

Is the Pig Sales and Purchase Cooperation the Local Solution for the Global Challenge in Hungary?

Peter Balogh^a Imre Ertsey^b and Lajos Nagy^c

^aAssistant professor (corresponding author), Department of Economic Analysis and Statistics, Faculty of Agricultural Economics and Rural Development, Centre of Agricultural and Technical Sciences, University of Debrecen, Hungary, 4032 Debrecen, Böszörményi street 138. Phone: 00-36-52-508444/88009, Fax: 00-36-52-508343, Email: balogh@agr.unideb.hu

^bProfessor, Department of Economic Analysis and Statistics, Faculty of Agricultural Economics and Rural Development, Centre of Agricultural and Technical Sciences, University of Debrecen, Hungary, 4032 Debrecen, Böszörményi street 138. Phone: 00-36-52-508472, Fax: 00-36-52-508343, Email: ertsey@agr.unideb.hu

^cResearch associate, Department of Economic Analysis and Statistics, Faculty of Agricultural Economics and Rural Development, Centre of Agricultural and Technical Sciences, University of Debrecen, Hungary, 4032 Debrecen, Böszörményi street 138. Phone: 00-36-52-508473, Fax: 00-36-52-508343, Email: nagyl@agr.unideb.hu

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Executive Summary

Whether particular countries, regions within countries, and particular societies gain or lose in the process of globalization depends on where they are in the process of agricultural transformation and to what extent they can adjust? The Hungarian pork verticum faces considerable disadvantages in several aspects as opposed to competing countries. In countries with developed meat verticum a powerful concentration could be observed, whereas in Hungary, although disintegration has not increased, decentralization still prevails. One of its consequences is that despite the outstanding results of concentrated large-scale farms, backwardness is still characteristic in natural production indicators on sectoral level and economic risks are high. Horizontal integration in the Hungarian pork sector is stipulated by the FVM decree of 85/2002. (IX. 18.), which allows the establishment of previously acknowledged production groups. As a result, 23 groups were set up for pork production in Hungary in 2003-2004. In our research the operation of a co-operative was modelled as a generalized network problem. This model is a linear programming (LP) application with 110 variables and 32 constraints. The model allows the quantification of the number of pigs from given farms to slaughterhouses, the maximum revenue from sales, the threshold prices of deliveries and the analysis on the impacts that the members of co-operatives exert on sales revenues. This LP application can also be used for other Sales and Purchase Cooperatives or it can help with refining the existing distribution methods of the cooperatives.

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Abstract

In countries with developed meat chain a powerful concentration could be observed, whereas in Hungary decentralization still prevails. In our research the operation of the pig sales and purchase co-operative was modelled as a generalized network problem. The model allows the quantification of the number of pigs from given farms to slaughterhouses, the maximum revenue from sales and the analysis on the impacts that the members of co-operatives exert on sales revenues. This model can also be used for other Sales and Purchase Cooperatives or it can help with refining the existing distribution methods of the cooperatives.

Keywords: cooperation, pork production, network, linear programming,

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Introduction

Globalization of the food chains in transition and developing countries has been driven by several factors. Some factors are not specific to these countries, such as the global process of increased international trade and investment and the structural changes in the global food markets (Jávor et al. 2008). Specific factors are the liberalization of the trade and investment regimes in transition and developing countries—policy reforms that often accompanied the privatization and domestic price reforms (Swinnen and Maertens, 2007). Globalization has resulted in the rapid growth of world trade, internationalization of production by multinational corporations, and declining information and communications costs (Pingali, 2007). The income rises, people tend to consume more calories in total, and the share of animal calories increases (Lotze-Campen et al., 2008). Global meat consumption can be expected to rise by up to 3% annually over the next decades (Keyzer et al., 2001). While global food supply may still outpace demand up to 2020, growth rates in production are likely to slow down in the longer run (Harris and Kennedy, 1999). Food standards are increasingly stringent, especially for fresh food products such as fruits, vegetables, meat, dairy products, fish, and seafood products, which are prone to food safety risks (Binh et al., 2007; Krystallis et al., 2007; Swinnen and Maertens, 2007; Gellynck and Molnár, 2009). The adverse impacts of animal disease outbreaks reach beyond national borders as the food supply chain becomes increasingly global (Park et al., 2008). Food scares or food safety risks emanating from foreign countries can be realized in domestic markets of importing countries. Shocks from localized animal disease outbreaks can be quickly transmitted to other regions and countries.

In recent years, Western-European countries have implemented large-scale technological developments (air conditioning, automated feeding, fodder production); therefore they have acquired devastating advantages at the expense of new member states. A key requirement is the selection of adequate varieties and variety-specific technologies, the improvement of the specific indicator of fodder conversion (fodder-utilization/weight growth) at growing fodder prices. More noteworthy is that the majority of Hungarian pig breeders produce source materials of various genetic background, so quality might radically fluctuate (Komlósi, 1999). In the past years the renewal of Hungarian genetic potentials declined markedly, biological bases were overexploited, breeding stock was heterogeneous, the number of breeders was low, and so selection base was not sufficient.

Competition in the case of pork meat is based on selling prices, on the quality of products (Gellynck et al. 2008) and on the public image of producers. The structure of the production path, the level of infrastructure, human resources, biological and economic environment are the factors which determine the competitiveness of the production path in the long term (Szabó and Bárdos, 2006; Horváth, 2008). In our present study we have investigated the first factor through the example of a concrete producer enterprise. In the wake of preliminary consultations with the managers of Alföldi Sertés Értékesítő és Beszerző Szövetkezet (Alföld Pig Sales and Purchase Cooperation, APSPC), a model was needed to distribute the animals of varied quality among slaughterhouses with different requirements for the maximization of sales revenues. This model

can also be used for other Sales and Purchase Cooperatives or it can help with refining the existing distribution methods of the cooperatives.

Literature review

The Hungarian pork chain

Today the production path of pigs includes 4 segments in Hungary Figure 1. Before Hungary's EU accession slaughterhouses almost exclusively processed domestic source materials. In previous years, the supply of slaughter pigs continuously decreased, so slaughterhouses were forced to purchase pigs from abroad. The decline of the pig population in the preceding years was in close connection with the bankruptcy of private farms, as the number of pigs kept in private farms decreased by 1 million by 2006 as compared to figures in 2000; however, in the case of economic organizations the number of pigs merely decreased by 200 thousand. The organization of producers is not very strong in slaughter pig production and sales, their number may be 20-25 located regionally in the country (Nábrádi, 2007).

The second segment includes slaughterhouses, one third of which manufactures meat products as well as slaughtering and chopping. At this time, the number of bought-up slaughter pigs amounted to slightly more than 50% of available slaughter capacities. Approximately 48% of produced slaughter pigs were killed in meat industrial companies, about 18% in slaughterhouses and 34% in households (Nábrádi and Szűcs, 2004). Not only concentration, but specialization also emerged in the sector: 56% of pigs were primarily processed in slaughterhouses with the capacity of 200 thousand pigs/year and the rate of these farms is 5% among the total number of farms (Nyárs, 2007). Pig slaughter and processing are becoming increasingly separated. The third segment of the production path includes farms which exclusively manufacture meat products (processing II.), do not slaughter pigs and purchase source materials necessary for production from slaughterhouses. The number of slaughterhouses producing for exclusively domestic markets is still rather high on the Hungarian product path. Nowadays, slaughter itself fails to produce considerable profit, similarly to boning and cutting (or accessible profit is minimal), higher profit can merely be reached through finished products (Salamon et al., 2007). The fourth segment of the production path is domestic consumption and sales on foreign markets. This segment shows an extremely high variety of products which require source materials of different quality categories. Chains of stores far exceeding customer needs and competition among multinational companies (AKI, 2009) break down prices, which leads to deteriorating quality.

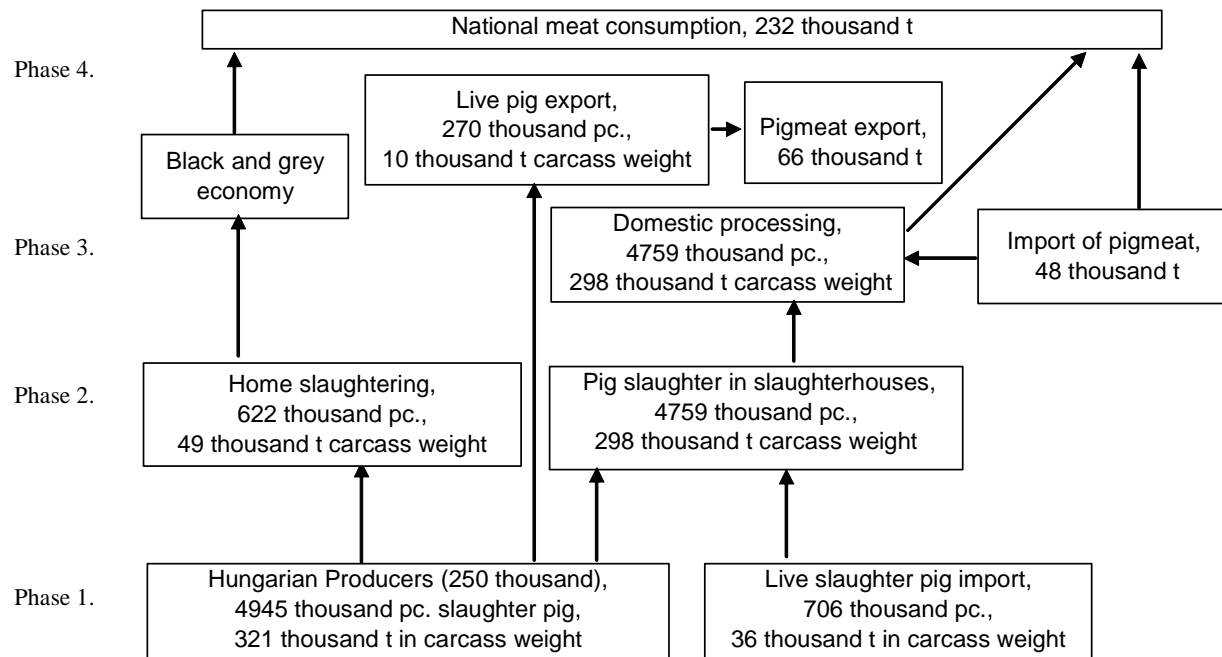


Figure 1. Segments of pork production path and distribution channels in Hungary in 2007
Source: AKI, 2009.

Methodology

In our research we modelled the operation of a purchase and sale co-operative in the Northern Great Plain Region. We applied the linear programming technics in a network model. Agricultural programming models have been used in many studies (Andersen and Stryg, 1976; Jonasson and Aplan, 1997). The network model was used earlier by many researchers in difference fields (Jonassen et al., 1993; Iacobucci et al., 1996). We sought the optimal solution by the help of the Winston and Albright's (1997) network model. Our conception was very simple: to deliver from each member to the slaughterhouse that pays the highest price for the produced quality.

The practical realization of the conception raises two significant questions:

What meat quality animals are to be delivered from farms?

- Grouping may be based on body weight; however, the actual meat quality parameters of certain animals will be known after feedbacks from slaughterhouses.

How is the return on sales reckoned for member organizations?

- Within one organization, products of the same quality are delivered for different slaughterhouses and distribution is merely influenced by transport distance.

The second question is easier to answer and the co-operative has already found the solution. The members deliver the pigs for the co-operative and righteous distribution is guaranteed by the application of the principle of "the same weekly price for the same quality". This means joint risk-taking for the members, and makes the delivery of market surplus safer. Trust is maintained by the continuous control of the members over the management. The Price Committee of the co-

operative sits together every week, supervises payments and each member receives a weekly statement on all the sales.

The first question is more difficult to answer. By the analysis of earlier slaughterhouse qualifications, the various distribution rates of meat quality can be defined rather precisely. Slaughterhouse quality categories can be regarded equal, but the system of deductions and bonuses is far from being uniform. The basic principle is more or less the same in the case of various slaughterhouses, but prices and parameters that influence prices present a diversified picture.

In our network model nodes include pig farms and slaughterhouses and arcs represent the amount to be delivered Figure 2. We indicate the price of one pig delivered from a farm to a given slaughterhouse on the arcs.

On the basis of earlier qualifications the data that can be defined in farms are the following:

- SEUROP quality rates, expectable average delivery weight, carcass weight out of this
- By using the expectable average delivery weight and earlier standard deviation values, the rate and body mass of animals of lower body weight than standard can be estimated
- Similarly to the earlier point, calculations are performed for potentially overweight animals as well
- Condemnation is estimated

On the basis of the above mentioned, taking the contracted slaughterhouse parameters into consideration, the average sales price can be calculated in every aspect and based on this, the average sales price of one pig as well.

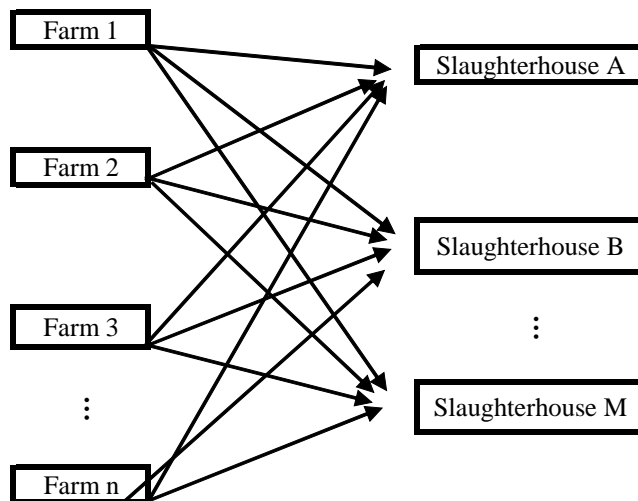


Figure 2. The schematic model of distribution

Source: Authors' own creation.

The variables of the model are the arcs of the network, i.e. there will be as many variables as many links can be created between farms and slaughterhouses. On the basis of the above data the target function of the model can be determined:

$$\sum_{i=1}^n \sum_{j=1}^m p_{ij} x_{ij} \Rightarrow \text{MAX!} \quad (i=1,2,\dots,n; j=1,2,\dots,m) \quad (1)$$

where

p_{ij} = the average price of pigs delivered from farm i to slaughterhouse j

x_{ij} = the average number of pigs delivered from farm i to slaughterhouse j

The constraints are defined in nodes, separately for farms and separately for slaughterhouses. In the event of farms the total output from a farm equals with the volume for delivery if the whole quantity for delivery from all the farms is lower than or equal with the quantity for delivery, otherwise a lower limit is given. In the case of slaughterhouses, conditions will have an upper limit.

Constraints for farms:

$$-\sum x_{ij} = -T_i \text{ if } \sum T_i \leq \sum S_j \quad (2)$$

$$-\sum x_{ij} \geq -T_i \text{ if } \sum T_i > \sum S_j \quad (3)$$

where

x_{ij} = quantity flowing on arcs towards slaughterhouse j

T_i = the number of pigs to be delivered from farm i

S_j = demand of slaughterhouse j

Constraints for slaughterhouses :

$$\sum x_{ij} \leq S_j \quad (4)$$

where

x_{ij} = quantity flowing on arcs towards slaughterhouse j

This model is a linear programming (LP) application with 110 variables and 32 constraints. The solution requires widespread vulnerability studies. The shadow prices of the coefficients in the target function, the values of permissible increases and decreases present the threshold prices of certain delivery relations and those lower and upper limits, which can include the variations of the values of the target function without modifying the optimal solution. The shadow prices related to the variables may allow the evaluation of the influences of the potential expansion or restriction of certain delivery relations on the sales revenues. The influence of the members of the Co-operative on sales revenues can be analysed by “What if...” examinations.

The network model was run from the 2nd week of August for 5 weeks in 2007. On the basis of data from the APSPC, 11 producers delivered their products to 5 large slaughterhouses. By information from producers the data of the model can be continuously refreshed, so it can be easily applied for even weekly optimization as well. Each farm and slaughterhouse represents two nodes in the network, allowing the simultaneous optimization of fattening pigs and culled

sows. As a result, we receive data on the number of pigs to be delivered from certain farms to certain slaughterhouses, the total potential maximum revenue from sales and after breaking it down, revenues for individual farms as well.

The basic data of the network model include members' information on the expected quality and weight, and also prices and quality deductions related to various quality categories given by slaughterhouses. When comparing the findings of the model to the actual sales data, we took the following items into consideration:

- the number of pigs calculated in given farm-slaughterhouse relations
- in the case of sold mass, actually transported mass
- for quality, instead of forecasts by farms, actual qualifications by slaughterhouses.

These modifications allowed the realistic evaluation of the model results.

Results and discussion

Introduction of the APSPC

In 2005 19 producer groups were granted official recognition, the number of their average members was 30, their production was 85.000 t i.e. 110.7 million USD, about 20% of Hungarian pig production. In 2008 there were 26 officially recognised pig producer groups in Hungary. The APSPC was established on 20 February 2003 with 26 members. The Co-operative has performed the joint sales of pigs from June 2003. Table 1 presents sales in the past 6 years.

On the basis of data from 2008 it can be calculated that more than 40% of the production of Hungarian producer groups are given by the APSPC. Since its establishment the share of the co-operative has been increasing in the number of produced domestic pigs, therefore it can validate the rights of its members to a greater extent. We have to emphasize the fact that the members of the Co-operative do not sell their pigs under one name, but hand them over for distribution for the Co-operative.

Table 1. Pig sales of APSPC in 2003-2008.

Name	2003	2004	2005	2006	2007	2008
Number of members	32	33	36	35	42	55
Sold animals	152 109	288 992	273 590	290 641	348 490	388 000
Sold (t)	16 948	30 443	32 244	33 482	40 250	44 814
Revenue on sales (million HUF)	4 128	8 944	9 123	10 104	11 753	13 220

Source: APSPC, 2009. (1 USD = 223.4 HUF in 2003; 1 USD = 203.3 HUF in 2004; 1 USD = 198.6 HUF in 2005; 1 USD = 211.2 HUF in 2006; 1 USD = 182.8 HUF in 2007; 1 USD = 249.7 HUF in 2008)

On one hand, the APSPC, considering the current regulations, can represent the interests of its members in terms of sales. As a result of the quantity of its produced slaughter animals, it can achieve higher prices than Hungarian average ones, due exclusively to its bargaining position. It must be noted that slaughterhouses offer various prices for equal quality at the same time. It often happens that slaughterhouses give periodically or permanently more than actual market prices for

animals of weaker quality or of greater body mass. The reasons may be various. The present study does not analyze this issue, but it includes demand and supply relations of consumers, demands from the processing industry or existing stocks placed in cold stores.

How can the positive potentials of market price fluctuations be exploited for increasing sales revenues?

In the case of a farm the only method may be the conclusion of exclusively short-term contracts and the sale of end products always for the buyer offering the highest price for them. In the short run it may be a useful method, but in a supply position it poses the risk that nobody buys anything, increasing market risks so high that they can endanger the existence of the enterprise. By concluding long-term contracts, market risks can be reduced but in this case low volumes cannot exploit the positive effects of price fluctuations and increase vulnerability.

Table 2 presents the sales revenues of the study period (in 2008) calculated by the model and the actual sales revenues of the cooperation. Sales revenue data showed clearly that for considerable amounts of sale volumes, the application of simple network models can exploit price fluctuations as a result of various quality requirements by slaughterhouses and thus surplus revenues can be gained. However, further gains can be made by more precise meat quality forecasts, as this explained the necessity for the modification of the model data. These corrections reduced the value of the model target function more or less in each case. Unfortunately, farms mostly rely on the data of earlier periods and their own experience, as they lack the required measurement devices.

Table 2. The development of actual sales revenue before and after optimization in the study period in 2008 (million HUF).

Denomination		48. week	49. week	50. week	51. week	52. week	Total
Fattening pig	Sales revenues of optimization	102.1	104.1	115.1	100.0	125.4	546.8
	Actual sales revenues	99.6	101.7	114.1	97.9	121.3	534.6
Culled sow	Sales revenues of optimization	8.2	7.5	5.6	4.4	7.9	33.6
	Actual sales revenues	6.4	7.4	5.4	4.2	7.5	31.0
Surplus sales revenues by optimization	million HUF	4.3	2.6	1.2	2.2	4.5	14.8
	%	4.0	2.4	1.0	2.2	3.5	2.6

Source: Authors' own calculation. (1 USD = 263.2 HUF)

Table 3 presents the reduced costs of some variables and related information, which are highlighted by the management of the Co-operative, but are not included in the optimal solution. Certain relations cannot be actually compared in terms of calculated reduced costs, as they are calculated for one animal. However, this comparison may be carried out by average carcass weight. The findings suggest that farm 5. can transport to slaughterhouses B and C only when sales revenues calculated in the optimal solution decrease in the cooperative.

On Table 4 shadow prices as model solutions show the amount of money by which further transports from certain farms increase income. The sensitivity report calculates this amount for one pig basically, but similarly to reduced costs, it can be converted into kg/HUF unit easily in the light of average weights.

Table 3. Development of the reduced costs of some variables in the model of week 48.

Relation of transport	Reduced cost HUF/pc	Coefficient of target function HUF/pc	Reduced cost HUF /kg	Average price HUF /kg	Upper limit HUF /kg
Farm 2.-slaughterhouse B	-319.5	42830.4	-3.0	399.6	402.6
Farm 4.-slaughterhouse B	-249.0	35133.5	-2.8	398.3	401.1
Farm 5.- slaughterhouse B	-172.6	43724.0	-1.6	395.8	397.4
Farm 6.- slaughterhouse B	-268.8	34160.8	-3.2	402.3	405.5
Farm 7.- slaughterhouse B	-118.0	37645.6	-1.3	400.6	401.8
Farm 8.- slaughterhouse B	-201.5	38309.7	-2.1	400.6	402.7
Farm 9.- slaughterhouse B	-280.7	35171.4	-3.2	402.5	405.7
Farm 1.- slaughterhouse C	-200.2	40298.6	-1.9	391.1	393.0
Farm 5.- slaughterhouse C	-263.5	43298.8	-2.4	392.0	394.3
Farm 10.- slaughterhouse C	-446.4	44262.7	-3.9	383.5	387.4
Farm 11.- slaughterhouse C	-150.2	38789.0	-1.5	392.1	393.6

Source: Authors' own calculation.

On Table 2, optimized sales revenues from qualified pigs is 102.1 thousand HUF on the 48th week, marketed quantity is 2655 pigs with the carcass weight of 259.7 tons based on the model's data, so the average market price is 393.2 HUF/kg.

Table 4. Shadow prices of net flow boundaries related to quality pig sales in the model of week 48.

Name	Final value pc	Shadow price for 1 pig	Right side of condition pc	Allowable increase pc	Allowable decrease pc	Shadow price for 1 kg weight
net flow of 1. farm	-320	-40 308	-320	35	145	-391,2
net flow of 2. farm	-270	-42 625	-270	270	255	-397,7
net flow of 3. farm	-450	-35 776	-450	35	145	-394,5
net flow of 4. farm	-100	-34 857	-100	100	255	-395,2
net flow of 5. farm	-200	-43 371	-200	55	255	-392,6
net flow of 6. farm	-360	-33 904	-360	200	255	-399,3
net flow of 7. farm	-120	-37 238	-120	55	145	-396,2
net flow of 8. farm	-250	-37 986	-250	55	145	-397,2
net flow of 9. farm	-320	-34 927	-320	200	160	-399,7
net flow of 10. farm	-210	-44 518	-210	35	40	-385,7
net flow of 11. farm	-55	-38 748	-55	35	145	-391,7

Source: Authors' own calculation.

The analysis of Table 4 clearly shows that the extension of capacities in farms 2., 3., 4., 6., 7., 8. and 9. would increase sales revenues, as shadow prices for 1 kg of weight are higher here than

current average prices; however, if transport capacities of farm 5. are extended, average prices can be reduced substantially. Statements on reduced costs already projected the conclusions on farm 10.

Table 5 demonstrates sensitivity report data related to slaughterhouse boundaries. The demands of slaughterhouse 6. shall not be fully met, while the other slaughterhouses will receive the required quantities. The comparison of A, B, C, D slaughterhouse shadow prices clearly indicates that if a sequence is to be set up for potential excess or re-grouped quantities, the sequence of C – B – D – A slaughterhouses seems to be acceptable (the sequence of B – A – D – C seems unacceptable, as C shadow prices are the lowest; however, its allowable increase is the highest).

Table 5. Shadow prices of slaughterhouse net flow boundaries related to quality pig sales in the model of week 48.

Name	Final value pc	Shadow price for 1 pig	Right side of condition pc	Allowable increase pc	Allowable decrease pc
Slaughterhouse A	750	351	750	35	145
Slaughterhouse B	250	525	250	35	40
Slaughterhouse C	480	191	480	200	160
Slaughterhouse D	550	243	550	55	145
Slaughterhouse E	625	0	880	1E+30	255

Source: Authors' own calculation.

Conclusions

By the feedback of production information, the APSPC makes farmers on lower production levels as well produce better quality and more homogeneous source material for slaughter, thus they can achieve higher revenues. The extra income generated by the application of the model provides potentials for improvement in normal or more favourable years. Thus our long-term farming can be more balanced, which affects the production safety of the other members of the chain; therefore, profitability risk can be reduced in the whole chain. However, it should become clear for political decision-makers that regulations should enhance the quality awareness of each member in the chain.

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