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Harvest failures, temporary export restrictions and global food security: the example of limited grain exports from Russia, Ukraine and Kazakhstan

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Abstract Russia, Ukraine and Kazakhstan (RUK) are major players in the international grain markets and their exports help to improve global grain availability and hence food security. However, during the last decade the availability of RUK grain exports was repeatedly diminished by harvest failures and further reduced by the introduction of export restrictions. By simulating a reoccurrence of the 2010 RUK harvest situation this paper assesses the impact of grain harvest failures and subsequent temporary export restrictions (bans, quotas, taxes) on national and international food security, specifically quantifying the effects on agricultural market prices and quantities. For the analysis AGLINK-COSIMO, a recursive-dynamic, partial equilibrium, supply–demand model, has been employed. Simulation results highlight the importance of RUK's grain production for world markets and global food security, indicating substantial price increases due to limited grain exports from RUK. Moreover, scenario results illustrate that temporary RUK export restrictions can considerably aggravate the situation on world grain markets, with particularly adverse effects for grain net importing countries. At the same time, results show that for a country like Ukraine, i.e. a country usually exporting large shares of its total grain production, the introduction of export restrictions could potentially result in decreases of domestic consumer prices to a level even below a situation with normal weather conditions. The results put international trade policy into focus and underline the necessity of greater cooperation on the part of exporting countries in order to avoid importing countries being denied necessary grain supplies.

Keywords Harvest failures · Export restrictions · Food security · Agricultural markets

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Background

During the Soviet times, Russia, Ukraine and Kazakhstan (RUK) were main producers of wheat and coarse grains[1] for other Soviet republics. However, on aggregate, the USSR was a grain importer rather than exporter. After the breakup of the Soviet Union in 1991 the RUK countries began their transition from centrally planned to market economies. This transition comprised an overall restructuring of the agricultural sector and the production of almost all agricultural commodities in RUK went down dramatically. During the 2000s agricultural output in RUK began to rebound, and the three countries became big players in the international trade of agricultural products, especially with regard to exports in the grain sector. A major driver of the increase in production and exports was the rise of large and dynamic, vertically-integrated farming operations (big farm co-operatives)[2] which are engaged in more efficient agricultural and management practices and

[1] Under the term coarse grains mainly maize and barley are considered, but also oats, sorghum, rye, millet, triticale and other cereals.
[2] The big farm co-operatives have little or nothing to do with the Soviet time *kolhoz & sovhos*, as they have a completely different management structure and property type.

enjoy better credit access. Furthermore, the livestock sector in RUK experienced a severe contraction during the 1990s, which led to big decreases in domestic feed demand and hence an increase in exportable grain surpluses (Liefert et al. 2010; OECD-FAO 2011; Liefert et al. 2013).

By the end of the 2000s, RUK exports in wheat accounted for about a fifth of total grain traded on the world market. Russia is a major exporter of wheat, with a share of 13.1 % of total world exports, followed by Ukraine (7.9 %) and Kazakhstan (5.1 %). Regarding coarse grains, Ukraine has a share of 9.9 % in total world exports, while Russia and Kazakhstan have shares of 3.3 % and 0.3 % respectively (cf. Table 1).

According to the OECD-FAO (2012) agricultural outlook, Russia alone is expected to surpass the USA as the world's largest wheat exporter over the next decade and RUK together are expected to account for about 35 % of total world wheat exports by 2021. For coarse grains projections indicate that Russia will reduce significantly its exports as expected increases in domestic animal production will require more feed. Kazakhstan is currently not a major exporter of coarse grains and this situation is not expected to change in the coming years. In Ukraine, exports are projected to remain stable at the high level of 17 million tonnes (Mt) (OECD-FAO 2012). The dynamics of wheat and coarse grain exports from RUK countries are presented in Fig. 1, comprising both historical data from 2000 to 2012 and projections until 2021.

The projected developments in RUK with regard to grain production certainly could help to improve grain availability on international markets and hence global food security.[3] However, during the last decade the availability of grain exports from the RUK countries was repeatedly diminished by harvest failures due to severe droughts and then further reduced by the introduction of export restriction policies. The most recent examples of temporary export restrictions were in the years 2007–2008 and 2010–2011: between July and October 2007, Ukraine introduced a total grain quota of only 12,000 tonnes (3,000 tonnes each for wheat, barley, rye and corn), which virtually meant an export ban.[4] In 2008, Russia implemented an export tax of 40 % on wheat and Kazakhstan applied an export ban from April to September 2008 (Dollive 2008; OECD 2013a). In 2010, both Russia and Kazakhstan considered the introduction of bans on grain exports and, while Kazakhstan finally refrained from export restrictions, Russia implemented an export ban from August 2010 to June 2011. Ukraine opted for a grain export quota of 6.2 Mt in total from October 2010 to July 2011[5] and then introduced export taxes of 9 % for wheat, 12 % for maize and 14 % for barley from July to December 2011 (OECD 2011; OECD 2013b).

It should be noted that Ukraine has been a member of the WTO since May 2008 and Russia since August 2012, whereas Kazakhstan might also soon achieve WTO membership (WTO 2012; WTO 2013). Under WTO commitments, members are generally not allowed to ban exports completely. However there are exceptions, and therefore even under WTO rules countries can prohibit or restrict exports of agricultural products if national food security is threatened, but only temporarily and only if they comply with Article XI of the General Agreement on Tariffs and Trade (GATT) and Article XII of the Agreement on Agriculture (AoA).

In general, export restrictions are introduced by a country to reduce the flow of exports of a given good, which should lead to increased volumes available of this product on the domestic market and decreased domestic prices. With an export ban, no exports of the respective product are allowed. With an export quota, exports are quantitatively limited to the amount of the quota. An export quota is only effective if it is binding, i.e. if the export demand exceeds the quota amount. Export taxes[6] can be applied as a percentage of product value (ad valorem tax) or as a fixed rate per physical unit of product (specific tax). In theory all export restrictions have an equivalent tax level, i.e. an export tax could be set at a level that results in the same amount of exports as an export quota and in an extreme case a prohibitive tax would have the same effect as an export ban. Consequently, apart from possible administrative costs and government revenue (export taxes generate revenues for the government), the effects of export restrictions depend more on the level of the restriction made rather than on the instrument used to achieve this level, i.e. regarding exports the kind of policy instrument generally only matters with respect to the level of restriction it implements (Kazeki 2006; Mitra and Josling 2009; Sharma 2011).

Temporary export restricting policies are used when a country's production is lower than usual or/and when international prices are rising. This was the case in the two periods mentioned above, and RUK countries implemented measures to restrict grain exports with the aim of keeping domestic prices low for human consumption and animal feed. Internationally, the RUK governments justified the introduction of export restrictions on the grounds of national food security (Abbott 2009; Mitra and Josling 2009; WTO 2011). When a country with usually large grain exports modifies its net

[3] Food security is generally considered to comprise four pillars: availability (whether enough food is available either through domestic production or imports), access to food (physically and economically), utilization (concerns regarding health and nutritional diet) and stability (whether a state of food (in)security is transitory or permanent) (FAO, 1996; FAO, 2009; Pinstrup-Andersen, 2009). In this paper we concentrate on the pillars of food availability and the price aspect of access.

[4] For wheat this was followed by an export quota of 200 000 tonnes from January to March 2008. The quota was then further expanded to 1.2 Mt and finally cancelled in May 2008 due to an expected exceptionally large wheat harvest (FAPRI 2013).

[5] The quota was lifted earlier (in May-June 2011) for wheat, maize and barley.

[6] A variety of similar or complementary terms are used for export taxes such as export tariffs, export duties, export fees, export levies or export charges (Kazeki 2006).

Table 1 Share (%) of wheat and coarse grains exports in total world trade (2008–2009 average)

Country	Crop	2008-2009 average (1000 t)	Share in total exports (%)
Russia	Wheat	18,475	13.1
	Coarse Grains	3,946	3.3
Ukraine	Wheat	11,187	7.9
	Coarse Grains	11,628	9.9
Kazakhstan	Wheat	7,203	5.1
	Coarse Grains	329	0.3
RUK	Wheat	36,865	26.2
	Coarse Grains	15,903	13.5
USA	Wheat	25,783	18.3
	Coarse Grains	52,802	44.7
EU	Wheat	23,733	16.8
	Coarse Grains	4,271	3.6
Canada	Wheat	18,959	13.5
	Coarse Grains	3,483	3.0
Australia	Wheat	14,787	10.5
	Coarse Grains	4,420	3.7
Argentina	Wheat	5,947	4.2
	Coarse Grains	15,609	13.2
Total World	Wheat	140,875	100
	Coarse Grains	118,036	100

Source: USDA, 2012

supply (level of exports) to the world markets, the quantity can be sufficiently large to influence world prices. In general, export restrictions implemented by a country will reduce supply to the rest of the world, which in the case of a large grain exporting country can imply a substantial fall in world supply that results in an increase in international prices. While in the short term the increased prices will benefit producers in the rest of the world (by increasing their profits), consumer welfare will decline as consumers have to pay a higher price for food. As a response to higher prices, producers in the rest of the world will increase their production, which in turn then leads to a fall in prices from the short-run level. Given the importance of RUK countries with regard to grain exports it is assumed that the above mentioned export restrictions in RUK had adverse effects on international food security by adding to instability in world grain markets and contributing to spikes in international food prices; however it is not clear to what extent (Abbott 2009; Mitra and Josling 2009; Anderson and Nelgen 2011; Headey 2011; Sharma 2011).

In 2012, grain production in all three countries was once more hit by severe droughts. Especially Russia and Ukraine suffered bad wheat harvests, which led to speculation that both countries would impose again some restrictions on wheat exports (Reuters 2012; 2013). Even though no effective restrictions were finally put into place, the recent events show that harvest failures and respective ad hoc policy decisions in RUK

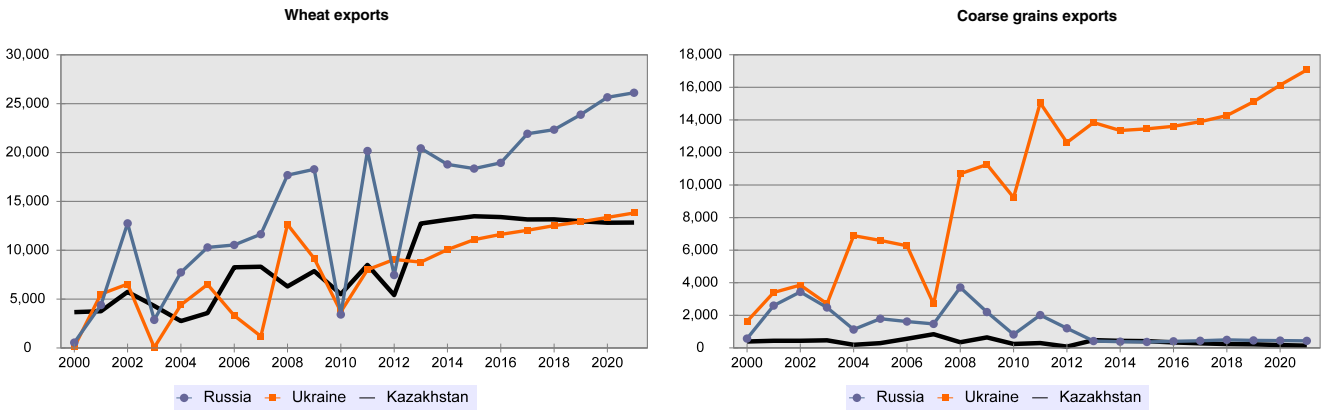

Fig. 1 Historical and projected wheat and coarse grains exports in RUK (in 1000 t). Source: OECD-FAO (2012), data for 2012 corrected according to USDA (USDA 2012a, 2012b). Data extracted with DataM (cf. Hélaine et al. 2013).

might occur again and threaten global grain availability and food security. Against this background the purpose of this paper is to quantitatively assess the impact of harvest failures and subsequent trade restricting measures temporarily introduced in the RUK countries. Specifically we aim to address the following questions: What would be the impact of a reoccurrence of a similar RUK harvest situation as in 2010 on global grain markets and food security? How do different temporary export restrictions implemented in RUK affect quantities and prices on both the domestic and world markets? How do the impacts vary between net exporting and net importing countries?

To answer these questions we use the AGLINK-COSIMO model. In a benchmark scenario we simulated harvest failures in the cereal sector of RUK and, in three policy scenarios, we separately simulated the implementation of export bans, export quotas and export taxes in RUK. In all scenarios we assessed the respective impacts on food security by quantifying the effects on agricultural grain availability and prices. With respect to prices we analysed the effects on world prices as well as domestic producer and consumer prices in the RUK countries. Furthermore, in the examples of the European Union (EU) and Egypt, we analysed how the simulated harvest failures and export restrictions in RUK affect net exporting countries and net importing countries, respectively.

Specification of the modelling approach and the scenarios

The AGLINK-COSIMO model

For the quantitative analysis, AGLINK-COSIMO, a global recursive-dynamic, partial equilibrium, supply–demand model, was adjusted and employed. The model was developed by the OECD Secretariat[7] and the FAO to conduct policy analysis and prepare medium-term agricultural market outlooks in a consistent analysis framework.

AGLINK-COSIMO endogenously calculates annual supply, demand, trade and prices for the main agricultural commodities produced, consumed and traded in each of the countries represented in the model. The overall design of the model focuses in particular on the potential influence of agricultural and trade policies on agricultural markets in the medium-term. The projection period is 10 years and an outlook exercise for the development of agricultural markets and prices is provided annually in a joint publication of the OECD and the FAO. The final product of the outlook exercise reflects the evolution of the markets assuming a current policy framework, normal weather conditions, given and expected yield growth rates and exogenous assumptions on macroeconomic variables such as GDP growth, exchange rates, world oil prices and population growth (OECD 2007; OECD-FAO 2012). In the context of market analysis it has to be highlighted that AGLINK-COSIMO is based on several major assumptions (OECD 2007): (i) World markets are assumed to be competitive; neither buyers nor sellers behave as if they have market power and market prices are determined via global or regional equilibria in supply and demand; (ii) AGLINK-COSIMO is not a spatial model and hence importers do not distinguish the origin of commodities (i.e. transportation costs are not included); (iii) AGLINK-COSIMO is a partial equilibrium model focused on agricultural commodities (i.e. non-agricultural markets are treated exogenously to the model).

As AGLINK-COSIMO covers many global agricultural commodity markets and also many individual countries, the scope of the model allows the estimation of agricultural and trade policy impacts at the global and national levels. The country and regional modules in AGLINK-COSIMO are all developed by the OECD and FAO Secretariats in collaboration with country and commodity market experts. Country specific information on agricultural, biofuel and trade policies is updated annually and thus allows the analysis of agricultural market developments in a setting that reflects an up-to date policy framework (OECD 2007; OECD-FAO 2012). Price elasticities of demand and supply are kept constant over the projection period but are revised regularly by the OECD and FAO secretariats. However, the model does not explicitly incorporate risk aversion or specific strategic behavior of the economic agents (such as producers, consumers and stock agents) that may arise in the context of volatile commodity markets. A further limitation of the model is that it does not take into account ad-hoc changes in policy mechanisms or goals that may occur, for example, under volatile market situations in the medium-run. We partly tackle this latter limitation by quantifying the effects of both major harvest failures and subsequent temporary export restrictions in RUK.

Scenarios description

For the purpose of this paper five simulation scenarios have been constructed. The starting point for the simulations was the data of the agricultural outlook of the OECD-FAO (2011) and the European outlook for agricultural markets (DG AGRI 2010; Nii-Naate 2011). However, the data on export and import tariffs in the AGLINK-COSIMO database needed to be updated according to the latest available information on Russia, Ukraine and Kazakhstan. All scenarios assume the same underlying macroeconomic development for the period 2011–2021 (cf. DG AGRI 2010; OECD-FAO 2011), but they partially differ with regard to the assumed weather conditions and applied trade measures in RUK (Table 2).

The *Baseline Scenario* provides 'standard' projections for the development of agricultural commodity markets until

[7] The results of any analysis based on the use of the AGLINK-COSIMO model by parties outside the OECD are outside the responsibility of the OECD Secretariat. Conclusions derived by third-party users of AGLINK-COSIMO should not be attributed to the OECD or its member governments.

Table 2 Scenario overview

Scenario Name	Scenario assumptions regarding weather conditions and temporary grain export restrictions in RUK countries in 2015	
Baseline scenario	No temporary export restrictions are introduced	Normal weather conditions
Benchmark scenario	No temporary export restrictions are introduced	Production decline in 2015 due to severe droughts in RUK
Scenario 1	Export bans in RUK	
Scenario 2	Export quotas in RUK	
Scenario 3	Export taxes on ad valorem basis in RUK	

2021, based on a coherent set of assumptions on exogenous macroeconomic developments and under the assumption of normal weather conditions and steady demand and yield trends that follow recent time paths. The baseline assumes continuation of existing policy measures over the projection period, i.e. the RUK countries will not apply any temporary export restrictions (cf. DG AGRI 2010; OECD-FAO 2011).

The *Benchmark Scenario* follows the general assumptions of the Baseline Scenario; however it is assumed that in 2015 the RUK countries suffer severe reductions in grain production due to unfavorable weather conditions. As/ orientation for the production decrease we mimic the real harvest situation in RUK as occurred in the year 2010, i.e. in the reference scenario RUK wheat and coarse grains production in 2015 is set at the level of the year 2010. This scenario represents the benchmark for the three export restriction policy scenarios.

The three policy scenarios follow the assumptions of the benchmark scenario, but simulate separately the temporary introduction of export bans, quotas and taxes in RUK as a reaction to the production decline in 2015. As mentioned above, these trade restricting instruments have been employed in the RUK countries in recent years, though their use varied in the countries with regard to the year, duration and level of application. In our simulation scenarios each of the instruments is applied for the time of the entire (production) year 2015 and for illustrative reasons we translate the levels of application as occurred in Ukraine to the situation in Russia and Kazakhstan.

Scenario 1 simulates a situation where the three RUK countries introduce complete export bans on wheat and coarse grains for the year 2015.

Scenario 2 simulates a situation where all three countries introduce export quotas in 2015. The size of the export quota was calculated as a share of the production in each of the countries. As reference point for this share we used the actual export quota applied in Ukraine in 2010, when Ukraine introduced export quotas of 1.0 Mt for wheat and 5.2 Mt for coarse grains (OECD 2011).[8] The export quotas simulated for Russia and Kazakhstan represent the same share of production in the respective countries.[9] The derived export quotas for Russia are 1.39 Mt and 0.21 Mt for wheat and coarse grains respectively[10] and for Kazakhstan 0.9 Mt and 0.18 Mt.

Scenario 3 assumes that all three countries introduce the same export taxes in 2015, 9 % for wheat and 13 % for coarse grains on an ad valorem basis. These taxes correspond to the tax levels implemented by Ukraine in 2011. Thus, in this scenario, we assumed that the three countries have good market information on prices and availability of wheat and coarse grains and it is known a priori that the level of export duties is enough to keep domestic prices low. It has to be mentioned that in reality it is very unlikely that different countries use exactly the same export duties unless they belong to a Custom Union as for example Russia, Belorussia and Kazakhstan. Thus it could indeed be the case for Russia and Kazakhstan but rather not for Ukraine. However for this scenario we used this simplification for didactic reasons as it allows a better interpretation of scenario results.

For the technical implementation of the export restrictions into the model we used different levels of export duties to model export bans, quotas and taxes. This way of modelling export restrictions is a well established technique in economic modelling and follows a common way of modelling agricultural trade policy (see e.g. Alston and James 2002; Korinek et al. 2008). However, it has to be stressed that the modelling results depend on the level of the restriction made and actually not on the instrument used to achieve this level, as the kind of policy instrument only matters with regard to the level of restriction it implements. Thus, the aim of the paper is not to show that there is a difference between the three policy instruments as such regarding RUK exports, prices, consumption etc., but rather that the level of restriction matters.

[8] In 2010, export quotas were in place in Ukraine from October 2010 to May-June 2011 (i.e. 8–9 effective months); however in our simulation exercise we assumed that quotas were effective throughout the year 2015 (i.e. from July 2015 to June 2016).

[9] A 'rational' export quota should be related to the size of production, stocks and domestic demand. RUK stock-to-use ratios in 2010, as indicated in both the OECD-FAO and USDA databases for the three countries, have been in a similar range as they are in our baseline projections for the year 2015. Therefore it is a rather good estimate to calculate the size of the modelled export quotas as a share of the production in each of the countries. To further level out differences in production and also stock-to-use ratios we used the average of the production during the period 2009–2011 in each country.

[10] Due to the decreasing trend in the projection for Russian coarse grains production we used the years 2010 and 2011 as an historical average.

Scenario results

To depict the impact of the drought in RUK, results of the reference scenario (drought in RUK) are compared to the baseline (normal weather conditions), whereas the policy scenarios (temporary export restrictions in RUK) are compared to the benchmark scenario in order to show the additional market and price impacts of the policies implemented. The final projection year in the scenario simulations is 2021. However, here we present only the scenario results for the year 2015, i.e. the year of the modelled harvest shock and the implementation of temporary export restrictions in RUK. We concentrate on the year 2015 because the scenario results indicate that the short-term effects are the most critical ones in terms of global food security. In the short-term, farmers have only limited possibilities for adapting their production behaviour to the new market conditions (as most of the planting decisions have already been taken). The further scenario results show that in 2016 farmers reacted to changed (world) market conditions, and world grain markets started to regain their pre-shock baseline levels.

Benchmark scenario

Simulation results of the benchmark scenario show that a reoccurrence of the 2010 RUK harvest situation in 2015 would cause a total decrease in production in RUK of 29 % for wheat and 34 % for coarse grains compared to the baseline (i.e. under normal weather conditions) (Table 3). For wheat, the production decrease in RUK implies a decline in world production of 4 %, which leads to a 23 % increase in world market prices. Due to the higher world prices, certain countries such as the USA and the EU increase their exports.[11] However, increases of exports in third countries are rather limited, because planting decisions of farmers have already been taken before the drought event in RUK. Therefore an export increase by third countries is only possible with a switch from domestic use to exports or with stock releases. A switch in domestic use can occur due to the substitution of wheat by other feedstock, but this is also rather limited as wheat demand for food consumption is quite inelastic, and scenario results indicate that substitution takes place mainly in the feed sector and only marginally in the biofuels sector. The higher world market prices for wheat are transmitted to consumers through higher consumer prices for bread and other foods containing wheat, which provokes a decrease in global wheat consumption of 2 %. With regard to the RUK domestic markets, aggregated consumption decreases by 7 % and exports by almost 70 % compared to the baseline. Lower supply leads to higher producer prices. However, in Ukraine and Kazakhstan, the price increase does not compensate for the loss in quantity produced, resulting in decreases in production value[12] by 5 % and 20 %, respectively. By contrast, in Russia, where the highest producer price increases are projected, the production value increases by 10 %. Consumers are penalised by the increase in food prices in all three countries, being least affected in Russia and moderately affected in Ukraine and Kazakhstan.

For coarse grains the simulated drought in RUK has less effects on the world market than for wheat, which is attributable to the lower share (10 %) of RUK exports in the world market. However, even though world coarse grain production and consumption decrease each by only 1 % in comparison to the baseline, the effect on the world price is substantial, as it increases by 15 %. This price increase triggers an increase in coarse grain exports of third countries (especially USA, Brazil and EU) by almost 10 %.

Export restriction scenarios: Impact on world food prices

Not surprisingly, scenario results show that the world market prices for wheat and coarse grains would increase more with RUK export restrictions than if the market were free to adjust to the lower grain availability caused by the drought in RUK. However, the effect on world market prices varies significantly in the policy scenarios, depending on the level of restriction adopted (cf. Fig. 2).

Wheat

In Scenario 1, when all three countries introduce export bans, world trade in wheat decreases by 6 % compared to the benchmark scenario. Due to RUK's high share in world exports this provokes an increase in the world price of wheat of 11 %. In Scenario 2, where the RUK countries restrict their wheat exports to a total quota of 3.3 Mt, total exports decrease by 4 %. The impact on the world market price is lower than in Scenario 1, but it still increase by 7 %. Contrary to an export ban or tight export quotas, the introduction of a 9 % export tariff on wheat in Scenario 3 allows the RUK countries to continue exporting significant amounts, which results in exports of more than 9 Mt. Therefore total RUK exports decrease by only 1 % and the world price increase by 1 %.

Coarse grains

For coarse grains, only the export restriction measures introduced in Ukraine are projected to have a noticeable impact compared to the benchmark scenario, as the other two countries are major producers but do not export such significant

[11] This could also be observed in 2010, when e.g. the USA exported 35 Mt of wheat in comparison to 26 Mt on average in 2008 and 2009.

[12] Calculated as the quantity produced times the producer price.

Table 3 Impact of the simulated drought on the world and RUK grain markets (2015)

		Baseline				Benchmark Scenario (Drought) vs. Baseline			
		Prod. (Million tonnes)	Exports	Cons.	Prod. price (USD/t)	Prod. (%)	Exports	Cons.	Prod. price
Wheat	Ukraine	24	11	13	233	−27	−45	−5	30
	Russia	59	14	46	115	−27	−86	−8	50
	Kazakhstan	17	8	9	103	−41	−67	−5	36
	RUK	100	33	68	na	−29	−68	−7	na
	World	692	133	694	237	−4	−11	−2	23
Coarse grains	Ukraine	26	12	14	193	−16	−29	−2	19
	Russia	30	0	33	144	−50	−83	−4	37
	Kazakhstan	3	0	2	115	−30	−99	−12	71
	RUK	59	13	49	na	−34	−32	−4	na
	World	1,202	130	1,200	196	−1	6	−1	15

Note: 'na'=not applicable, Prod. = Production, Cons. =Consumption, Prod. price =Producer price

quantities. Moreover, the share of RUK in the world coarse grains market is lower than the total share of RUK in the wheat world market. Therefore the effects of the export measures on world market prices for coarse grains are similar to those for wheat but at a lower level. The increase in world coarse grains prices varies between 6 % in Scenario 1 and less than 1 % in Scenario 3. The increase in world prices induces major coarse grains producers, such as the USA and the EU, to further increase their exports (up to 3 % in Scenario 1) compared to the benchmark scenario. This export increase in third countries is possible because coarse grains can be substituted by other feedstock to feed animals or to produce biofuels.

Export restriction scenarios: Domestic impacts in RUK

Wheat

In the benchmark scenario Russian wheat production was set at 43.5 Mt (as experienced in 2010), implying that the drought caused a 27 % decrease in Russian wheat production compared to the baseline (Table 3). With the introduction of the export ban in Scenario 1, Russian exports drop to 0, whereas the 1.39 Mt export quota restriction in Scenario 2 results in a 28 % decrease of exports in comparison to the benchmark scenario. The 9 % export tax in Scenario 3 is more restrictive than the quota and implies a 39 % decrease in Russian exports (Fig. 3). Russian producer prices are only slightly affected by the introduction of the different export restrictions. The drop in exports is already drastic in the benchmark scenario (almost −90 %), considering that the simulated decrease in production (−15.9 Mt) is relatively close to the quantity exported in the baseline scenario (13.7 Mt). Compared to the benchmark, the decrease in Russian producer prices for wheat varies between no change with an export quota to decreases of 6 % and 3 % with an export ban and export tax, respectively. Domestic consumption increases by 4 % with an export ban and by 2 % with the export tax, whereas consumption remains stable with the modelled export quota.

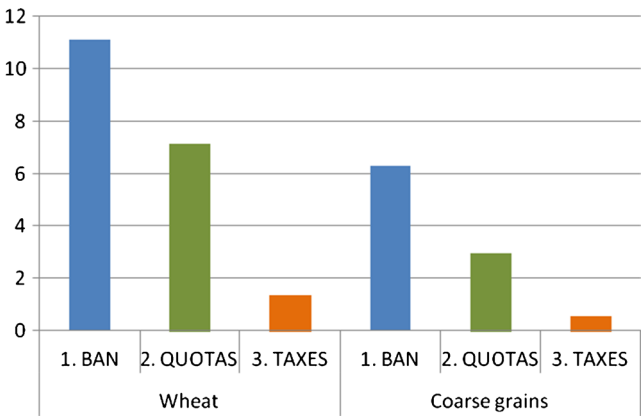

Fig. 2 Changes in world prices due to RUK export restrictions (%-changes compared to the benchmark scenario in 2015)

In Ukraine and Kazakhstan the situation is very different from the situation in Russia, as in the baseline, i.e. under normal weather conditions, the two countries are projected to export almost 50 % of their wheat production in 2015 (whereas Russia exports about 23 % of its production). With the drought in the benchmark scenario, wheat production decreases by 27 % in Ukraine and 41 % in Kazakhstan, resulting in production of 17 Mt, and 10 Mt respectively. Thus the simulated production loss is lower than the countries' export levels in the baseline scenario (Table 3) and therefore Ukraine and Kazakhstan continue exporting significant quantities of wheat (6 Mt and 3 Mt respectively) in the benchmark scenario. Under these circumstances the introduction of an export ban or a very restrictive quota has considerable impacts on producer prices. As such policies imply that huge quantities of wheat would be released on the domestic market, they

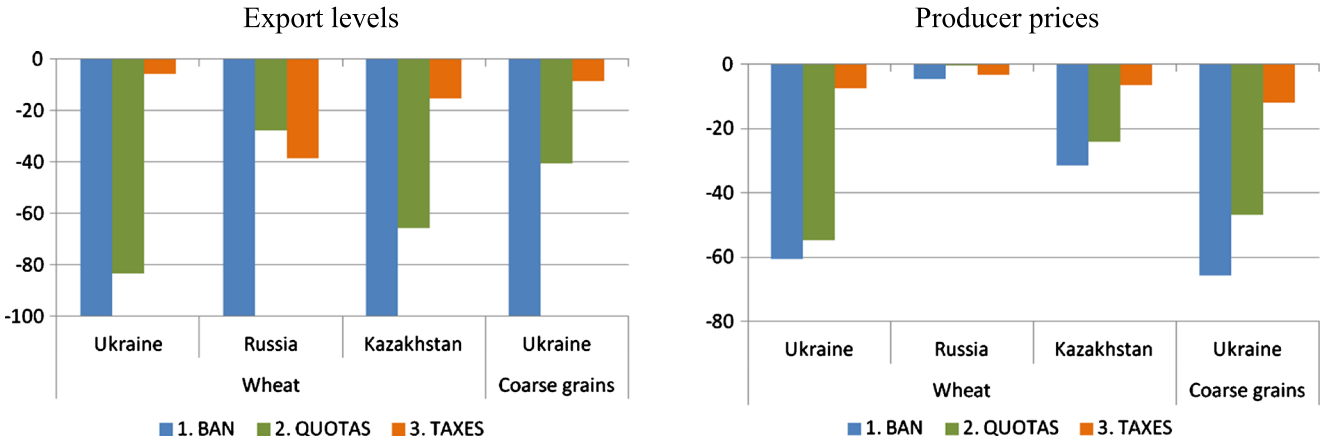

Fig. 3 Changes in RUK export levels and producer prices due to the export restrictions (%-change compared to the benchmark scenario in 2015)

put downward pressure on domestic prices. Consequently, Ukrainian producer prices are projected to be 61 % (Scenario 1) and 55 % (Scenarios 2) below the prices in the benchmark scenario. This implies that in Ukraine the producer prices could be even below the baseline level, which would be remarkable because production declines due to drought would usually imply an increase in prices rather than a decrease. Introducing an export ban or a restrictive export quota would therefore also potentially result in lower consumer prices than in the situation without a drought, leading to consumption increases of 19 % and 17 %, respectively. By contrast, the introduction of a 9 % export tax on Ukrainian wheat in Scenario 3 is much less market disruptive. Compared to the benchmark, Ukrainian exports decrease by only 6 % and producer prices by 7 %, whereas domestic consumption remains stable. Nonetheless, Ukrainian wheat producers still loose 12 % of production value compared to the baseline, whereas without any export restrictions the loss would be 7 % due to the drought (Fig. 4).

In Kazakhstan the impact of the export restriction measures is similar to the impacts in Ukraine, but the magnitude is different because in Kazakhstan the level of quantity exported in the baseline is closer to the simulated production loss due to the drought. Consequently, when exports are banned, the additional quantity released on the domestic market put slightly less pressure on domestic market prices. Nevertheless, in Scenario 1, producer prices in Kazakhstan decrease by 32 % and consumer prices by 10 %, whereas consumption increases by 11 % compared to the benchmark scenario. With an export quota set at 0.9 Mt in Scenario 2, exports decrease by 66 %, producer and consumer prices decrease by 24 % and 7 % respectively, and consumption increases by 8 %. By contrast, the introduction of a 9 % export tax on wheat in Scenario 3 is not very restrictive, with exports decreasing by 10 %, producer prices by 6 %, consumer prices by 2 % and domestic consumption increasing by 2 %. Thus, the simulated policy objective of maintaining stability of domestic consumer prices in Kazakhstan is reached with both the export ban and the export quota. However, with the modelled export quota, Kazakh producers are better off than with the export ban, as it allows for a small price increase (+3 %) in comparison to the baseline, whereas with an export ban, producer prices are below the baseline level (−7 %). The tax level of 9 % used in Scenario 3 are not enough to keep consumer prices at the same level as in the baseline, as they increase by 7 %, which is 2 percentage points less than in the benchmark scenario.

Coarse grains

The OECD-FAO (2012) agricultural outlook projects an increase in livestock production in Russia over the coming years and therefore the domestic consumption of coarse grains is expected to increase in order to feed the livestock. This development implies reduced levels of exports of Russian coarse grains in the simulated year 2015. In this context, the introduction of export restrictions on Russian coarse grains is less relevant because the quantitative restrictions are not binding and therefore do not further affect producer prices. Moreover, as a reaction to the drought and in order to be able to feed its livestock, Russian coarse grain imports in all policy scenarios are five times greater than in the baseline. Kazakhstan is not a major producer or consumer of coarse grains and therefore coarse grains scenario results are not further commented for this country. By contrast, Ukraine is a major player on the world market for coarse grains. As a consequence of the drought, a drop in coarse grains production of 4 Mt is simulated. Simulation results of Scenario 1 show that, with an export ban, almost 9 Mt of coarse grains are additionally kept on the domestic market. As a consequence, and despite the increase in world prices, Ukrainian producer prices would be 66 % and consumer prices 26 % below the prices in the benchmark scenario. With the implementation of a 5.2 Mt export quota in Scenario 2, the producer price decrease in Ukraine is less than with an export ban, but is still very significant (−47 %) as this export quota implies a reduction of 40 % of the exports in comparison to the benchmark scenario. Accordingly, Ukrainian consumer prices

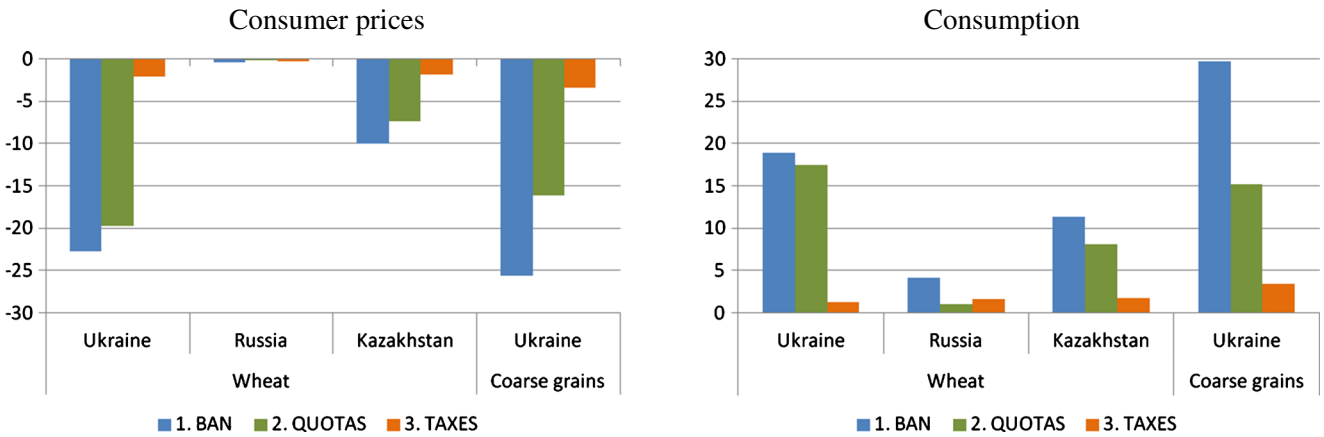

Fig. 4 Changes in RUK consumer prices and consumption due to the export restrictions (%-change compared to the benchmark scenario in 2015)

are 16 % lower than in the benchmark scenario and domestic consumption increases by 15 %. In Scenario 3 the export tax of 13 % implies a limited reduction of exports (−9 %) compared to the benchmark scenario and a slight increase (+3 %) in domestic consumption. Consumer price levels are maintained, i.e. they are lower than in the benchmark scenario and actually equal to the baseline level. Ukrainian coarse grain producers still benefit from a small price increase (+5 %), but with regard to farm income this price increase would not be enough to compensate for the production loss caused by the drought.

Impacts on a major grain exporting consortium: the EU

The EU is a major exporter of grains on the world market. Between 2008 and 2011 the EU exported a yearly average of 21 Mt of wheat and more than 8 Mt of coarse grains (two-thirds of it being barley and one-third maize). At the same time the EU also imported 6 Mt of wheat and 5.5 Mt of coarse grains (mainly maize) per year.

Benchmark scenario: impact of the RUK drought

The increase of the world price due to the lower grain harvest in RUK is partially transmitted to the EU market where producer prices increase by 21 % for wheat and 7 % for coarse grains. As in RUK, European farmers are not able to adapt their production in the short-term and supply remains stable. However, the significant increase in world wheat prices (+23 %) triggers more EU exports (+8 %) and causes a decrease in EU stocks (−5 %). At the same time imports are reduced by 7 % as they become too costly. The lower availability on the domestic market translates into a reduction of the use of wheat by 1 %, in particular for ethanol production (−5 %) and for food (−1 %), while EU consumer prices potentially increase by 8 %.[13] For coarse grains,[14] the picture is more complex as both exports and imports increase considerably by 22 % and 28 %, respectively, while total use only slightly increased (+0.4 %). The EU producer price of coarse grains increases less than the world market price, implying a gain in relative competition of the EU, which boosts EU exports. On the domestic market the price increase of barley (+8 %) is higher than for maize (+6 %). Therefore the domestic use of barley (mainly for feed) decreases and barley is substituted in animal diets by maize. This demand for feed drives the significant increase of maize imports (+30 %).

Export restriction scenarios

The introduction of export restriction measures in RUK amplifies the drought effects (Fig. 5). In the scenario with a full ban on RUK exports (Scenario 1) EU wheat producer prices increase by 10 % (reaching 307 USD/t) compared to the benchmark. In Scenario 2 the price increase is slightly lower at 7 %. The modelled export taxes (Scenario 3) have a minor impact and EU producer prices increase by only 1 %. Further effects in the policy scenarios are that EU exports of wheat are higher, domestic consumer prices increase more and the total consumption decrease further compared to the benchmark scenario. The effects for EU coarse grains are quite similar but at a lower magnitude, with the EU producer price increase varying between +5 % in the case of a full ban on RUK exports and 0 % with export taxes. In the case of an export ban, the high world price causes EU maize imports to diminish by 6 % compared to the benchmark, whereas the import decrease is less in the other

[13] In the EU the transmission of the producer price increase to the consumer price may seem rather high in comparison to the other countries presented in this article. However, this is because the food product used as reference in the model for the EU (wheat flour) is not as processed as the respective reference (bread) in other countries.

[14] In the European module of the AGLINK-COSIMO model detailed information on barley and maize is available.

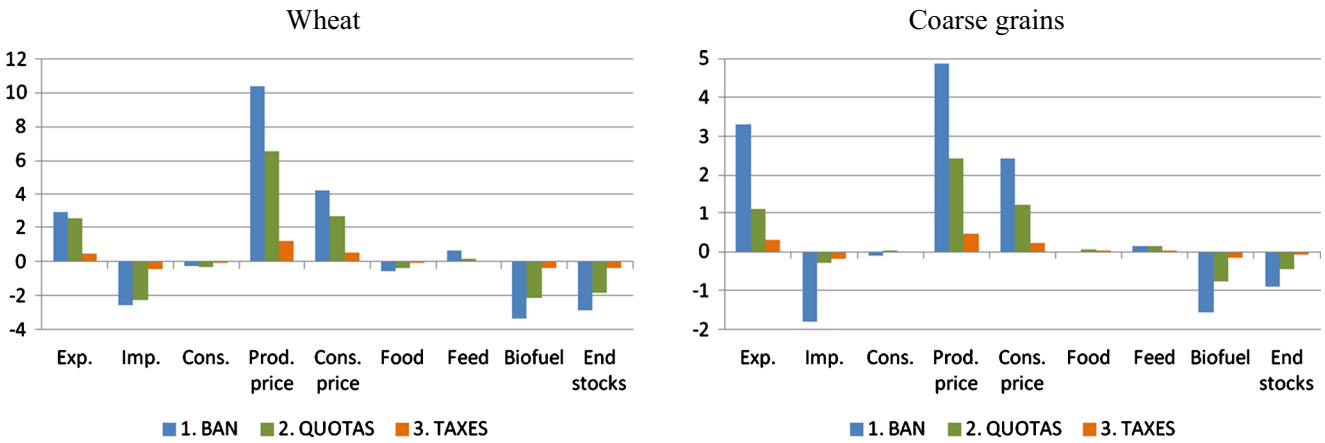

Fig. 5 Changes in EU wheat and coarse grains markets due to RUK export restrictions (%-change compared to the benchmark scenario in 2015)

scenarios. In general, results indicate that for a net exporting region such as the EU, except for producer prices, the effects of the simulated bans and/or export quotas in RUK are rather small and equivalent between the different policy measures. Moreover, the simulated temporary export taxes in RUK have almost no effect on EU markets.

Impacts on a major grain importing country: Egypt

Egypt is the largest wheat importer in the world, with yearly imports of around 10 Mt. This implies that Egypt is importing about half of its domestic wheat requirement, almost 90 % of which is used for human consumption. In addition, Egypt imports between 5 and 6 Mt of coarse grains per year (almost all maize, mostly used for animal feed). Given the dependency of the country on imports, the government aims to keep strategic wheat stocks of about five months of the countries' consumption level. Wheat is considered as a major component in the Egyptian diet, with Egypt having one of the highest wheat per capita consumption levels in the world. For food security reasons, Egypt operates a food subsidy system, which comprises a specific bread subsidy programme available to every citizen (about 85 % of the bread produced in Egypt is either fully or semi-subsidized). To keep the price for the typical Egyptian 'baladi' bread at a low level, wheat is given to mills at a low price, with Egypt's General Authority for Supply Commodities (GASC) covering the difference from the purchased wheat price. This policy of food subsidy has considerable impact on the public budget and becomes even more burdensome for the Egyptian government the higher the wheat prices are (World Bank 2010; Trego 2011; Abis 2012; USDA FAS 2012).

Benchmark scenario: impact of the RUK drought

The world wheat price increase of 23 %, due to the RUK drought, is almost entirely transmitted to the producer price in Egypt, which increases by 21 %. Imports become very expensive and decrease by 16 % (−1.8 Mt). As a consequence, huge quantities of stocks are released (1.3 Mt). The consumer price is projected to increase by 5 %. This increase may seem rather small, but this is because, for Egypt, the reference for wheat consumer prices in the model is bread, i.e. a product with a high degree of processing compared to the raw product. Moreover, it has to be kept in mind that the price increase is measured as a yearly average and hence does not reflect the intra-year price changes, which can be very important. For coarse grains, the world price increase leads to a 14 % rise in Egyptian producer prices, imports decrease by 8 %, whereas stock releases increase by 14 %.

Export restriction scenarios

The simulated introduction of export restrictions in RUK has a major impact on the Egyptian market, considerably amplifying the effects of the drought (Fig. 6). In Scenarios 1 and 2, Egypt's wheat producer prices rise further compared to the benchmark scenario, by 10 % and 6 %, respectively. Due to the increased global prices, wheat imports further decrease by 9 % in Scenario 1 and 6 % in Scenario 2. In order to allow maintenance of the food use of wheat, additional stocks are released on the market (10 % in Scenario 1 and 7 % in Scenario 2). Nonetheless consumer prices for wheat (bread) rise further compared to the benchmark scenario (3 % in Scenario 1 and 2 % in Scenario 2). By contrast, the modelled level of export taxes in Scenario 3 has only marginal effects on the Egyptian wheat market. For coarse grains, scenario results indicate similar effects to those for wheat, however, at a lower magnitude. It has to be kept in mind that in Egypt most of the coarse grains are used to feed animals, therefore consumers may not be immediately affected by the price increases. However, livestock producers are badly hit by increased

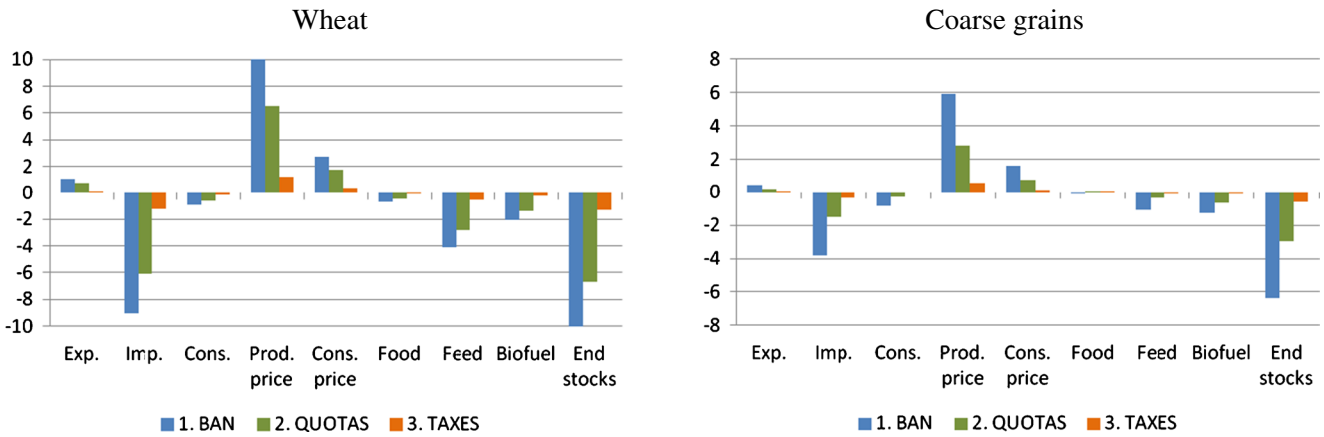

Fig. 6 Changes in Egyptian wheat and coarse grains markets due to RUK export restrictions (%-change compared to the benchmark scenario in 2015)

feed cost and thus consumers might be affected with a few months delay by a rise in meat prices.

Discussion of results

The scenario results underline the importance of RUK's grain production for world grain markets and international food security, indicating substantial price increases for wheat and coarse grains due to both the simulated drought and subsequent temporary RUK export restrictions. Related to the modelled prices, several issues have to be highlighted. The AGLINK-COSIMO model uses yearly price averages and monthly fluctuations are not reflected. This can have significant implications on food security as monthly price spikes may be much higher than those measured in our analysis, concentrating on average yearly effects. In this context it also has to be noted that, during a period of low grain availability, private stock agents may be tempted to keep the grain in stocks and wait for even higher prices before selling, thus putting additional pressure on the market and causing further price increases. Such strategic behaviour of stock agents is not taken into account in the model, but may very well take place also in RUK, decreasing the dampening effect of the export restrictions on domestic prices and consequently leading to higher domestic price increases in RUK during some months than those projected in our scenarios. Thus, in the presence of strategic behaviour of stock agents or intermediaries such as millers and bakeries, our scenario results might rather overestimate the indicated domestic price decreases in RUK. Nonetheless, the results clearly show the decrease in price transmission between world and domestic grain prices due to the RUK trade restrictions. In this respect our results support findings of other studies on price-insulating trade policies (e.g. Myers and Jayne 2011; Götz et al. 2013a and Götz et al. 2013b). Although an actual price decrease in domestic producer prices could not be observed by Götz et al. (2013b), their findings indicate that, due to export restrictions in 2008, domestic wheat prices in Ukraine were about 30 % below the world market price. The USDA (2011) also reported that the export restrictions in Ukraine resulted in a slower growth rate of domestic feed and milling wheat prices in the first half of the marketing year 2010/2011, with the difference between domestic and world market price of milling wheat reaching in some cases over 100 USD/t.

With regard to consumer prices, it has to be noted that the entire impact on food prices cannot be assessed as consumer prices in the model relate to specific commodities and do not cover the whole panel of commodities using wheat or coarse grains as feedstock. In addition, the product used as reference for consumer prices in the model is not the same in all countries and, in particular, the degree of processing can be unequal (for wheat e.g. it can be flour or bread). The more a product is processed the less the developments in producer prices are transmitted to consumer prices. Although AGLINK-COSIMO has its limitations with respect to the representation of consumer prices and their direct comparability among different countries, consumer prices as provided by the model give a good indication of the *potential* magnitude of consumer price changes. Empirical findings of Welton (2011) for example also showed that the export ban in Russia in 2010–2011 did not help much in reducing domestic food prices. On the other hand, studies on Ukraine's wheat export restrictions in 2007–2008 and 2010–2011 indicate that Ukrainian intermediaries along the wheat-to-bread supply chain exhibited market power and did not really pass on the price decrease to the Ukrainian end consumers (Grueninger and von Cramon-Taubadel 2008; FAPRI 2013; Götz et al. 2013a).

In the analysis we only focus on the short-run effects (one year), during which supply is inelastic as farmers cannot alter their production decisions. At the global level, farmers will respond to increased prices by increasing production of the relevant crops in the following season. However, in export restricting countries, the domestic market interventions can have adverse effects on the production portfolio and incentives in the following years. In Russia and Ukraine, a growing switch from wheat and barley to maize and oilseeds production can be observed, which is assumed to be partially attributable to the circumstance that the latter crops experienced none or, at least, less government intervention during the previous few years (Kobuta et al. 2012; van Leeuwen et al. 2012; Salputra et al. 2013). Furthermore, export restrictions impede the development of RUK future markets with forward contracts (as their fulfilment cannot be guaranteed), which has adverse effects on financing possibilities in the agricultural sector (see e.g. Zorya 2006; World Bank 2008; OECD 2012). Moreover, temporary export restrictions act as a disincentive for domestic producers with regard to input use (fertilizer and plant protection) and investments. This observation is, for example, supported by the analysis of Götz et al. (2013a), who found empirical evidence indicating negative long-run domestic market effects in the case of Ukraine's export restrictions in 2007–2008, especially by reducing incentives for farmers and traders to invest. When producers hold back necessary investments and also use less fertilizers and plant protection because they are uncertain if they will be able to benefit from higher world prices, the implications are at least twofold. First, it implies that, without the fear of temporary export restrictions, RUK producers might increase production, which would have positive effects on global grain availability. Second, it makes grain production in RUK more vulnerable to weather conditions, which partially explains the high volatility in RUK's grain production over the last few years and, as demonstrated in our paper, has adverse effects on both domestic and global grain markets. Thus, apart from negative effects for global grain markets, temporary export restrictions in RUK bear also various negative domestic effects and it can be expected that the countries could benefit in the mid- and long-term from renouncing the use of temporary export restrictions and creating a more reliable policy environment for domestic producers and private investors.

Regarding the impact on net importing countries, the example of Egypt shows that limited RUK grain exports may have major impacts on the countries' food security. Moreover, the increased consumer prices for bread due to RUK harvest failures and even more so due to wheat export bans or restrictive quotas imply that the cost for the Egyptian government of subsidizing bread would increase remarkably. In this context it should be mentioned that in the specific case of Egypt, several authors highlight flaws of the Egyptian bread subsidy programme, which become particularly obvious in times of high wheat prices. Egypt's food subsidy system is widely considered as costly, inefficient and not well targeted (World Bank 2010; Trego 2011; Abis 2012; USDA FAS 2012; Breisinger et al. 2013). Interruptions on the world grain markets are likely to occur again and the scenario results on the effects of RUK droughts and export restrictions indicate that this can become quite burdensome for Egypt. Hence our simulation results support findings of the World Bank (2010), which highlight the need to reform Egypt's food subsidy system, especially reducing costs by better targeting towards the poor population.

It has to be kept in mind that drought and import restrictions in RUK may only be one source affecting world grain markets. There might be other events, for example droughts or exceptionally good harvests in other countries that may worsen or compensate for the situation in RUK. Furthermore, causalities can become quite complex, as price increases due to negative supply shocks and subsequent export restrictions can cause importing countries to lower import tariffs (Headey 2011; Yu et al. 2011; Bouët and Laborde Debucquet 2012; Martin and Anderson 2012; Rutten et al. 2013). For example, of 81 countries surveyed during the food price crises in 2007–2008, 25 economies increased export restrictions while 43 economies reduced import tariffs (Demeke et al. 2009). This demonstrates that there are usually several events that influence world market prices and it can become rather difficult to separate the various effects. By separating the effects of RUK harvest failures and temporary export restrictions our analysis helps to improve the understanding on how quantitatively important supply shocks in major exporting countries are reflected in global grain availability and food security.

Regarding the impact of the different export restriction levels modelled, our scenario results indicate that, compared to the export bans and restrictive export quotas analysed, the modelled export taxes in RUK would be preferable from an international perspective. Moreover, and even though this issue is not covered within the AGLINK-COSIMO model, major exporting countries are considered to be generally better off by implementing export taxes because such taxes raise government revenues (Mitra and Josling 2009; Rutten et al. 2013). In the context of food security the revenue raised by the export tax could, for example, be redistributed to poorer households in order to mitigate more directly the slightly higher increases in domestic RUK consumer prices indicated in the results of the export tax scenario. However, this does not mean that the scenario results should be used generally to advocate the implementation of export taxes; it just implies that, in the modelled situation, the level of restriction imposed in the export tax scenario would have less distorting effects on the world markets than export bans or tight quotas, as they would still allow RUK to export considerable amounts of grain. Some interesting alternative, less market-distorting policies to export bans were analysed by Liefert et al. (2012). Their analysis shows that a specific export licensing scheme

could provide an incentive for producers to first sell at an autarky level domestically (which would allow domestic consumers to face lower prices) before realizing more profitable exports (Liefert et al. 2012).

The issue of temporary export restrictions certainly puts international trade policy into focus, especially regarding existing WTO rules and the ongoing WTO negotiations within the Doha Development Agenda. WTO disciplines comprise a rather large grey area that can lead to differing interpretations of the rules and obligations on export restrictions in the multilateral context (Howse and Josling 2012; Korinek and Bartos 2012). In the light of the analysed effects of RUK export restrictions on world grain markets it seems necessary to reconsider or, at least, strengthen existing WTO rules regarding temporary export measures. Exporting countries certainly have a responsibility to provide food security to their own population. However, multilateral trade is crucial for many food insecure countries and therefore some level of cooperation on the part of exporting countries is needed to avoid importing countries being denied necessary supplies. Howse and Josling (2012) and Smith (2012) indicate that the implementation of new WTO rules might actually not be necessary, but rather a stricter interpretation of existing WTO disciplines should be applied. Therefore it might, for example, need multilateral recognition as to whether a country is indeed facing a food security crisis that justifies the implementation of temporary export restrictions (FAO and OECD 2011).

Concluding remarks

This paper assesses the effects of harvest failures and subsequent temporary grain export restrictions in RUK on national and international food security by quantifying their impact on agricultural market quantities and prices. For the analysis, AGLINK-COSIMO, a recursive-dynamic, partial equilibrium, supply–demand model, has been employed. Simulation results highlighted the importance of RUK's grain production for world markets and global food security. A reoccurrence of the 2010 RUK harvest situation in 2015 is projected to cause increases in world market prices of 23 % for wheat and 15 % for coarse grains. In the three policy scenarios, the modelled RUK export restriction measures further aggravate the situation on world grain markets. However, the impact on the world market varies significantly, depending on the policy measure chosen and the level of restriction adopted. The export bans reflect the most extreme reaction by RUK to harvest failures and therefore give a good indication on the maximum impacts on the world market that would occur if there were no grain exports at all from RUK during one year. Accordingly, export bans result in the highest increase in world producer prices (+11 % compared to the benchmark), whereas the modelled ad valorem export taxes would result in the least effects on the world cereal markets (+1 % price increase) as they would allow RUK to continue exporting significant amounts.

Regarding the effect of the export restrictions on domestic grain prices in RUK, scenario results vary not only with respect to the policy measure implemented, but also with respect to the country profile. For Russia, a country playing a major role on the international grains market but where the share of exports in the national production is projected to be rather low in the future, strong export restrictions do not prevent sharp price increases of domestic producers in the scenarios, while effects on domestic consumer prices are rather limited. In Ukraine and Kazakhstan, the situation is quite different because both countries usually export large shares of their overall wheat production. While wheat output decreased considerably in Ukraine and Kazakhstan with the simulated drought, the decreases were lower than the export levels in the baseline scenario and hence the two countries continued to export large quantities of wheat as in the benchmark scenario. Therefore the introduction of an export ban or a very restrictive export quota in Ukraine (and to a lesser extend in Kazakhstan) implies that huge additional quantities are kept on the domestic markets. This puts not only considerable downward pressure on domestic producer prices, but could (depending on domestic price transmission) potentially result in consumer prices at a level even below a situation with normal weather conditions and without export restrictions. By contrast, the simulated level of export tax is much less disruptive for domestic producer prices, and consumer prices would be only slightly higher than in the baseline situation. For coarse grains, simulation results show similar patterns to those for wheat, but at a generally lower level. The simulation results also underline the key asymmetry of the impact of limited RUK grain exports on grain net exporting and net importing countries. In the example of the EU, we analysed the effects of the simulated RUK harvest failures and export restrictions on food security in a major net grain exporting country. Scenario results showed that although consumers may face somewhat higher prices, food security in the EU was not generally affected. EU producers would benefit from increased world prices and the augmentation of EU wheat exports contributes to a partial compensation for the lower grain availability on the world market. However, for coarse grains, EU imports increased more than exports, indicating that the EU is actually adding to the pressure on the world market.

Our analysis of the effects in Egypt, the major wheat importing country in the world, indicated that net grain importing countries were hit most by RUK export restrictions as the increased prices put considerable pressure on their food security (although their farmers also benefitted from increased producer prices). This can be especially problematic for poor net importing countries as they might not be able to bear the budget burden of subsidising the basic needs of their populations. Thus, our scenario results highlight that food security needs of third countries, especially those of net food importing developing countries,

should to be taken into account more seriously before temporary export restrictions are implemented. In this respect, a stricter interpretation of WTO rules and obligations seems to be necessary. In any case, as pointed out by FAO and OECD (2011), temporary export bans or very restrictive export measures should only be implemented as a last resort, if other measures (such as domestic safety net measures for the poorest) have been exhausted.

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