

Responses of EU feed system to calamities in trade and production

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Introduction

Currently, Europe is self-sufficient in nearly all basic food items, and even capable of exporting various agricultural commodities. Two major exceptions are vegetable oils and soybean, for which the EU is import-dependent. Former studies (Bindraban *et al.*, 2008, 2009), where effects of single and one-off calamities on food production were analysed, indicate that the food situation most likely will remain virtually unchanged towards 2020, even under a scenario of trade liberalization. Even a disruption of soybean imports, which in itself would reduce meat and milk production, and possibly result in diet change, would not endanger food security in terms of nutritional needs.

As such, the European food system seems rather robust in terms of food availability, with surplus domestic production and strong purchasing power to acquire food on the international market. However, trends such as climate change, increasing world population, increasing per capita consumption of meat, increasing demand for biofuels and a reduction in the supply of phosphorus may tighten the supply and demand balance after 2020, resulting in smaller buffers to withstand fluctuations in supply. This could make the European food system less resilient, especially when food and fodder production in addition is affected by a combination of two or more different types of calamities and/or through a sequence of calamities.

This paper focuses on the consequences of shocks in the availability of feed and fodder on prices production and prices of animal products and specifically on the following questions:

- What are the effects of individual or a combination of calamities that reduce the production and/or import of food and fodder on the availability and pricing of feed and animal production and their prices?
- To what extent can increasing the size of stocks of critical food (and fodder?) items reduce the effect of calamities?

Because of the many interactions between the various factors as well as the time dependency of several of these interactions, a model was developed to provide answers to these questions. This model has a focus on the changes during and directly after a calamity in production, trade and prices of a limited set of agricultural products: grains, roughage, soybean equivalents, milk, beef, eggs, chicken meat and pork. To model the time-dependency of production, consumption and prices, the model has a time-step of calculation of 3 months. Consequently, the simulated course in time of these variables and of the size of the various stocks is a direct result of the interactions described in the model.

The focus on ultra-short-term changes, i.e. changes within a year, necessitates taking into account seasonality of production and the evolution of stocks within the EU. A sudden stop in imports just after the harvest in the EU has less immediate consequences than a similar import stop a few months before the harvest. The short-term focus also requires reconsideration of supply and demand responses. The usual elasticity estimates are based on annual data, and describe how, say, demand responds to prices changes in normal times, when other components of the feed system are predictable. In the case of calamities, these ‘certainties’ are no longer valid. Demand may be required to adjust dramatically, say to 30% of its previous levels, and with the usual elasticities such adjustment is not attainable for prices that are feasible. Hence, elasticities must be flexible.

The seasonality also highlights the role of stocks. When a trade calamity strikes (say a stop on imports), those who have feed in store are suddenly in a position of oligopoly or even

monopoly. This changes their behaviour: their stocks used to serve only transaction goals, but now also speculative or even strategic goals.

A third aspect that must be accounted for in such short-term models is the composition of the animal stocks by age. Culling of old animals may be a fairly easy response to sudden feed shortages, and the same may hold for the very young animals. But other age classes, that may be in the most productive phase of their lives, yielding highest growth in weight or highest production (eggs, milk) per unit of feed, will be retained on the farm as long as possible.

Finally, we consider the feeding strategies: when a feed shortage occurs, does it pay to reduce feed per animal, or had one better reduce the number of animals and optimize feed per animal as before?

These reactions are set against a background of the EU by 2020, when some further changes in technology are assumedly made, when EU takes position in the world market in which it is a major importer of soy beans or soy bean meal, and a minor exporter of grains.

Shocks in feed supply would not affect consumption of animal products if smooth international trade in these products would be possible. Therefore, we assume for the purpose of this paper, that no such trade takes place, and that reductions in animal product supply must lead to rising prices so as to restore equilibrium between demand and supply in these markets. We do assume some substitution between various types of meat.

The focus of the paper is on grains and soy. Both are important ingredients in feed. Grains also serve human consumption, while soy is also used to extract oil. For dairy cattle, roughage is another feed component that must be considered.

Production of cereals in the EU-25 in 2005 required roughly 50 million ha, with an average yield of 5 ton per ha for a production of 253 million tons, of which 4.3% was (net) exported. Approximately half of this production consists of wheat and about 20% is maize. Of all cereals, two thirds are destined to the animal sector as feed, and one third is for human consumption. Soy beans are hardly produced in the EU (0.8 million tons), and about 15 million tons is imported.

General set up of the animal production modules

In each animal production system, the model keeps track of the number of animals in various age groups and the distribution over age groups. These numbers are variable because during each quarter, animals may:

- die from natural causes, in which case they are removed from the production system and do not contribute to the production of meat for human consumption; here a difference is made between ‘normal’ causes and extreme situations during calamities caused by virulent and deadly animal diseases or zoonoses that require massive culling of animals. For the calamity type, it is assumed that also starter animals are directly affected at the start of the quarter, whereas for ‘normal’ causes the effect is assumed to build up during the quarter.
- be selectively removed, either at the end of their productive life or because of underperformance during their productive life. Selective removal for underperformance is here only applied to the dairy system;
- be slaughtered when they reach their optimal weight for slaughtering (meat production systems);
- or be culled (e.g. because of lack of sufficient feed); these animals are added to the meat production for human consumption;

At the end of each quarter, the remainder of the animals in each age group is shifted to the next quarter and next age group.

Each quarter, new starter animals are introduced in the system; the number of these starter animals depends on the number of starters in the quarter before, with an elasticity to quantify the effect of the ratio of prices of the product coming from the production system (e.g. milk) and the feed (assuming an optimum feed quality and specific fractions of soy/oilseeds, grain and roughage). The method to estimate the number of starter animals reflects the differences in set-up of the various production systems:

For the broiler production system, with a very short production cycle, it is assumed that setting up new batches of chicken reacts on short notice changes in the ratio of product over feed prices. As such, this ratio of the previous quarter determines to a large extent the number of animals that will be set-up.

For the egg production system, which has a longer production cycle, it is assumed that the change in number of starter layers depends on the average price of the four preceding quarters and, as for broilers, on the average number of starters in the these quarters (price elasticity ϵ set at 0.175).

Setting up new piglets in the pork production system a combination of fast response to prices in the preceding quarter is slowed down by assuming that the response is related to the average number of starters in the four preceding quarters (ϵ set at 0.2).

In the dairy sector model, starters are assumed to replace the animals that died or that were selectively removed (e.g. because of underperformance) in the preceding quarter. When the ratio of product over feed prices is high, more starters may be set-up than is needed for this replacement. However, since the model allows starters to be recruited only from calves produced within the sector, some quarters may see a relative shortage of potential starters, when demand for starters is more than the number of cow-calves that were produced in the preceding quarter. This shortage is accumulated and added to the demand for starter calves in next quarters (ϵ set at 0.15):

The set-up of new animals in the beef production system differs from that in the other systems in the sense that new animals enter not only in the first age group, but also in some of the older age groups. In the model, animals younger than 16 months that are selectively removed from the dairy system enter the beef production system to be fattened to a desired slaughter weight. In addition to animals from the dairy sector, calves are also produced within the beef sector itself. To allow modelling of this internal production of calves, both the number of cow and of bull animals has to be followed:

Feed

During each quarter, the potential demand of the different feed substances (roughage, grain and soybean equivalents) is calculated, assuming an optimal performance of the animals during the quarter. Thus optimal growth, optimal milk or egg production all lead to a technically determined optimal requirement of feed.

For systems where roughage is used, the use for roughage is related to the potential demand, multiplied by the effect of the relative price of roughage with a elasticity of -0.1.

From the potential demand of concentrate, the amount of protein coming from concentrate is calculated that is required for this potential production. Depending on the ratio of the prices for protein from soybean and from grain, the required amounts of soybean and grain to supply the protein are chosen so as to use the feed that contains the cheapest protein.

Under 'normal' conditions, these prices are the average over the 4 preceding quarters while under conditions with trade limitations these prices are those of the last preceding quarter. This reflects the change in expectations of producers when normal price setting mechanisms

are not valid any more. Since the protein content of soybean is about 3 times higher than that of grains, switching to grains will only occur when soybean prices are more than 3 times higher per unit dry matter than those of grains

The use of concentrate with the resulting soy-grain-additive content is made dependent on the relative price of the concentrate, with an elasticity of -0.27.

Account is taken of a minimum requirement of roughage as fraction of total intake, e.g. to prevent problems in the digestion system in high productive dairy cows

The actual intake of food is translated into production, i.e. meat, milk, eggs. Meat is expressed in average carcass weight after slaughtering, which is assumed to be an age specific fraction of the live weight that varies between bovines, pigs and chicken. For all meat producing systems (including dairy), an optimal growth of live weight of animals is assumed to exist. In the case of dairy, it is assumed that animals indeed follow this curve and that only the production of milk is affected by quantity and quality of feed. In the other meat production systems, the growth of live weight will follow this curve when optimal quantity and quality of feed is provided, but will be reduced when less quality and/or less quantity is available.

In the dairy system, milk production is related to the uptake of roughage and concentrate, where the feed quality determines the feed conversion. The optimal amount of feed for dairy is calculated by dividing the average potential milk production per cow per year by the maximum Feed Conversion; the optimal amount of roughage is then determined by multiplying the total feed by the optimal roughage fraction, with the optimal amount of concentrate as remainder. Implicitly, this calculation assumes an optimal composition of concentrate, which in the module is described by the fraction of grain products, of soybean products and of other material.

In the egg production module, it is assumed that under optimal diet, chicken produce a maximum number of eggs per year, depending on their age. When the quality of the diet, expressed in protein content, becomes less than optimal, egg production is reduced.

Incorporating starter animals (calves, piglets, chicks)

In the pork, broiler and egg production systems, the potential amount of starter animals is assumed not to be limiting apart from very short limitations (no more than 125% of previous average levels). In the beef production system, calves that are not needed in the dairy system form one part of the potential starters. This is a limited supply and is determined by the dynamics in the dairy production system. Another source of starters is formed by the calves produced within the beef production system, which here is assumed to respond to the price ratio. In the dairy and beef modules, production of calves is explicitly included, since the amount of available cow calves can limit the expansion of the sector. The availability of bull calves and cow calves from the dairy sector generally is an important input to the beef module.

The model assumes that different age groups (heifers, cows between 3 and 7 years and 'senior' cows above 7 years old) have different calving rates, while there is also some seasonality in calving. Animals selectively removed from the dairy sector (see next paragraph) contribute to the production of beef. Animals younger than 7 months enter the beef sector for further fattening, while older animals are slaughtered directly.

Selective removal of animals

In the beef, pork, broiler and egg production systems, it is assumed that selective removal of animals, e.g. because of underperformance, is included in the mortality rate. It is also assumed that such selective removal is not affected by the ratio of prices of produce and feed. In the dairy system, selective removal takes place over the whole range of animals, where fraction of animals being removed depends on the age group (**Fout! Verwijzingsbron niet gevonden.**).

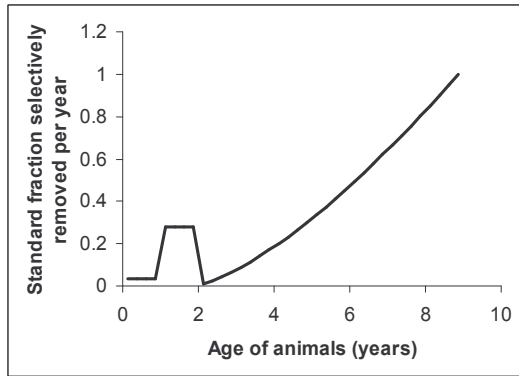


Figure 1 Standard fraction of animals selectively removed yearly in dependence of age of the animals

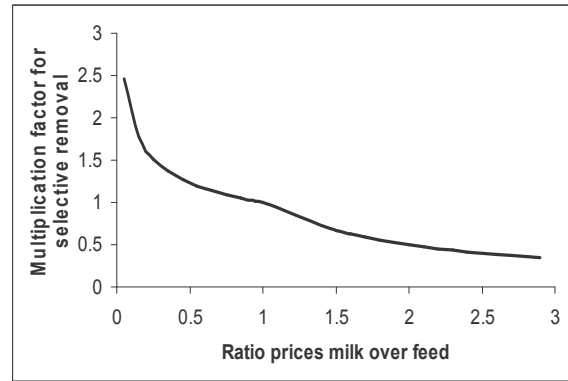


Figure 2 Effect of the milk/feed price ratio on selective removal of animals from the dairy sector, expressed as a multiplication factor on the standard removal rate.

In addition, selection of animals is affected by the ratio of prices of milk over feed, such that at higher ratios, less animals are removed (**Fout! Verwijzingsbron niet gevonden.**).

Culling because of food shortage

When not enough feed is available, the model assumes that in the meat production systems, growth of the animals will be slower, leading to a delay in reaching the slaughtered weight. In the dairy and egg production systems, some of the animals will be culled to allow the remaining animals sufficient access to feed to produce as close as possible as under optimal conditions. Animals that will be culled first are the less productive animals, which in the model is related to the age group.

Table 1 Order of culling of animals in case of shortage of feed

Production system	Culling group		
	1	2	3
Dairy	Cows > 8 years	Calves & heifers ≤ 2 years	Cows >2 and <8 years
Eggs	Chicken > 12 months	Chicken <4 and > 9 months	Chicken >4 and < 9 months

In the dairy system, it is assumed that culling starts when a particular culling group has too little roughage available, first the old cows, next calves and heifers, and only in the last place the more productive cows.

Economic considerations for price formation under autarky.

A stockholder who controls stocks accumulated from domestic production will normally sell the stock gradually over the year. A minimum level may be kept for security reasons. If the next harvest approaches, the stockholders will tend to sell whatever is in store (above a minimum), while shortly after harvest, about a quarter will be sold per quarter.

Production

Produced is realized in the third quarter of the year. Yields per ha are taken to be slightly sensitive to prices (elasticity of 0.1, source FAPRI). The area sown (in quarter 2) is sensitive to prices. Indicative prices are taken to be those of the previous harvest season: prices in quarter 3 of the previous year.

For the purpose of predicting area adjustments to large price changes, we follow a special approach. Typically, the current models distinguish an own price elasticity of supply of grain of 0.1 and a cross-price elasticity with respect to oil seed prices of minus 0.5 (source: FAPRI model). Our purpose is, however, not served well by including such an assumption. The implication of the above elasticities would be that a price rise of oilseeds by 10% would lead to a drop in wheat area by 5% or approximately 2.5 million ha. The corresponding model parameters for oil seed (or more precisely the soybean area) would, however, generate an increase in area of 4% of the soybean area, or 4% of 2 M ha, which is only 80,000 ha.

To solve this asymmetry in the effects on grain and soybean area, we model the reactions in two stages, one is a change in total area (grains + soy), with an elasticity of 0.2; and the other is a change in ratio of grain to soybean area in response to a change in the ratio of the prices with an elasticity of 1.

Therefore, the **total area sown** in quarter 2 of year t is a function of the prices in quarter 3 of year $t-1$:

$$A_{t,2} = C \left(\bar{P}_{t-1,3} \right)^{0.2}$$

The constant C is set to the initial, total area of 53.8 million ha (for 2005).

And the ratio of grains to soybean area is given by

$$\frac{A_t^g}{A_t^s} = c \cdot \left(\frac{P_{t-1}^g}{P_{t-1}^s} \right)^1$$

The actual area of each crop, grain or soybean, can be calculated from the two equations.

The implied elasticities depend on the share: the lower the share, the higher the elasticity. At the prevailing ratio of grain to soybean area of 25:1, the area elasticity of grains (w.r.t. grain prices) is 0.23; the own-price elasticity of soybean area is 0.97. We are working, therefore, with stronger price responses than is assumed for business-as-usual models. However, note that we hardly include other area than grain and soybean. The implied cross-price elasticities are -0.03 and -0.77 for grains and soybean area respectively.

Demand D consists of demand for food D^c , and demand for feed D^f . Food demand depends on the price of the previous quarter

$$D_t^c = d \cdot \left(P_{t-1}^g \right)^{-0.26}$$

The variable d is set equal to the initial grains consumption of the chosen scenario. The elasticity is taken from FAPRI (and actually refers to wheat). In scenarios where the EU is autarkic in grains, we apply a smaller elasticity (-0.13) to reflect the reduction in alternative sources of food and to have grains preferentially destined to human consumption.

Feed demand D^f follows from the various demand schedules that are specific for each type of cattle, and will be discussed there.

No trade

If no free trade is possible, stockholder's behaviour changes. Supply out of stocks no longer follows the earlier pattern of gradual depletion of stocks until the next harvest, but is now more careful. While the assumptions can be changed, the basic assumption is that planned release of stocks occurs with a view to maintaining the stock for two years. Reason is that stocks can be more easily kept in store than repurchased later. This planned release affects the price via some 'planning elasticity', but actual consumption may exceed the planned release. Thus, for the price formation in times of autarky, it is assumed that prices should adjust so as equate – by approximation – demand to the planned supply. However, actual demand may be less or more, because it follows the various demand schedules of the animal sectors. Resulting stock levels may differ from the planned level and prices will accommodate this. Thus, the planning involves: 1. setting a target for supply next quarter; 2. setting a price that is expected to bring demand to this level; 3. adjust stocks in view of actual developments.

If the original demand function is $D = d.P^{-\varepsilon}$ with $-\varepsilon$ the demand elasticity, then to make this equal to an actual supply of S , we need a price of $(S/d)^{-1/\varepsilon}$. In this formula, the parameter d is approximated by its equivalent in the previous period, of which we know the value. The demand elasticity used for planning is only approximate.

In a case (say period 0) with information on values for all variables and the elasticity, d can be derived from:

$$d = \frac{D_0}{P_0^{-\varepsilon}}$$

Hence, to have a price that equalizes demand to a given supply S_1 , we need

$$P_1 = S_1^{-1/\varepsilon} \left(\frac{D_0}{P_0^{-\varepsilon}} \right)^{1/\varepsilon} = \left(\frac{S_1}{D_0} \right)^{-1/\varepsilon} P_0$$

In a more general setting: price in quarter t equals price in quarter $t-1$, adjusted by a factor that is responsive to the new level of supply, relative to the old level of demand.

Thus, the sequence at the start of a calamity is that first stocks are assessed. These are then divided into equal volumes of quarterly supply until the end of next year. The prices in each quarter then lead to demand in the quarter being approximately equal the given supply. The cattle sector responds to these prices.

This procedure presumes that all supply must be consumed by the sector, and it assumes that there is no need to look beyond year 2. We discuss both presumptions and adjust the model accordingly.

In case of a net exporter, a sudden disruption in international trade causes a surplus of the commodity. While prices should obviously fall, it need not be so that in this case all supply must be absorbed by the sector within a year. Hence, supply from stocks will not strive toward releasing all stock in a year. We assume two years for this process.

In case of a net importer, the trade disruption causes supply to fall short of demand; prices should rise by enough to establish a new equilibrium of demand and supply. In fact, as supply is very tight, prices may have to rise quite out of the normal range. In these special conditions, the usual elasticities do no longer apply. Working with normal demand elasticities would not reduce demand to levels that are required (say to a quarter of normal supply) without raising prices to astronomic levels. Therefore, we introduce demand elasticities that rise when prices go to extremes.

In stead of a normal demand function with a constant elasticity $D_t^c = d \cdot (P_{t-1}^g)^{-\varepsilon}$ we have $D_t^c = d \cdot (P_{t-1}^g)^{-\varepsilon P_{t-1}^g}$. One can easily verify that for normal prices, which we set at 1, the elasticity is what it is in normal conditions. For high prices, the demand response is however taken to be stronger than normal.

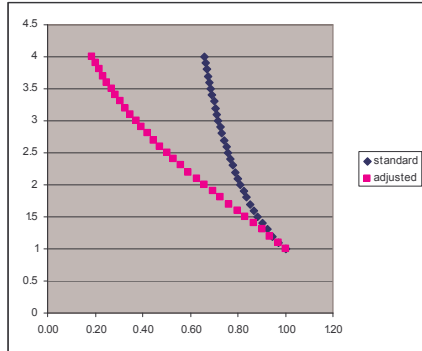


Figure 3 Effect of two elasticities on price (y-axis) and demand (x-axis) relations for grains

Figure 3 shows two demand functions. One with a simple elasticity of -0.3, the other with an elasticity of -0.3 times p. The adjusted function shows that a price of 2 leads to a demand of 0.66, compared to a demand of 0.81 for a constant elasticity.

The procedure for setting a price in case of no trade is to ‘predict’ demand for normal (world market) prices, and also to ‘predict’ production and the normal release from stocks, and then to check if predicted supply meets demand.

The predicted demand in this formula is set equal to standard demand levels, as recorded before the calamity. At this price, demand only approximately equals supply, with any discrepancies solved in later quarters, and made

possible by the use of the minimum stocks that act as a buffer. To implement the price-dependent elasticity, we first simulate the price at a fixed elasticity, and then, when the thus generated price is very high (higher than 1.4) a formula is used to translate these prices into the prices, that are conformable to the assumption that the elasticity increases with the price. The approximate formula for $P_{gen} > 1.4$

$$\text{is } P_{trans} = 1.196 + 0.586 \ln P_{gen} - 0.014 (\ln P_{gen})^2$$

(see Figure 4)

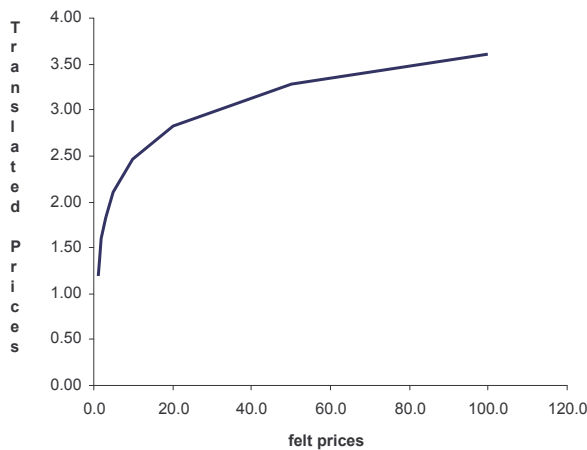


Figure 4 Relationship between extreme prices that should apply to constant elasticities (‘felt prices’) and those that correspond to elasticities linearly increasing with p (‘translated prices’).

With constant elasticities, consumption can be modelled as dependent on the ‘felt’ prices, which is tantamount to consumption actually being dependent on prices with an elasticity that is increasing in prices. Production decisions are influenced by the ‘translated’ prices directly.

An important element is the release of stocks in these times of scarcity. A rational assumption is that this release is spread

equally over the quarters of the period of shortage.

It takes into account what production will be forthcoming. In the standard case, where

only little area of soybeans is cultivated in the EU, the predicted supply response is dependent on the information available:

- in the first quarter, no scarcity prices can be known yet. Stockholders take 1.5 times the previous harvest as a ‘guesstimate’ for upcoming production

- in Q2 and Q3, the Q1-price of soybean acts as a guide: with an elasticity of 1, the best guess is the previous crop times the price in Q1
- in Q4-Q7, the recent harvest of Q3 is known, and is taken as a predictor of the next harvest in Q7 (3rd quarter of year 2), but a factor of .75 is used to prevent stockholders from selling the crop before it is available
- in Q8, no new harvest is expected

Prices are established that make predicted demand equal to this release from stocks. Predicted demand is simply the standard import before the calamity, adjusted for increases in prices of pork and poultry. A demand elasticity of -0.4 is used in this price setting stage. This elasticity corresponds to the value of the price-dependent elasticity that applies to price increases of around 50%, which seems fair as a heuristic for the stockholders.

On the animal products side, we assume the following set of own and cross price elasticities:

	Pbeef	ppork	ppoultry	For eggs demand an elasticity of -0.15 is taken, and for milk demand -0.4. The direct application of these formulas to single quarters (with occasional large changes in supply) leads, however, to great changes in prices from one quarter to the next. This is unlikely, and in practice, product prices are smoothed by changes in stocks of products along the supply chain and with consumers. We therefore look at the change in price that would make demand equal to supply in the longer run. This is accomplished by introducing (a) price lags into the formula: in stead of the formula above we use previous prices (to the power 0.7) and the newly simulated price (to the power 0.3), to give a smoother transition to the new equilibrium; and (b) by using a moving average of production over 4 quarters rather than the previous quarter only.
Beef	-0.40	0.10	0.01	
Pork	0.03	-0.13	0.01	
Poultry	0.02	0.06	-0.31	

Results

The model is used to simulate a fictive situation in the EU by 2020. Technology, demand and areas are adjusted to reflect this situation.

We present three scenarios for dramatic changes. One is a sudden disruption in imports of soy beans. The next is a dramatic fall in yields within the EU. The third is a combination of the two. In all cases, the calamity is assumed to start in January and to last for 2 years.

The first simulation shows the results of a stop in imports of soybean (meal) in years 0 and 1. This important ingredient of feed then must be curtailed. Prices shoot up, and availability is also otherwise limited. After year 1, however, trade resumes its normal course, but the effects of the trade shock will linger on for some years as shown in Figure 5.

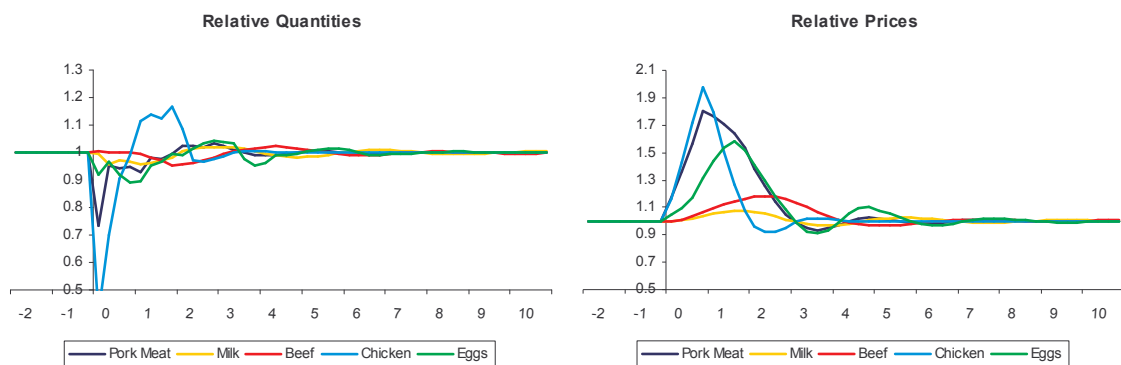


Figure 5 Responses to a stop on soy-imports in years 0 and 1. Year after start of calamity on X-axis, Relative quantities and prices on Y-axis.

The immediate changes in production of meat are quite severe. To reduce the consumption of soybean (meal) to levels that can be provided from the existing stocks, prices of soybean increase to 2.9 times the initial value (with increasing elasticities) in the first quarter. It reflects the scarcity and incidental unavailability of the feed.

In response to this sharp increase in feed prices, meat and egg production drops and prices of products start rising. These higher product prices leads to a later recovery of meat production. The recovery is quickest in sectors such as poultry, which produces the original quantities again by the fourth quarter, using much less soybean meal (-75%), and more grain (65%). The pork sector is not that flexible, and restores the original levels of production only by the end of quarter 8. As can be seen in Figure 5 (left), the pork production shows a small hick-up in quarter 2. This reflects the delayed supply of pigs that were being fattened when the ban on soybean imports became effective. On average, production of pork during the two years 0 and 1 is down by 7%, while soybean consumption in the sector is reduced by two third. The remaining third comes from the release of stocks, which stood at 6975, little less than a normal quarter’s consumption at the start of the import ban.

We now simulate what the effects would be of a yield reduction only, starting in January of year 0 and lasting until the end of year 1. We assume that prices of grains and soybean remain unchanged and equal to the world market prices of 1, as trade is still possible.

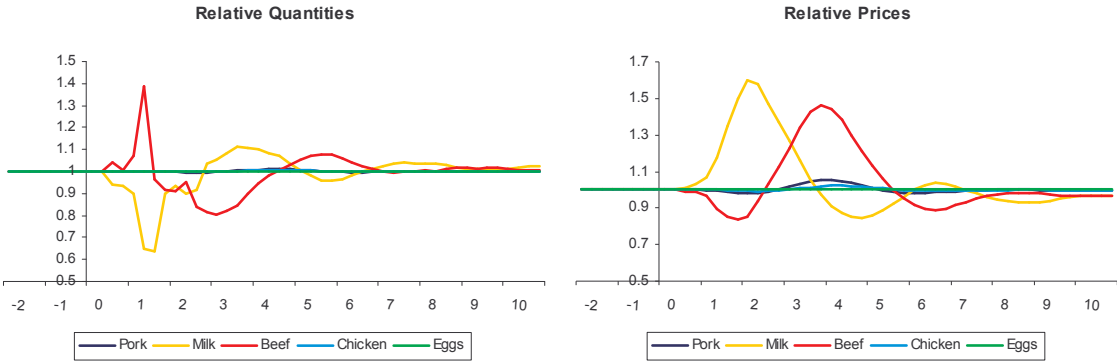


Figure 6 Responses to a 25% yield reduction in years 0 and 1. Year after start of calamity on X-axis, Relative quantities and prices on Y-axis.

We see that in fact only the dairy sector and the connected beef sector respond to such a shock (Figure). A severe shortage of roughage in the first quarter of year 1 leads to culling of cows, reduced milk production, higher beef supply. Milk prices soar, and beef prices fall temporarily in year 1. When arable production recovers, however, cattle stocks on the dairy farms soon are replenished, not least because of the attractive product prices prevailing in year 3.

The small changes in pork prices shown in the figure are due to the substitution effects between beef and pork: the higher beef prices lead to more demand for pork and higher pork prices.

Finally, a reduction of yields is added to the import stop on soybean. This reduction applies to grains, soybean and roughage production. This affects the availability of soybean and grains to the extent that these have to be produced in the EU, while the reduced production of roughage will have strong effects on the dairy sector (Figure 7).

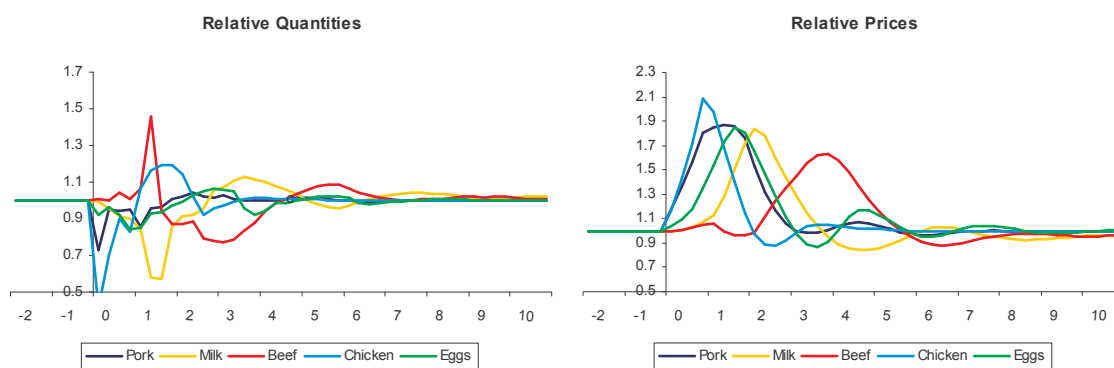


Figure 7 Responses to an import stop on soybean combined with yield reduction in years 0 and 1. Year after start of calamity on X-axis, Relative quantities and prices on Y-axis.

Conclusions

Scenario	Short-term effects	long term-effects
1. Soybean import stop: No import for two years	Price of soybean (equivalents) increases up to 2.9 fold; production of poultry, eggs and pork drops 50, 10 and 25%; prices up 1.5-2.5 times; 75% reduction in use of soybean and 50% increase of grain in feed	Cyclic fluctuations in production and prices of all animal products; strongest in pork/poultry; lowest in dairy and beef
2. yield reduction: 25% reduction for 2 years in availability of roughage, grains and protein crops in EU; free trade in soybeans and grains	Only milk and beef sector respond: milk with 35% production drop and max 1.6 times higher price; beef 40% production increase, price drop of max 10%	Recovery in milk production in 3 rd year, of beef in 4 th ; pork prices slightly higher because of substituting demand for beef
3. soybean import stop AND yield reduction	Milk and beef react slightly stronger than in scenario 2; responses in other sectors similar to scenario 1.	

Further simulations show that higher levels of initial stocks have a smoothing effect on the price and volume changes that follow calamities. The combined consumption of beef, mostly roughage-based, and pork and poultry, mostly based on important feed, makes the EU consumer quite robust against either a trade or a yield shock. EU meat producers are exposed to such shocks, however. In a situation of autarky on the product market, a sudden change in feed supply can be expected to be quickly compensated by a change in product prices, but when trade in products is still possible, the exposure to supply shocks is even more severe. Feed stockholders may find themselves suddenly in a position where monopoly profits can be made. Higher required levels of minimum stocks can help against drastic price fluctuations.