.00	-0.04	0.08	-0.01	-0.02	-0.04	0.24	0.14
Slovenia	-0.02	0.00	0.00	-0.01	-0.01	-0.71	-0.06	0.38	-0.02	-0.02	-0.01	0.00	0.00
Spain	-0.04	-0.02	-0.06	4.86	-0.01	0.00	-0.04	0.45	-0.06	-0.03	-0.06	1.90	0.88
Sweden	-0.28	0.00	0.00	1.40	0.00	-0.33	0.25	0.00	-0.21	0.23	-0.30	0.00	1.76
Turkey	0.00	0.00	-0.01	0.03	-0.01	-0.34	0.00	3.94	0.00	0.00	-0.01	0.07	0.03
United Kingdom	-0.12	0.00	0.00	0.86	0.00	-0.58	0.09	0.20	-0.10	0.08	-0.21	1.94	0.45

Table 7. Changes in household demand, % changes.

	Apples	Bananas	Citrus	Cucumbers	Grapes	Nurs. Mat.	Onions	Ornamentals	Oth. Fruits	Oth. Vegs	Pears	Peppers	Tomatoes
Austria	-0.01	-0.02	-0.03	-0.12	-0.02	-0.66	0.07	-0.95	-0.02	0.07	0.01	-1.00	-0.36
Belgium & Lux.	0.02	-0.01	-0.02	-0.74	-0.01	-0.60	0.13	-0.85	-0.01	0.02	0.00	-0.69	-0.29
Cyprus	-0.02	-0.02	-0.02	0.03	-0.02	-0.60	0.05	-1.30	-0.02	0.03	-0.02	-0.20	-0.19
Czech Rep.	0.01	-0.02	-0.02	-0.14	-0.01	-0.87	0.05	-1.12	-0.01	0.04	0.00	-0.23	-0.18
Denmark	-0.01	-0.08	-0.09	-1.17	-0.08	-0.09	0.14	-0.07	-0.09	0.14	0.13	-2.59	-0.23
Estonia	0.00	-0.04	-0.04	-0.12	-0.04	-1.90	0.16	-2.69	-0.04	0.05	0.12	-1.84	-1.41
Finland	0.03	-0.04	-0.04	-0.12	-0.04	-0.32	0.10	-0.39	-0.04	0.06	0.06	-3.13	-0.49
France	0.01	0.00	-0.01	-0.24	0.00	-0.54	0.02	-0.75	-0.01	0.01	0.02	-0.43	-0.06
Germany	-0.07	-0.12	-0.13	-2.26	-0.12	-0.71	0.28	-0.96	-0.12	0.27	-0.07	-2.19	-1.49
Greece	0.00	0.00	0.00	0.00	0.00	-0.35	0.01	-0.43	0.00	0.00	0.00	-0.07	0.00
Hungary	0.00	0.00	-0.01	-0.01	-0.01	-0.24	0.01	-0.33	-0.01	0.00	0.00	-0.01	-0.03
Ireland	-0.02	-0.06	-0.06	-1.58	-0.06	-0.22	0.12	-0.53	-0.07	0.07	0.00	-3.87	-1.39
Italy	0.00	0.00	0.00	-0.05	0.00	-0.21	0.00	-0.24	0.00	0.00	0.00	-0.06	0.00
Latvia	0.05	-0.03	-0.04	-0.10	-0.03	-1.61	0.08	-2.05	-0.03	0.04	0.11	-1.94	-1.45
Lithuania	-0.01	-0.02	-0.03	-0.31	-0.02	-1.95	0.04	-2.93	-0.02	0.01	0.07	-2.14	-1.60
Malta	-0.03	-0.08	-0.08	0.67	-0.07	-0.74	0.75	-1.73	-0.07	0.81	-0.02	-3.23	-1.02
Morocco	0.00	0.00	0.00	0.00	0.00	-0.03	0.00	-0.02	0.00	0.00	0.00	0.00	0.00
Netherlands	-0.02	-0.20	-0.20	-4.36	-0.20	-2.01	0.63	-3.04	-0.20	0.63	0.13	-4.40	-4.21
Poland	0.01	0.00	-0.01	-0.02	0.00	-0.78	0.13	-0.89	0.00	0.00	0.01	-0.90	-0.19
Portugal	0.00	0.00	0.00	0.00	0.00	-0.41	0.00	-0.51	0.00	0.00	0.00	-0.05	0.00
ROW	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00
Slovak Rep.	-0.01	0.00	-0.01	-0.03	-0.01	-0.91	0.01	-1.12	-0.01	0.00	0.02	-0.04	-0.03
Slovenia	-0.01	0.00	0.00	-0.01	-0.01	-0.97	0.06	-1.55	0.00	-0.01	-0.01	-0.01	-0.02
Spain	-0.01	-0.01	-0.01	-0.02	-0.01	-0.19	-0.01	-0.15	-0.01	-0.01	0.00	-0.01	-0.01
Sweden	-0.08	-0.14	-0.14	-1.35	-0.14	-0.50	0.33	-0.68	-0.15	0.36	-0.03	-3.14	-1.89
Turkey	0.00	0.00	0.00	0.00	0.00	-0.20	0.00	-0.23	0.00	0.00	0.00	0.00	0.00
United Kingdom	-0.06	-0.06	-0.06	-1.01	-0.06	-0.73	0.11	-1.07	-0.07	0.13	0.09	-2.51	-0.52

6 Conclusions

Rising energy prices are a potential threat to Dutch glasshouse horticultural producers. Natural gas required for heating should be taken into account when assessing relative competitiveness. A 25 percent increase in energy costs leads to a potential 9 to 13 percent drop in sector output for glasshouse vegetables and cut flowers. Nursery plants producers are likely to be affected as well. The loss of output, and consequently demand for labour and capital, is more pronounced for products that are more export oriented, and for which Dutch producers face more competition from foreign producers on their traditional markets.

References

Velden, N.J.A. van der, et al. Duurzaamheid van vruchtgroenten in Spanje; proeve van monitoring. LEI & PPO, Wageningen-UR, The Hague, May 2004.

Bunte, F.H.J. and M.A. van Galen. HORTUS; Modelling HORTicultural Use and Supply. LEI, The Hague, Forthcoming.