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RASMU: Regional Agricultural Sector Model for Ukraine

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1 Introduction

Ukraine's agriculture seems to have overcome the worst phase of the transition period and has started to increase its overall output in a more reliable economic and institutional environment. This latter fact makes the sector-specific impacts of external shocks and policy interventions more predictable. At the same time Ukrainian agricultural policy is using increasingly differentiated instruments to achieve a broad variety of goals, e.g. support producer incomes, use of existing production capacities, price stabilisation, food security, development of the processing industry, or compliance with WTO rules. The impact of such policies is often difficult to anticipate without the support of a numerical simulation model.

The development of the Regional Agricultural Sector Model for Ukraine (RASMU) offers the opportunity to analyse a broad variety of existing or planned policy measures within a simplified, consistent framework regarding quantities and prices. In its current version, RASMU comprises 27 raw and processed products, whose production, consumption and trade is modelled. Regarding the spatial dimension, the oblasts of Ukraine are aggregated into four representative regions, which trade among each other and the rest of the world. This regional partition is variable and can easily be changed in order to facilitate the analysis of policy measures aimed at regions with certain characteristics.

This paper is organised as follows: chapter 2 outlines and discusses the general features of RASMU, while chapter 3 delivers a detailed documentation of the model's content and algebraic design. Chapter 4 describes the derivation of parameters and the set-up of the base run. Chapter 5 presents an exemplary simulation exercise, and chapter 6 gives an outlook on future modelling developments.

2 Basic Features of RASMU

The agricultural sector model for the Ukraine so far possesses the following attributes:

Regionally differentiated

The model captures the diverse agro-ecological conditions in Ukraine, and thereby allows determining where certain policy measures have the greatest effect. Four aggregate regions composed of neighbouring oblasts with similar agro-ecological conditions have been identified.

Comparative-static

The model is comparative-static in nature in the initial phase. This means that it will *not* be a multi-period dynamic model producing future forecasts. This model feature may be added at a later stage. For the moment, the development in Ukrainian agriculture is too volatile to derive appropriate trend parameters for yields and land use.

Partial equilibrium

Partial equilibrium means that only agricultural product and input markets will be the subject of the model in order to keep the data management and equation system as simple as possible for the time being. However, this creates the problem that certain repercussions from the macro-economy may be not sufficiently accounted for. Thus, integrating RASMU into a general equilibrium model for the Ukrainian economy in the future would be desirable.

Welfare measurement

When analysing policy measures, the researcher is often confronted with the observation that some groups win, while others lose. In the policy debate, the prosperity of producers is frequently mistaken as the welfare of the whole society. One example is the frequent demand for higher agricultural prices which are meant to help farmers, hence the countryside, hence total Ukraine. This point of view grossly neglects the needs of low-income consumers to have access to low-price food commodities. Aggregate welfare measures which take both consumer and producer welfare into account help the decision maker to avoid this erroneous approach. Aggregate welfare measures also include a budgetary component in order not to disregard the impact of policy measures on the status of public finance.

Representation of trade as commodity flows

The interregional and foreign trade relations in RASMU are represented as net trade flows. As soon as a region has excess supply, it exports the commodity to those regions where the price difference (minus trade costs) is highest. The trade flows provide for a relative equalisation of commodity prices between the regions and the world market. In the real world, trade costs comprise handling and packaging, transport, transaction costs, and administrative trade barriers. Due to lacking information, only railway transport costs have been considered in RASMU so far. As a proxy for real transport costs, these are probably overestimated. Existing estimations of trade costs for Ukrainian grain trade, however, indicate that the magnitude of the current transport costs in RASMU comes relatively close to the level of overall trade costs.

Policy instruments

The choice of policy instruments described in the model depends on which policy instruments are used by Ukrainian central and oblast governments. However, there are, on the one hand, policy instruments that have rather straightforward effects that are easily reflected in a trade model. Among these measures are ad-valorem and specific (fix per unit) customs tariffs and export taxes, which are part of RASMU's price transmission equations. Also very commonly used, but more complicated to model are tariff rate quotas (TRQs) which are in force for sugar and grain. Another more complicated policy instrument is a floor price beyond which the state is obliged to buy grain surpluses from producers at a minimum price. TRQs and minimum prices will be represented in the next release of RASMU.

As compared to similar modelling approaches, the current concept of RASMU described above has both advantages and shortcomings. Pustovit (2003) developed an agricultural sector model for Ukraine which is relatively similar to RASMU. The major difference is the treatment of trade: while RASMU has no differentiated treatment of the world outside Ukraine, Pustovit's model separates trade relations with the EU and other major trade partners. On the other hand, while the Pustovit model treats Ukraine as one singular market, RASMU allows for regionally differentiated analyses within Ukraine.

3 Detailed Outline of RASMU

3.1 The RASMU Database

The database is at the heart of a modelling system. It is the most costly and time-consuming element, and therefore the most precious asset of a model. Changing simulation model features through adding of equations is easily done, and the same holds for carrying out policy simulations once the whole model system is established. Modellers spend most of their time with data collection and consistency checks.

The database of RASMU contains the following elements:

- Regional production and consumption
- Regional prices (producers, consumers)
- Border prices
- Trade costs (at the moment railway fees)

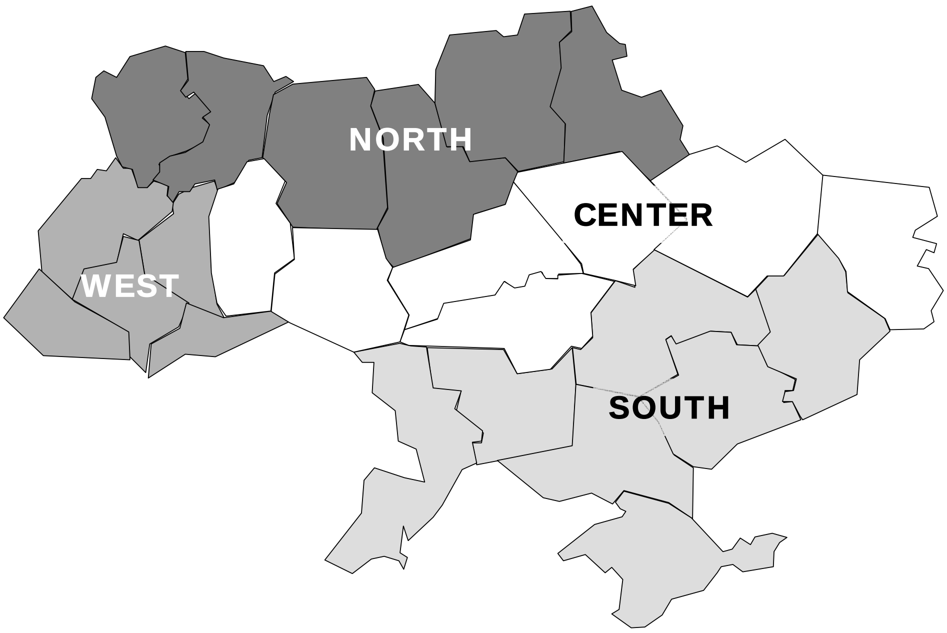
The data sources are:

- National and regional statistics
- International statistics (FAO)
- Surveys of farms, rural households, and consumers
- Own parameter estimations on the basis of surveys (elasticities)

Regional composition

The model is built on a database comprising all Ukrainian oblasts. Since this number is too large to be reasonably used in a regionally differentiated model, the oblast will be aggregated to four regional groups. These groups are distinct primarily by their agricultural conditions, which means soil quality and climate. The following graph provides an overview of the regional aggregation.

Graph 1
Representative regions in RASMU



Commodity breakdown

The selection of commodities has been carried out under the objective to cover both a large share of Ukrainian agricultural land use, but also the most important food commodities. The following table shows the products considered divided into raw and processed commodities.

It is obvious that this list is not complete. Regarding human consumption, the wide array of fruits and vegetables has not been included. This is justified by a) the fact that these commodities are currently produced almost exclusively by households and backyard farmers, b) that the significance of these products for food security is less important, and c) that neither these products nor their producers are subject to major political support measures or other interventions.

While most of the above commodities are assumed to be tradable, this is temporarily ruled out for some products for which trade is negligible for cost reasons, or where no sufficient data where available.

Table 1
Commodities in RASMU

Raw commodities	Processed commodities
Wheat	Bread products (from wheat and rye)
Barley	Maize flour (from maize)
Rye	"Grechka" (from buckwheat)
Maize	Sunflower oil
Oats	Sugar
Buckwheat	Butter
Potatoes	Cheese
Sunflower seed	Other milk products
Sugar beets	Beef
Pulses	Pork
Milk cows	Poultry meat
Beef cattle	Eggs
Pigs	
Poultry	
Hens	

3.2 The Algebraic Set-Up

3.2.1 Commodity Supply

The first version of the model will use double-log functions for supply and demand. Supply of crops is measured in activity levels and driven by the change in revenue per hectare (i.e. price x yield). This formulation has been chosen to allow for the simulation of abrupt yield shocks for a crop, which often happens in Ukraine due to adverse weather conditions. The increasing price of the affected crop alone, however, does not trigger an increased acreage for itself of decreasing acreage for competing crops. To account for this, the revenue per ha has been introduced in the formula instead in order to smoothen crop supply under abrupt price shocks.

$$\ln A_{i,r}^{sim} = \ln A_{i,r}^{bas} + \sum_{ii} \left(\varepsilon_{i,ii,r} \cdot \left(\ln\left(PP_{ii,r}^{sim} \cdot y_{i,r}^{sim} \right) - \ln\left(PP_{ii,r}^{bas} \cdot y_{i,r}^{bas} \right) \right) \right)$$

with

A	= Level of production activity (thousand hectare)
$PP^{bas,sim}$	= Producer price (reference and simulation price)
ε	= Supply elasticity
y	= Yield (production per hectare)

Production of livestock and processed commodities are driven by the change in the prices of crops, livestock, and processed products.

$$\ln Q_{i,r}^{sim} = \ln Q_{i,r}^{bas} + \sum_{ii} \left(\varepsilon_{i,ii,r} \cdot \left(\ln PP_{ii,r}^{sim} - \ln PP_{ii,r}^{bas} \right) \right)$$

with

Q = Level of production

In the case of livestock production, activity levels are the result of commodity production divided by yields.

$$A_{i,r}^{sim} = {Q_{i,r}^{sim}} \Big/ {y_{i,r}}$$

with

A = Level of production activity (number of animals)

y = Yield (production per animal)

3.2.2 Commodity demand

Regional commodity supply has to meet demand which consists of feed, seed, processing (= indirect food demand) and immediate consumption (= direct food demand).

Consumer demand will be reflected on the regional level by a linear expenditure system.

$$CPC_{c,r}^{sim} = \frac{P_{c,r}^{C} \cdot \tau_{c,r} + \beta_{c,r} \cdot \left(Y_r^C \cdot (1 - sav_r) - \sum_{cc} P_{cc,r}^{C} \cdot \tau_{cc,r}^{bas} \right)}{P_{c,r}^{C}}$$

with

CPC = Human consumption per capita

τ^{bas} = Minimum consumption at base solution

β = Marginal budget shares

Y^C = Household income

sav = Household savings rate

A demand function derived from a linear expenditure system works as follows: It is assumed that the amount of consumption which is subject to price influence is lower than total household income. First, savings are subtracted from household income, and also the expenditures for so-called subsistence consumption, the sum of p x τ in the parenthesis in the denominator. The remaining income is spent according to fixed marginal expenditure shares β. An advantage of the LES for this model is that it allows a straightforward calculation of consumer welfare due to the integrability of the LES demand function (see below).

Commodity consumption is the product of per-capita consumption and the regional population.

$$C_{i,r}^{sim} = CPC_{i,r}^{sim} \cdot POP_r$$

with

POP = Regional population

C = Regional consumption

Processing demand: To derive the demand for raw products, a Leontief-type function using fixed input-output coefficients will be used.

$$I_{i,r} = Q_{c,r} \cdot io_{i,c}$$

Feed demand is determined on the local level as far as data availability allows for this. The functional form is double-log as with production.[1]

$$\ln F_{f,r}^{sim} = \ln F_{f,r}^{bas} + \sum_{ff} \left(\lambda_{f,ff,r} \cdot \left(\ln PC_{ff,r}^{sim} - \ln PC_{ff,r}^{bas} \right) \right)$$

Seed demand: Demand for seeds ($S_{i,r}$) is determined as a fixed ratio of area seeded according to the base situation.

$$S_{i,r}^{sim} = A_{i,r}^{sim} \cdot \left(S_{i,r}^{bas} / A_{i,r}^{bas} \right)$$

Other demand: The remaining demand ($O_{i,r}$) consists predominantly of uses by agents not especially specified, and waste. It is determined as a fixed ratio of total demand.

$$O_{i,r}^{sim} = D_{i,r}^{sim} \cdot \left(O_{i,r}^{bas} / D_{i,r}^{bas} \right)$$

Total demand is the sum of the individual demand items.

$$D_{i,r} = C_{i,r} + F_{i,r} + I_{i,r} + S_{i,r} + O_{i,r}$$

3.2.3 Prices, Inter-Regional and International Trade

There are four levels of prices used in the model: regional producer prices, market prices for processed products, consumer prices, and world market prices, the parity level of which may vary depending on the net trade position of Ukraine.

The link between producer and market prices is established through a marketing margin:

$$PP_{i,r} = PD_{i,r} - t_{i,r}^{mark}$$

1 The final design for feed demand is planned to take energy and protein contents of feedstuffs into account according to specific needs of the individual livestock enterprises.

In the case of processed products, the producer incentive price is reduced by the necessary expenditure for raw materials inputs (e.g. sunflower oil – sunflower seed):

$$PP_{c,r} = PD_{c,r} - PD_{i,r} \cdot io_{i,c} - t_{i,r}^{mark}$$

The link between market and consumer prices is established through a processing and marketing margin:

$$PC_{i,r} = PD_{i,r} + t_{i,r}^{proc}$$

The **market price** in the target region is smaller (no trade) or equal to the market price in the region of origin plus transport costs (trade flow positive):

$$PD_{i,rr} \leq PD_{i,r} + t_{i,r,rr}^{dom} \perp FLOW_{i,r,rr}$$

In the case of foreign trade, the model will consider the rest of the world as an additional region in the network set-up. The model will work as a net trade model first. World supply and demand are perfectly elastic, which means that world prices are fixed. The above price equation will have to be modified in order to take into account tariffs and other trade barriers in international trade.

$$PD_{i,rr} + t_{i,r,rr}^{dom} + t_i^{spec} \cdot \left(1 + t_i^{adval}\right) \geq PD_{i,r} \cdot \left(1 - t_i^{x}\right) \perp \left\langle FLOW_{i,r,rr} > 0 \right\rangle$$

This equation applies to both an import or export flow from a certain Ukrainian region to the world market. The equation enforces equality only when there is a positive trade flow from *r* to *rr*. Otherwise, the price difference is too small to cover the costs arising from trade barriers. If PD represents a world price, a c.i.f. or f.o.b. margin is taken into account accordingly.

3.2.4 Regional commodity balance

Regional production in region r minus the sum of sales (both to the own region, other regions, and abroad) is equal to regional consumption minus the sum of sales to regions r (both from the own region, other regions, and abroad). The equation holds as long as the market price in region r is positive.

$$Q_{i,r} - \sum_{rr} FLOW_{i,r,rr} \leq D_{i,r} - \sum_{rr} FLOW_{i,rr,r} \perp \left\langle DP_{i,r} > 0 \right\rangle$$

3.2.5 Government balance and welfare

The welfare estimation in RASMU is based on four elements: Producer surplus, feed user surplus, consumer surplus and the balance of the government budget.

Regional producer surplus (PS_r) is calculated on the basis of producer prices as:

$$PS_r = \sum_i \left(PP_{i,r}^{sim} - PP_{i,r}^{bas}\right) \cdot Q_{i,r}^{bas} + 0.5 \cdot \left(PP_{i,r}^{sim} - PP_{i,r}^{bas}\right) \cdot \left(Q_{i,r}^{sim} - Q_{i,r}^{bas}\right)$$

The reason for using the simplified calculation method of adding rectangles and triangles is that the integral of a double-log function does not deliver consistent welfare calculations. The use of a supply function that is based on an estimated profit function will solve this problem in the future.

The welfare function for feed users is calculated in a similar way, assuming a linear demand system, and based on market prices:

$$FS_r = \sum_f \left(DP^{sim}_{f,r} - DP^{bas}_{f,r}\right)\cdot Q^{sim}_{f,r} + 0.5\cdot\left(DP^{sim}_{f,r}-DP^{bas}_{f,r}\right)\cdot\left(Q^{bas}_{f,r}-Q^{sim}_{f,r}\right)$$

The regional equivalent variation (EV_r) of consumer welfare is calculated as:

$$EV_r = \prod_c \left(\left(\frac{P^{Cbas}_{c,r}}{P^{Csim}_{c,r}}\right)^{\beta_{c,r}}\right)\cdot\left(Y^{Csim}_r\cdot(1-sav_r) - \sum_{cc} P^{Csim}_{cc,r}\cdot\tau_{cc,r}\right) - \left(Y^{Cbas}_r\cdot(1-sav_r)-\sum_{cc}P^{Cbas}_{cc,r}\cdot\tau_{cc,r}\right)$$

To complete the welfare calculations, the balance of public expenditure has to be added to the producer and consumer welfare calculations:

$$GB = \underbrace{\sum_{i,r} FLOW_{i,r,'World'}\cdot PD_{i,r}\cdot t^x_i}_{\text{Export taxes}} + \underbrace{\sum_{i,r} FLOW_{i,'World',r}\cdot PD_{i,'World'}\cdot t^{adval}_i}_{\text{Import tariffs ad-valorem}} + \underbrace{\sum_{i,r} FLOW_{i,'World',r}\cdot t^{spec}_i}_{\text{Import tariffs per unit}}$$

Overall national welfare changes are calculated as:

$$WF = \sum_r PS_r + FS_r + EV_r + \Delta GB$$

4 Getting the Model Started

Parameterisation

The results of a comparative-static model such as RASMU are primarily driven by fixed model parameters, predominantly the supply and demand elasticities in the behavioural equations. To obtain these elasticities, several methods can be chosen. The most accurate method is econometric estimation of the elasticities. This, however, requires a sufficiently large sample of producer or consumer data, and certain time resources to design and run these estimations properly.

Another common method is to calibrate a set of elasticities from other sources (e.g. studies on similar countries). Calibration means that the existing set of un-calibrated elasticities is changed in a way that the calibrated set is consistent with restrictions which are derived from commonly accepted theory on rational producer and consumer behaviour (profit under a cost constraint, or utility maximisation under a budget constraint).

In RASMU, elasticities of crop supply have been obtained by estimating a set of elasticities for Ukraine as a whole from annual data on the oblast level, imposing restrictions on homogeneity and symmetry. The remaining elasticities (supply of livestock and processed products, feed demand) have been chosen on the basis of plausibility considerations. The demand parameters for the Linear Expenditure System have been taken from Sheng (1997), who has estimated an LES for Russia based on household surveys. Other parameters are transport costs between regions and the world market. Railway freight rates were used as proxies.

Building a consistent database

Every comparative-static simulation model needs a consistent quantitative baseline against which counterfactual experiments can be compared. In RASMU, the quantities represent a three-year average from 1999 to 2001. Regional supply and demand of commodities (differentiated into human demand, feed use, processing, and other uses), and net trade of Ukraine as a whole served as the uncalibrated basis. Then, preliminary trade flows among the model regions and with the rest of the world have been calculated under the assumption of fixed net trade and minimal deviations from regional supply and demand.

Derivation of regional prices

The set-up of a realistic price system for the model's base run is a problem which has not yet been solved satisfactorily. As shown in the price transmission equation above, the existence of a trade flow requires a functioning "price link", meaning that the price differences between two regions must not be smaller than trade costs. As long as price differences between two regions are larger than trade costs, trade flows will occur until the price difference is reduced to trade costs. If, on the contrary, the initial price difference is smaller, no trade will take place. The problem arising from this is that the set-up of a base run has to fulfil these special conditions, while at the same time aiming at minimising the deviations from both initial regional quantities and prices. The first problem is usually formulated as a mixed complementarity problem, while the latter is usually solved by minimising an objective function with non-linear programming (NLP). To turn the objective function of the NLP into an MCP means deriving the objective function under consideration of all constraints. This can become a very tedious task, particularly when the objective function consists of numerous arguments.

For the time being, the model is first calibrated in quantitative terms using NLP, including an initial solution on trade flows. Then the price system is calculated with world market prices as price anchors for tradable goods, and other prices fixed. The calculation is carried out solving the regional commodity balance inequality and the price transmission inequality as an MCP with all other quantities fixed. The result of this two-stage process is a consistent quantity and price framework which serves as the baseline for the simulation model described algebraically in section 0 above.

5 An Exemplary Simulation: Winterkill 2003

To demonstrate both the achievements and limitations of RASMU, the failed wheat harvest in 2003 is simulated *ex-post*. In the winter of 2002/2003, heavy snowfall was followed by thawing, the latter covering large parts of the winter wheat area with water. Then came strong frost, which covered the young plants with ice for many weeks. This lead to serious 'winterkill', causing the harvested area under wheat to shrink from 6.5m ha in 2002 to 2.5m ha in 2003. On these remaining areas, average yields still dropped from almost 3.2 t/ha to only 1.6 t/ha. Production, consequently, reached only 3.6m tons, down from more than 20m tons in 2002. At the same time, by coincidence, world markets for food and feed grain became relatively tight, with wheat prices rising by roughly 30 % to USD 160 per ton in autumn 2003. This external shock had widespread repercussions on the agricultural sector, the food economy, and agricultural policy making:

- Instead of exporting wheat, Ukraine had to import wheat in the magnitude of 3.5m tons. This change in the net trade position caused tremendous price increases on the domestic market for wheat.
- Surprisingly, only very few of the fields initially seeded with winter wheat were re-seeded with spring crops such as maize, barley or sunflower. Thus, total harvested area fell by more than 15 percent. This means that other crops could substitute wheat only to a very limited extent; not as food grain, and as feed grain only to a minor extent (maize and barley).
- As prices for feed grain increased tremendously, livestock inventories were decreased to a considerable extent in the winter of 2003/04. This lead to decreasing meat prices in the short run, but will make prices for animal products rise in the course of 2004.
- As milling wheat prices rose, bread prices had to rise too, reportedly by about 40 to 60 percent, depending on the region.

This relatively complex incident is a good example to test the simulation model whether it produces reasonable outcomes which come close to reality. The simulation 'winterkill 2003' was implemented in the following way:

- The yield for wheat in the model was set to 30 % of the value in the base run for each model region.
- World prices for wheat were increased by 50 %, those for other grains by 30 %.[2]

The Ukrainian government responded to the harvest failure with a tight monitoring and control of commodity movements in order to curb bread

[2] The grain price increases have been calculated against the world prices in the baseline which represent average prices from 2000 and 2001. The world price increase from 2002 to 2003 was actually lower, as prices had already risen from 2001 to 2002.

and flour price increases. In particular, delayed refunding of VAT for grain exports was introduced to increase the domestic supply of feed grains. The government was also threatening not to refund VAT for feed grain exports at all if not the same amount of food grain was imported. Mills and bakeries were obliged to observe maximum trade margins.[3] Fortunately, the import duty on wheat of 40 EUR/ton was suspended for a limited period, but this move came too late to allow for cheaper wheat imports that would still have been possible in summer 2003.

This mix of measures is difficult to simulate. In order to identify the impact of an individual measure, each should be simulated separately. Moreover, some measures are difficult to translate into appropriate parameters within in the simplified 'RASMU world', as for instance the maximum trade margins. To arrive at meaningful simulation results, policy has to be implemented in a quite stylised way. When looking at the bundle of measures as a whole, all were aimed at keeping grain within the country and encourage imports. But some measures were probably not effective for that purpose. The excessive control of grain trade probably increased interregional price and scarcity differences, as the administrative costs of commodity movements increased. Moreover, while some measures such as suspending the import tariff removed market distortions, others such as the effective export taxation for feed grain created new distortions with probably adverse overall welfare impact. To deal with all these problems, three simulations have been run:

- Simulation A: Winterkill without policy action

  The 40% import duty remains, while no other measures are taken.

- Simulation B: Trade-relevant policy reactions of the GOU

  The duty on wheat imports is removed; and feed grain exports will be taxed with 15%. The simulation does not account for increased transaction costs caused by intensified controls through state authorities.

- Simulation C: Removal of market distortions

  The duty on wheat imports is removed, without other changes.

First test runs with RASMU yielded results pointing in the right direction with an important exception. However, as the feed demand elasticities were not econometrically estimated, and thus given only assumed values to of -1.5 (own-price elasticity) and 0.2 (cross-price elasticities), it turned out that the wheat feed use in the simulation was still too high compared with the real world result. Consequently, the own-price elasticities for feed demand were increased to -2.5.

The following table displays the results of the simulation for selected commodities on the national level. The results concentrate on three

[3] These maximum margins were called "maximum profits" in official documents, which indicates that Ukrainian most politicians and bureaucrats do still not understand the fundamental difference between a mere margin and the profit of an enterprise.

commodities, wheat (mostly representing winter wheat) as the commodity most affected by the winterkill, maize as a summer crop and a substitute for wheat on the market for feed grain, and pork production that is presumably affected by the rises in feed grain prices.

Table 2
Winterkill – Selected Results for the National Level, MY 2003/04

		Base run[a]	**Sim. A**	**Chg. A**[b]	**Sim. B**	**Chg. B**	**Sim. C**	**Chg. C**
Wheat	Area[c]	5978	5409	-9,5	5261	-12,0	5128	-14,2
	Production	15657	4272	-72,7	4157	-73,5	4051	-74,1
	Net trade	3049	-3440	-212,8	-3848	-226,2	-3973	-230,3
	Feed use	4790	538	-88,8	777	-83,8	830	-82,7
	Processing	6122	5722	-6,5	5804	-5,2	5801	-5,2
	Total demand	12608	7712	-38,8	8005	-36,5	8023	-36,4
	Price	91	242	164,9	202	121,2	202	121,2
Bread	Prod. / Demand	6102	5703	-6,5	5785	-5,2	5782	-5,2
	Consumer price	276	410	48,6	373	35,3	373	35,3
	Producer price	176	158	-10,4	161	-8,3	161	-8,4
Maize	Area	1201	1526	27,1	1334	11,1	1525	27,0
	Production	3747	4746	26,6	4160	11,0	4740	26,5
	Net trade	730	2413	230,6	1302	78,5	2466	237,9
	Feed use	2033	1423	-30,0	1896	-6,7	1367	-32,8
	Processing	723	702	-2,8	712	-1,5	704	-2,6
	Total demand	3018	2333	-22,7	2858	-5,3	2274	-24,6
	Price	80	107	33,2	91	14,0	106	32,8
Pork	Number of pigs	8862	8359	-5,7	8503	-4,1	8429	-4,9
	Production	633	598	-5,7	608	-4,0	603	-4,9
	Price	2068	2282	10,3	2213	7,0	2261	9,4
Welfare	Feed users		-643		-434		-533	
	All producers[d]		-139		-454		-246	
	Final consumers		-1133		-800		-876	
	State budget		142		56		9	
	Total welfare effect		-1130		-1199		-1113	

a ‘Base run’: Average Ukrainian marketing year (without winterkill)

Sim. A (Simulation A): Winterkill with no policy reaction

Sim. B: Import duty on wheat set to zero, implict export taxation of feed grains

Sim. C: Only the duty on wheat is abolished

b Chg. A: Change under Sim. A compared to the base run in percent.

c Quantities in 1000 MT (slaughter weight for pork); Area in 1000 ha; price in USD per ton; pig number in 1000 heads; welfare effects in 1000 USD.

d The welfare effect for ‘all producers’ includes welfare effects of feed users, the latter representing the livestock producers.

The most prominent result of the harvest failure is a pronounced increase of domestic market prices for wheat by 120% even when the import duty is suspended. The reason is that Ukraine has now to cover a wheat deficit in the magnitude of almost 4m MT, which has to be covered to a great extent through imports. In an import situation, the domestic price of wheat is determined by the world market price **plus** total trade costs (c.i.f., customs, domestic trade costs). The domestic trade costs alone range between USD 28 and 38 per ton. Consequently, prices for bread have to increase as well, even though at a much lower percentage (+35 %). Both the harvest failure for wheat and the increased world market prices for grains in general make feed grain more expensive (see results for maize), which leads to decreasing livestock inventories, as can be seen at the example of pigs in the table. Consequently, feed use of grains decreased dramatically. The overall welfare losses of the Ukrainian economy amount to at least USD 1.1 bn. The major part of these losses falls on feed users and final consumers.

When it becomes clear that a harvest failure like this is inevitable, consequent policy reactions can have a major impact on prices, commodity supply, and the distribution of welfare losses. The results of *Simulation A* show that keeping the import duty on wheat in the case of a harvest failure further aggravates the wheat scarcity and thus hurts consumers. The domestic wheat price would be higher at the amount of the duty (USD/t 40). The consequent bread price increase would be 13 percentage points higher. In absolute figures, consumers would have to expend USD 1.68 bn per year in the base situation before the harvest failure, but USD 2.34 bn in simulation A. Abandoning the duty (*Simulation C*) would make consumers pay USD 180 m less for bread. Similarly, feed users would enjoy USD 110 m in welfare gains compared to Simulation C. The simulation underlines the **redundancy of the wheat import duty**: in case of wheat exports, it is not effective, while in case of harvest failures it shifts the welfare losses further on the consumers and feed users; only grain growers would benefit from even higher prices.

The Ukrainian parliament fortunately suspended the import duty, but refused to abolish it in total. Moreover, to decrease the domestic prices on grain markets, the exports of grain crops were made more costly, primarily through delayed refunding of the VAT (*Simulation B*). The result of this policy measure was indeed a lower price for feed grain, as can be seen at the example of the maize prices in the table. Consumers and feed users (= livestock producers, see results for pork) benefit from this policy measure, while it makes grain farmers worse off. As the scenario behind *Simulation B* is replacing one market distortion by another, it is not surprising that the overall welfare balance is even worse as compared to *Simulation A*. Only the removal of market distortions can increase overall welfare compared to *Simulation A*, as it is done in *Simulation C.* Consumers and feed users are still better off than under Simulation A, whereas the crop producers are worse off only to a small extent.

The simulations show that on balance the differences between the overall welfare effects look relatively small. The overwhelming part of the welfare effects reported in Table 2 (USD 1.13 bn with policy distortions removed, as in Sim. C) originate from the harvest failure itself, i.e. in the damage caused by the non-production of several million tons of wheat. In the case of such a natural disaster, policy can do very little to ease the overall welfare situation of the country in the short run, as is demonstrated by the small improvements from Sim. A to Sim. C. Nevertheless, policy interventions can have tremendous distributional effects among the different groups of producers and consumers. Abolishing distortions as in Sim.C reduces the burden on consumers by about USD 250 m and shifts this amount mainly to crop growers who cannot benefit from the excessive price increase caused by the import duty on wheat. RASMU is able to uncover such effects and give decision makers an idea about their direction and magnitude. The flexible regional disaggregation of the model allows even deeper insights into interregional distribution effects of external shocks and policies.

Ukrainian agricultural policy has become more and more detailed and sophisticated over the past decade. Some support measures policies are trying to imitate similar policies of the EU or the US. This applies to the sugar market policy, which deals with tariff rate quotas and domestic minimum prices, but also to the various attempts to establish a minimum grain price, or the export tax on sunflower seed. Principally, all these policy measures can be simulated with RASMU, given that necessary adjustments in the database and the equation system are made.

6 Outlook

This technical paper shows that the RASMU modelling project has reached a stage where policy simulations have become possible. Nevertheless, a numerical simulation model always represents work in progress. Possible model improvements will be discussed in this last section.

Supply module

It would be desirable to have as much producer-specific information in the model as possible, since the main beneficiaries will be within the community of agricultural policy makers. The use of a supply module using a gross-margin based approach would be desirable, because it makes adjustment processes in the agricultural sector more transparent than a derived output supply/input demand function. The supply part of the model then would consist of an inherent linear programming exercise, as it is known from operations research. However, the problem with such an approach is that it basically represents farm supply as a normative planning exercise of representative farms, and not the observed supply behaviour of an aggregate of producers. The derivation of supply functions from a profit function would represent a viable compromise and will be implemented as soon as suitable parameter estimations are available.

Elastic world demand

The current model version assumes world demand to be infinitely elastic to Ukrainian export supply. This simplified notion will have to be replaced by reasonable assumptions on aggregate world import demand for grains and oilseeds, where Ukraine covers ever-increasing market shares. Particularly in the sunflower seed sector, the existing export tax is sometimes justified as welfare increasing for Ukraine, as the country has a certain amount of monopoly power in this market.

Differentiated consumers

Starting from a relatively egalitarian household income structure, Ukraine has experienced a widening disparity in income during transition. Few households have become very rich over time, while the major part remained relatively poor, with a narrow middle-class emerging in between. The demand structures between these economic strata are different to some extent and need to be considered separately in order to arrive at reasonable demand estimations matching regional supply. As there are detailed household data from surveys available, it should be possible to re-estimate the LES in RASMU for differentiated consumers.

Feed demand

The feed use of crops is becoming increasingly important in the course of economic growth and the accompanying demand increase for livestock products. So far, the feed use in the model is based on relatively weak statistical information on gross feed use of crops, the latter not being differentiated by livestock industry. This coarse approach should be replaced by the introduction of compound feed which would be split into livestock-specific varieties containing appropriate shares of energy and protein. To implement such a more realistic representation of feed use, farm data will have to be utilised.

Policy representation

Ukraine is pursuing a sugar market policy which is trying to mimic the common market organisation (CMO) for sugar which is regulating the EU's domestic sugar market and trade policy. Similar to the EU, there are minimum prices and a tariff rate quota on raw sugar from third countries, as Ukraine is a net importer of sugar. In the area of grain policy, there is a minimum price regime as well, even though it is practically not effective. However, after the winterkill in 2003, the government decided to devote more budget fund to grain intervention sales, intending to more effectively defend the minimum price and provide for sufficient emergency stocks. It is one of the next steps to explicitly represent these policies in the RASMU model. A sound modelling approach to these instruments requires a lot of creativity from the modeller, since the functional forms of such instruments are non-continuous and hence not differentiable by most NLP solvers. One way out is the use of non-linear approximations using logistic functions. Another, more rigorous approach is to formulate such policies as a mixed complementarity problem (MCP).[4] This approach is already used in RASMU.

But apart from such technicalities, the major problem with any policy instrument that involves payment obligations on the part of the state is the actual effectiveness of such a policy in the face of scarce funds. For instance, the floor price for grain which have been declared in Ukraine so far have not really been functional due to missing funds. Another area is the introduction of TRQs, which are often not filled completely because the price margin is not sufficient. Any numerical model is driven to its limits when policies are not consequently implemented.

4 Examples of modelling non-smooth relationships are described in Kuhn (2003).

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