UNISECO Deliverable 4.2

Economic Analysis

DRAFT – PRELIMINARY AND INCOMPLETE

Overview

The main purpose of the economic modelling in Work Package 4 is to investigate the economic impact of future storylines/scenarios and innovations studied in the biophysical models vis a vis the 2050 Business as Usual (BAU) baseline. This economic modelling analysis allows us to infer how changes in quantities of agricultural products produced, consumed and traded leads to changes in prices of those commodities. The economic model also allows us to study which economic policies or combinations of policies can be used to obtain the outcomes of the biophysical models for each storyline/scenario. The combination of prices and quantities also allow us to measure the economic impacts in terms of economic well-being and employment.

Data

The economic analysis is restricted to tradable agricultural commodities, using the same classification of commodities as the biophysical models. The economic analysis is carried out separately for 12 commodity groups used in BioBaM and SOLm.

The analysis focuses on two aggregated regions: the European Union and the "Rest of the World". The EU can be treated as a single region because it is a customs union and has harmonized its economic and trade policies in the agricultural sector via the Common Agricultural Policy (CAP).

The economic model requires input data on quantities produced, consumed, and exported in each of the two regions, which we take from the biophysical models. BioBaM provides the production/consumption data, and SOLm provides the detailed trade flow data. We require this quantity data for the baseline (2050 BAU), as well as for each scenario in 2050. The list of commodities included in the analysis as well as the quantities of production, consumption and trade for the EU and the Rest of the World are provided in Table 1. EU Production greatly exceeds imports for most commodities, with the exception of "other crops", which is driven by the import and export of coffee.

The economic model requires data on prices of the commodities, which we take from the most recent year of FAOstat. The commodities in the biophysical models are grouped into major food categories, so we must choose a price for a particular good and country. The choice of price statistics affects the magnitude of the economic welfare and employment results, but not the results for the policies required or the predicted percent change in prices. The economic model

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also requires data on the elasticity of supply and demand for each commodity. These elasticities determine how prices respond to changes in quantities produced and consumed in the model, and the value of these parameters is crucial for the results.

In part of the analysis we use the own-price demand elasticities estimated by Seale et al. (2003) for high-income countries. Supply elasticities are less well researched in the literature and we use the upper and lower bounds of the supply elasticities used in the Global Trade Analysis Project (GTAP) model (McDougall, 2016; Hertel et al., 2016). The assumed prices, supply elasticities and demand elasticities from the literature are provided in Table 2. The 2012 price in Germany is used for all commodities except coffee, which uses the 2012 Brazilian price instead.

The larger the demand or supply elasticities are, the more sensitive are the quantities consumed or produced respectively to price changes. Over the very short-term, food consumption and production tends to be relatively insensitive ("inelastic", in the jargon) to changes in price, with elasticities close to zero. However, production and consumption are more responsive to prices in the longer term as consumer preferences or production technologies adapt, implying that "long-run" elasticities are larger than "short-run" elasticities.

As we are studying the impacts of different scenarios 30 years from now, one could argue that demand and supply may be less sensitive to price in such a long-run scenario as tastes and technology adapt to changing market conditions. Therefore, as a robustness check, we provide the results when we assume more elastic supply and demand elasticities. We analyze two different sets of elasticities, first assuming a supply elasticity equal to 5 for all goods, then assuming a demand elasticity equal to -1.

Another important point about elasticities is that small elasticities typically seen for agricultural commodities imply that a relatively large change in price-influencing policies is required in order to bring about a small change in the quantity demanded or supplied. For example, if the demand elasticity is -0.1, this would imply that a tax must increase the price by 100 percent in order to bring about a 10 percent decrease in the quantity demanded. In contrast, prices would only increase by 10 percent if the demand elasticity equals -1. This implies that even modest changes in quantities predicted by the biophysical models would require relatively large policy changes in order to square with the economic model if the elasticities are highly inelastic.

Modelling Approach

The analysis uses a partial equilibrium model of trade called an "equilibrium displacement model". This model was first developed by Muth (1964) and has been used in many studies of international trade, with prominent studies by Sumner and Wohlgenant (1985), Gardner (1987), and Alston et al. (1995).

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As with any model, the equilibrium displacement model has several advantages and limitations. The attractive properties of equilibrium displacement models are that they need very few inputs, they are flexible, and they are also tractable enough to allow for finding analytical solutions. Their drawbacks include that they only model a single market ("partial equilibrium" in the jargon) and do not model the whole economy or complex interactions between markets. As with most models, they are not as trustworthy when studying large deviations from the baseline.

The economic model is a set of equations that defines the interaction between changes in prices, quantities and policy variables in a market. In our case, there is a separate market for each particular BioBaM/SOLm food commodity group produced, consumed, and traded between the EU and the Rest of the World. We assume that both regions produce and consume the good, and they each produce their own specific variety of the good. The model allows for changes in three policy variables: an EU import tariff, a production subsidy or tax for EU farmers, and a consumption subsidy or tax on EU consumers, which are always expressed as a percentage of the price. The policy variables in the economic model are additional to the existing policy instruments already in place under the EU Common Agriculture Policy (CAP). We do not include policy changes by the RoW.

The model consists of five equations: two equations defining EU and RoW import demand, two equations defining EU and RoW export supply, and an equation specifying that difference in the price between the regions for the good produce in RoW equals the size of the EU import tariff. For example, if the EU applies a tariff on imports from the Rest of the World of *t* percent, this implies that the price paid by EU consumers will be *t* percent higher for the good compared to the price paid by consumers in the Rest of the World. Tariffs thus drive a "wedge" between the price in the RoW and the price in the EU. The derivations of the economic model are provided in Appendix A.

The economic model invokes the so-called Armington assumption, whereby domestically produced food and imported food are assumed to be imperfect substitutes. The elasticity of substitution captures how the relative demand for imports versus domestically-produced goods responds when their relative prices change. A low elasticity of substitution would imply that a large change in relative prices would not affect relative demand very much. We assume an Armington elasticity equal to 5, following Costinot et al. (2016). Interactions between the broad categories are not modelled, as these cross-category effects are likely small since cross price demand elasticities are usually a small fraction of the magnitude of own-price demand elasticities.

Solution Procedure and Outputs

We solve the model analytically to find unique solutions for the quantities exported from each region and the prices in each region for its domestically-produced and imported products. The model's solution for prices and quantities depends on the three policy variables and also on

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additional parameters such as the elasticities of supply and demand. In a standard economic analysis, one would usually be interested in the impact of a policy change on market quantities and prices. However, in this case the quantities are provided by the biophysical model, and we would like to know which policies and prices are congruent with the biophysical results with respect to quantities produced, consumed and exported from each region.

It is important that the economic model matches not only the export quantities given by the biophysical model, but also matches the quantities produced and consumed in each region. We must thus "constrain" the economic model's solution for each scenario in order to match not only the traded quantities, but also the production and consumption outcomes.

The model allows us to calculate the change in each economic policy that would be required to match the change in quantity outcome for each scenario compared to 2050 BAU. Once we have the policies needed to match the biophysical quantities, we can then use the economic model to calculate the resulting change in commodity prices in each region for each scenario compared to BAU. Once we have determined the traded quantity and the prices in each region, we can calculate the economic well-being in each region for producers and consumers of each commodity, using what is called "producer surplus" and "consumer surplus" respectively. Consumer surplus is defined as the difference between what a consumer was willing to pay for a good and the actual market price. Producer surplus is defined as the difference between what they are willing to accept and the actual market price. In a supply and demand graph, consumer surplus is the area between the demand curve and the price level, while producer surplus is the area between the supply curve and the price level. Given the change in revenues from the production of each commodity and assuming a multiplier effect from the JRC jobs calculator[1], we can also determine the impact on employment in the EU.

Main Results

We now present the results of the economic analysis. We analyze each 2050 alternative scenario (Agroecology for exports, (AEexport), Local for protection (LfP), Local for sustainability (LfS), Local agroecological food systems (AEfood)) compared to the 2050 BAU.

Changes in Production, Consumption, Imports and Exports

The percentage changes in EU production, consumption, import and export quantities predicted by BioBaM and SOLm when moving from the 2050 BAU scenario to the Local for each scenario are summarized in Table 3. Production, consumption and trade patterns change only slightly for most commodities in the AEexport scenario, with the exception of nuts, where production and exports are predicted to increase dramatically. In contrast, EU production and consumption decreases for most commodities and traded quantities decrease for all commodities in the LfP,

[1] https://datam.jrc.ec.europa.eu/datam/mashup/JOBS_CALCULATOR/index.html

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LfS and AEfood scenarios. Trade tends to decrease more than production and consumption in percentage terms. The biophysical models predict, for example, that cereals production and consumption decreases by 39 percent and 36 percent respectively in the LfP scenario, but imports and exports of cereals decreases by 74 percent and 83 percent respectively.

Required policy changes: 2050 BAU versus AEexport scenario

We enter the biophysical model's output regarding the predicted changes in production, consumption and traded quantities into the economic model in order to calculate the required change in EU policies and the resulting prices moving from the 2050 BAU to each selected scenario. The results for the AEexport scenario are summarized in Table 4. The results using inelastic supply and demand based on the literature are presented in Panel A. The results assuming a more elastic supply elasticity are presented in Panel B. Finally, the results assuming a more elastic demand elasticity are given in Panel C.

The results in Panel A of Table 4 illustrate that taxes on EU production and consumption are required for most products in order to fit the production, consumption and trade quantity data using the base case supply and demand elasticities, but import tariffs are relatively unimportant (except for nuts). Relatively modest import tariffs are required, with a mean of 46 percent and a median of 39 percent. The production taxes required to change production levels have a mean of 114 percent and a median of 0 percent, but there is a lot of heterogeneity based on the commodity. Relatively modest consumption taxes or subsidies would be required to reach the LfP scenario, with a mean of 47 percent and a median of 1 percent.

Given the policies required to reach the LfP scenario, we can also calculate the resulting change in prices due to these policies, which are given in the last columns of Table 4, Panel A. The results suggest that prices for most domestically produced and imported food products would rise for fall only slightly in the EU, although the price of nuts would fall more sharply.

The results in Panel B of Table 4 use baseline demand elasticities, but assume a supply elasticity equal to 5, which presumes that technology will be able to adapt to the new production and consumption regime. The main impact of this assumption is that production taxes need not be as high. Import tariffs change slightly and are small for all commodities except nuts, while consumption taxes are unchanged compared to the base case. The results in Panel C of Table 4 also assume an elastic supply elasticity equal to 5, and also assumes a higher demand elasticity equal to -1, which presumes that tastes will adapt to the new scenario. The main impact of this assumption is that consumption taxes need not be as high.

Required policy changes: 2050 BAU versus LfP scenario

The results for the LfP scenario are summarized in Table 5. The results in Panel A of Table 5 illustrate that taxes on EU production, consumption and imports are required for most products in order to fit the production, consumption and trade quantity data using the base case supply and demand elasticities. Relatively modest import tariffs are required, with a mean of 46 percent and

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a median of 39 percent. Reaching the LfP scenario would require very large decreases in production for most goods. The production taxes required to achieve lower production have a mean of 1544 percent and a median of 107 percent. Using the base case elasticities, the production taxes for some goods would not be reasonable to implement in the real world. Relatively modest consumption taxes or subsidies would be required to reach the LfP scenario, with a mean of 56 percent and a median of -25 percent (a consumption subsidy).

Given the policies required to reach the LfP scenario, we can again calculate the resulting change in prices due to these policies, which are given in the last columns of Table 5, Panel A. The results suggest that prices for most domestically produced and imported food products would rise in the EU. The mean increase in the price of EU-produced goods is 80 percent, with a 59 percent increase in price for the median good. The mean and median price increase for imports are 50 percent and 39 percent respectively.

The results in Panel B of Table 5 using a more elastic supply elasticity suggest that import tariffs change slightly and are positive for all products, while consumption taxes are unchanged compared to the base case. The results in Panel C of Table 5 also assume an elastic supply elasticity equal to 5, and also assumes a demand elasticity equal to -1. The main impact of this assumption is that consumption taxes need not be as high.

<u>Required policy changes: 2050 BAU versus LfS scenario</u>

The results for the LfS scenario are summarized in Table 6. The results in Panel A of Table 6 illustrate that relatively modest import tariffs are required, with a mean and median of 24 percent. Reaching the LfS scenario would require very large decreases in production for most goods, even larger than the LfP scenario. The production taxes required to achieve lower production have a mean of 2301 percent and a median of 77 percent. Again, the production taxes for some goods would not be reasonable to implement in the real world using the base case elasticities. Relatively modest consumption taxes or subsidies would be required to reach the LfS scenario (except for Roots and Tubers and Milk), with a mean of 630 percent and a median of 1 percent.

The impacts on price reported in the last columns of Table 6, Panel A, suggest that prices for nearly all domestically produced and imported food products would rise in the EU, although the increase is not as high compared to the LfP scenario. The mean increase in the price of EU-produced goods is 39 percent, with a 40 percent increase in price for the median good. The mean and median price increase for imports are 27 percent and 23 percent respectively.

The results in Panel B of Table 6 using a more elastic supply elasticity suggest that import tariffs change slightly and are positive for all products, while consumption taxes are unchanged compared to the base case. The results in Panel C of Table 6 assuming elastic supply and demand do not change the results much compared to Panel B.

<u>Required policy changes: 2050 BAU versus AEfood scenario</u>

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The results for the AEfood scenario are summarized in Table 7. The results in all panels of Table 7 illustrate that relatively modest import tariffs are required, with a mean and median around 40 percent. Reaching the AEfood scenario would require the largest production taxes of any scenario in the analysis, with an implausible high mean of 3022 percent and a median of 145 percent. Similar to LfP and LfS, relatively modest consumption taxes or subsidies would be required to reach the AEfood scenario.

The impacts on price reported in the last columns of Table 7, Panel A, suggest that prices for domestically produced and imported food products would rise in the EU, with a mean increase in the price of EU-produced good equal to 65 percent and a 58 percent increase in price for the median good. The mean and median price increase for imports are 44 percent and 39 percent respectively.

The results in Panels B and C of Table 7 using a more elastic supply elasticity suggest that import tariffs change slightly and are positive for all products, while a higher supply and demand elasticities reduce the need for high production and consumption taxes respectively.

Comparing the results in Tables 4–7, it is apparent that different elasticity assumptions have a very large impact on the required policy instruments.

Economic welfare, producer revenue and employment effects

The last step of the analysis is to calculate the resulting impact of the price and quantity changes on economic welfare, producer revenue and employment when moving from BAU to alternative scenarios. The results of this exercise when moving from BAU to the four selected scenarios are provided in Tables 8 and 9 assuming that the elasticity of demand equals -1 and the elasticity of supply equals 5.

The results with respect to economic welfare are described in Table 8. In the AEexport scenario the quantity and price effects are generally small, which results in relatively small welfare effects that are positive or negative, depending on the commodity. In the other three scenarios, generally higher prices for the EU good and for imports, combined with lower consumption quantities, lead to lower EU consumer surplus for most crops on both domestically produced and imported commodities. EU producer surplus decreases for most commodities the three scenarios.

The impact of moving from BAU to each scenario on producer revenue and employment are summarized in Table 9. The pattern of producer revenue effects is similar in sign and magnitude to the producer surplus effects in Table 8. We calculate the employment effects based on producer revenue, and also based strictly on changes in production quantities. The revenue-based approach to calculating employment effects is relevant if price and quantity changes affect employment. However, if price changes do not affect employment then the quantity-based approach is more appropriate. Revenues and employment decline for all commodities except oilcrops and other crops. We generally find larger impacts on employment using the revenue-based approach compared to the quantity-based approach.

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Conclusions from the economic model

Overall, the biophysical model output suggests that moving from the 2050 BAU to the LfP, LfS and AEfood scenarios generally imply very large decreases in the production and consumption of most food commodities, and even larger decreases in trade. The economic model finds that a combination of EU production taxes, EU consumption taxes, and EU import tariffs are sufficient to generate the quantity outcomes from the biophysical model. In general, reaching these three scenarios requires relatively modest taxes on EU imports and EU consumption, and larger taxes on EU production. In contrast, the AEexport scenario requires less policy intervention due to its relatively small impacts on quantities produced, consumed, and traded.

The magnitude of the policies that would bring about these sweeping changes in production and consumption depends crucially on the elasticities of demand and supply, which are based on our best guess of the sensitivity of future food supply and demand to future price changes. If the supply of food is more sensitive to price changes, then the production taxes do not need to be so large in order to reach any scenario.

Most of the results of from the economic model seem reasonable in the sense that large changes in quantities will require large policy measures, which we see on the production taxes in particular. Since the model calculates everything in percentage terms, the percentage taxes become economically implausible for some products. As with many economic models, the results become less trustworthy the further one departs from the initial equilibrium.

A purely economic model may have come to different conclusions in some cases compared to applying an economic model to quantity output from a biophysical model. One example is the policy solution for cereals, which prescribes a large production tax to reach the LfP, LfS and AEfood scenarios. An economic model yielding a decrease in meat production would likely have allowed for more EU exports of cereals in response to a decrease in cereal demand, making such large production taxes unnecessary. However, the output from the biophysical model in these three scenarios predicts a decrease in EU cereal exports. This is one example of the possible limitations of not fully integrating biophysical and economic models. However, the results of the economic model are instructive in that they provide some insight on how the output from the biophysical models would affect prices and economic welfare.

Overall, the economic model thus provides indications of how strong interventions on prices may be needed to establish the envisaged scenario, or, as an alternative and less direct interpretation, how much consumer preferences would need to change for this. Thus, in the end, the model indicates whether a certain scenario will only be possible with large interventions or preference changes or whether already moderate interventions or changes may suffice. In this context, the scenarios with high demand elasticity (-1) can be seen as taking up large part of potential preference changes directly within the model, thus requiring lower taxes to realize the scenarios.

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Table 1: List of commodities and associated production, consumption and trade, EU and Rest of the World, 2050 Business as Usual, million tonnes

Commodity	EU Production	EU Consumption	EU Exports	RoW Production	RoW Consumption	RoW Exports
Cereals	442.0	438.8	56.9	3874.8	3840.6	35.9
Fruits	109.0	136.5	10.7	1073.0	1051.3	36.9
Nuts	1.0	2.9	0.2	17.2	15.1	1.9
Oilcrops	300.3	613.3	27.7	3299.3	2972.8	320.4
Other crops	3.0	11.9	13.5	282.7	275.7	27.4
Pulses	3.1	3.9	0.6	111.6	109.6	1.5
Roots and Tubers	103.9	97.2	6.5	1014.9	1028.9	1.2
Sugarcrops	522.5	583.4	1.8	6265.5	6135.2	124.6
Vegetables	118.8	117.0	5.8	1362.2	1355.1	5.4
Milk	365.7	342.7	27.4	1593.0	1605.2	2.5
Meat	63.2	56.8	6.2	432.0	430.9	1.2
Eggs	8.4	8.2	0.3	106.8	106.6	0.1

Source: BioBaM and SOLm.

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Table 2: List of commodities and associated prices and elasticities, 2012

Commodity	Product used for price data	Price per tonne, USD, 2012	Supply elasticity	Demand elasticity
Cereals	Wheat	319	0.24	-0.287
Fruits	Apples	558	0.24	-0.287
Nuts	Almonds, with shell	1153	0.24	-0.287
Oilcrops	Soybeans	567	0.24	-0.158
Other crops	coffee, green	3000	0.24	-0.287
Pulses	Beans, dry	2428	0.24	-0.287
Roots and Tubers	Potatoes	317	0.24	-0.287
Sugarcrops	Sugar beet	44	1.12	-0.287
Vegetables	Tomatoes	694	0.24	-0.227
Milk	Milk, whole fresh cow	391	1.12	-0.288
Meat	Meat, pig	1733	1.12	-0.288
Eggs	Eggs, hen, in shell	2436	1.12	-0.288

Notes: The price data is for Germany for all goods except coffee, which is taken from Brazil. The price data is taken from the FAOstat database. Demand elasticities are taken from Seale et al. (2003) for high-income countries. Supply elasticities are taken from the Global Trade Analysis Project (GTAP) model (McDougall, 2016; Hertel et al., 2016).

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Table 3: Change in EU production, consumption, import and export quantities, 2050 Business as Usual versus selected 2050 scenarios

	Percentage change in EU production, consumption, import and export															
	AE for exports				Local for protection				Local for sustainability				Local AE food systems			
	Prod	Cons	Import	Export	Prod	Cons	Import	Export	Prod	Cons	Import	Export	Prod	Cons	Import	Export
Cereals	2	1	0	5	-39	-36	-74	-83	-52	-46	-61	-80	-58	-54	-75	-88
Fruits	73	46	10	70	0	-10	-73	-82	-4	-9	-59	-70	5	-6	-73	-81
Nuts	747	128	241	2058	-38	-61	-72	-72	356	61	-16	243	415	64	-50	146
Oilcrops	-27	-12	-1	-19	79	4	-70	-63	42	-4	-55	-55	21	-23	-70	-73
Other crops	0	10	-1	-12	14	-28	-72	-91	-64	-29	-58	-82	-63	-45	-72	-92
Pulses	-26	-15	-2	-30	-36	-39	-71	-85	277	196	-53	14	303	218	-69	-19
Roots and Tubers	-43	-39	-20	-34	-61	-58	-83	-95	-58	-54	-74	-93	-56	-53	-83	-96
Sugarcrops	-42	-32	-4	-32	-23	-25	-71	-80	-68	-60	-58	-82	-67	-62	-72	-88
Vegetables	94	95	20	51	-56	-49	-77	-93	5	10	-61	-68	22	25	-74	-74
Milk	-18	-16	-4	-14	-32	-27	-72	-81	-78	-71	-63	-86	-54	-49	-74	-86
Meat	11	13	0	1	-27	-13	-71	-88	-34	-20	-57	-75	-49	-37	-71	-88
Eggs	50	51	3	3	1	7	-70	-89	3	10	-55	-75	-28	-22	-71	-90

Source: BioBaM, SOLm, authors' calculations.

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Table 4: Required change in EU policies and resulting prices, 2050 Business as Usual versus Agroecology for exports scenario

	Import tariff (percent)	Consumption tax (percent)	Production tax (percent)	% change EU price	% change RoW price
Panel A: Base case supply and demand elasticities					
Cereals	0	-1	-7	-1	0
Fruits	-3	-19	-91	-13	-2
Nuts	-52	269	-100	-84	-52
Oilcrops	0	3	305	10	1
Other crops	0	-6	7	7	0
Pulses	1	3	282	11	1
Roots and Tubers	5	362	1005	9	5
Sugarcrops	1	39	78	9	1
Vegetables	-4	-76	-94	-8	-4
Milk	1	81	23	3	1
Meat	0	-26	-9	0	0
Eggs	-1	-70	-31	-1	-1
Panel B: Supply elasticity=5, base case demand elasticities					
Cereals	0	-1	-1	-1	0
Fruits	-3	-19	-22	-13	-2
Nuts	-53	269	-90	-84	-52
Oilcrops	1	3	17	10	1
Other crops	0	-6	7	7	0
Pulses	1	3	18	11	1
Roots and Tubers	5	362	22	9	5
Sugarcrops	1	39	22	9	1
Vegetables	-4	-76	-20	-8	-4
Milk	1	81	7	3	1
Meat	0	-26	-2	0	0
Eggs	-1	-70	-8	-1	-1
Panel C: Supply elasticity=5, demand elasticity=-1					
Cereals	0	0	-1	-1	0
Fruits	-2	-12	-22	-13	-2
Nuts	-45	154	-85	-76	-44
Oilcrops	1	3	15	8	1
Other crops	0	-3	4	4	0
Pulses	1	1	17	10	1
Roots and Tubers	5	56	22	9	5
Sugarcrops	1	22	21	9	1
Vegetables	-4	-38	-20	-8	-4
Milk	1	18	7	3	1
Meat	0	-10	-2	0	0
Eggs	-1	-32	-8	-1	-1

Source: BioBaM, SOLm, authors' calculations. See Table 2 for the base case supply and demand elasticities.

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Table 5: Required change in EU policies and resulting prices, 2050 Business as Usual versus Local for Protection scenario

	Import tariff (percent)	Consumption tax (percent)	Production tax (percent)	% change EU price	% change RoW price
Panel A: Base case supply and demand elasticities					
Cereals	38	21	1079	50	36
Fruits	44	-41	59	60	43
Nuts	113	-47	1449	113	113
Oilcrops	5	-49	-86	53	68
Other crops	96	-73	112	264	96
Pulses	45	-36	1013	78	45
Roots and Tubers	48	606	9504	82	43
Sugarcrops	40	-15	80	42	31
Vegetables	36	227	5061	71	36
Milk	30	103	97	39	30
Meat	28	19	103	52	28
Eggs	28	-42	56	57	28
Panel B: Supply elasticity=5, base case demand elasticities					
Cereals	37	21	66	50	36
Fruits	44	-41	60	60	43
Nuts	117	-47	134	113	113
Oilcrops	70	-49	37	53	68
Other crops	97	-73	255	264	96
Pulses	45	-36	94	78	45
Roots and Tubers	43	606	120	82	43
Sugarcrops	32	-15	50	42	31
Vegetables	36	227	102	71	36
Milk	30	103	51	39	30
Meat	28	19	62	52	28
Eggs	28	-42	57	57	28
Panel C: Supply elasticity=5, demand elasticity=-1					
Cereals	36	-9	65	49	36
Fruits	41	-39	56	56	40
Nuts	83	-38	98	80	80
Oilcrops	57	-44	27	43	54
Other crops	45	-51	95	100	43
Pulses	41	-35	86	70	41
Roots and Tubers	43	27	120	82	43
Sugarcrops	31	-19	48	41	30
Vegetables	36	12	101	70	36
Milk	30	0	50	39	30
Meat	28	-19	62	52	28
Eggs	28	-38	57	57	28

Source: BioBaM, SOLm, authors' calculations. See Table 2 for the base case supply and demand elasticities.

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Table 6: Required change in EU policies and resulting prices, 2050 Business as Usual versus Local for Sustainability scenario

	Import tariff (percent)	Consumption tax (percent)	Production tax (percent)	% change EU price	% change RoW price
Panel A: Base case supply and demand elasticities					
Cereals	25	85	2887	44	24
Fruits	28	-29	63	39	27
Nuts	11	32	-100	-52	11
Oilcrops	3	-39	-67	41	41
Other crops	58	-56	17872	147	58
Pulses	25	-49	-100	-4	25
Roots and Tubers	34	497	6150	70	30
Sugarcrops	27	61	301	46	21
Vegetables	22	-35	1	26	22
Milk	23	7042	486	49	22
Meat	18	83	90	32	18
Eggs	18	-35	29	33	18
Panel B: Supply elasticity=5, base case demand elasticities					
Cereals	24	85	66	44	24
Fruits	28	-29	40	39	27
Nuts	11	32	-65	-52	11
Oilcrops	43	-39	31	41	41
Other crops	59	-56	204	147	58
Pulses	25	-49	-26	-4	25
Roots and Tubers	30	497	102	70	30
Sugarcrops	21	61	83	46	21
Vegetables	22	-35	25	26	22
Milk	22	7042	103	49	22
Meat	18	83	43	32	18
Eggs	18	-35	32	33	18
Panel C: Supply elasticity=5, demand elasticity=-1					
Cereals	24	16	65	43	24
Fruits	26	-28	38	37	26
Nuts	9	15	-59	-44	8
Oilcrops	35	-35	24	33	34
Other crops	28	-33	100	63	28
Pulses	23	-42	-26	-3	23
Roots and Tubers	30	26	102	70	30
Sugarcrops	21	23	81	44	20
Vegetables	22	-26	25	26	22
Milk	22	190	103	49	22
Meat	18	4	43	32	18
Eggs	18	-28	32	33	18

Source: BioBaM, SOLm, authors' calculations. See Table 2 for the base case supply and demand elasticities.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773901.

Table 7: Required change in EU policies and resulting prices, 2050 Business as Usual versus Local Agroecological Food Systems scenario

	Import tariff (percent)	Consumption tax (percent)	Production tax (percent)	% change EU price	% change RoW price
Panel A: Base case supply and demand elasticities					
Cereals	39	94	5815	63	37
Fruits	43	-42	26	57	42
Nuts	52	3	-100	-42	52
Oilcrops	5	-49	-19	77	69
Other crops	96	-71	23980	281	96
Pulses	42	-56	-100	7	42
Roots and Tubers	47	387	5887	87	42
Sugarcrops	42	42	325	60	32
Vegetables	33	-55	-42	32	32
Milk	31	547	200	49	31
Meat	28	189	178	54	28
Eggs	29	50	112	58	29
Panel B: Supply elasticity=5, base case demand elasticities					
Cereals	37	94	93	63	37
Fruits	43	-42	55	57	42
Nuts	54	3	-58	-42	52
Oilcrops	72	-49	70	77	69
Other crops	98	-71	365	281	96
Pulses	42	-56	-19	7	42
Roots and Tubers	43	387	121	87	42
Sugarcrops	33	42	99	60	32
Vegetables	33	-55	27	32	32
Milk	31	547	74	49	31
Meat	28	189	75	54	28
Eggs	29	50	69	58	29
Panel C: Supply elasticity=5, demand elasticity=-1					
Cereals	36	12	92	62	36
Fruits	41	-39	52	54	40
Nuts	40	-6	-53	-34	39
Oilcrops	58	-43	55	61	55
Other crops	45	-47	150	105	44
Pulses	39	-49	-20	6	38
Roots and Tubers	42	11	121	87	42
Sugarcrops	32	11	96	58	31
Vegetables	32	-38	27	32	32
Milk	31	37	74	49	31
Meat	28	11	75	53	28
Eggs	29	-16	69	58	29

Source: BioBaM, SOLm, authors' calculations. See Table 2 for the base case supply and demand elasticities.

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Table 8: Economic welfare effects, 2050 Business as Usual versus selected 2050 scenarios

	Change in economic surplus in EU, EUR billions											
	AE for exports			Local for protection			Local for sustainability			Local AE food systems		
	Consumer surplus EU good	Consumer surplus imports	EU producer surplus	Consumer surplus EU good	Consumer surplus imports	EU producer surplus	Consumer surplus EU good	Consumer surplus imports	EU producer surplus	Consumer surplus EU good	Consumer surplus imports	EU producer surplus
Cereals	1.3	0.0	0.2	-58.8	-5.9	-8.7	-57.9	-3.6	-14.0	-81.3	-6.0	-17.4
Fruits	9.6	0.5	4.2	-25.6	-11.5	0.0	-17.4	-6.8	-0.2	-25.2	-11.4	0.3
Nuts	2.7	2.0	0.5	-0.7	-2.1	-0.1	1.0	-0.2	0.3	0.8	-1.0	0.3
Oilcrops	-14.0	-0.9	-6.2	-73.7	-125.9	12.7	-53.9	-73.7	7.0	-83.6	-128.3	3.5
Other crops	-0.3	-0.2	0.0	-6.6	-48.6	0.1	-6.5	-28.8	-1.4	-9.6	-48.7	-1.3
Pulses	-0.7	0.0	-0.3	-3.7	-2.0	-0.4	0.4	-1.0	1.7	-0.6	-1.8	1.8
Roots and Tubers	-3.3	0.0	-2.3	-26.7	-0.3	-4.6	-22.9	-0.2	-4.1	-26.7	-0.3	-3.9
Sugarcrops	-2.5	-0.1	-1.6	-8.9	-2.3	-0.7	-13.2	-1.5	-4.1	-16.2	-2.4	-3.9
Vegetables	8.8	0.2	7.3	-58.0	-2.0	-9.5	-19.0	-1.1	0.4	-24.2	-1.8	1.8
Milk	-4.4	0.0	-3.1	-51.0	-0.4	-6.7	-92.8	-0.3	-38.6	-71.9	-0.5	-15.6
Meat	0.2	0.0	1.2	-46.1	-0.8	-4.1	-31.9	-0.5	-5.4	-54.6	-0.8	-9.7
Eggs	0.2	0.0	1.0	-9.1	-0.1	0.0	-5.7	-0.1	0.1	-10.4	-0.1	-0.8

Source: BioBaM, SOLm, authors' calculations. Results assuming supply elasticity=5 and demand elasticity=-1.

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Table 9: Producer revenue and employment effects, 2050 Business as Usual versus selected 2050 scenarios

		Change in producer revenue (billion EUR) and change in employment (millions)											
		AE for exports			Local for protection			Local for sustainability			Local AE food systems		
	Emp. per million EUR	Prod. Rev. (billion EUR)	Emp., millions (Rev. -based)	Emp., millions (Quant. -based)	Prod. Rev. (billion EUR)	Emp., millions (Rev. -based)	Emp., millions (Quant. -based)	Prod. Rev. (billion EUR)	Emp., millions (Rev. -based)	Emp., millions (Quant. -based)	Prod. Rev. (billion EUR)	Emp., millions (Rev. -based)	Emp., millions (Quant. -based)
Cereals	22	2.7	0.1	0.0	-83.6	-1.8	-1.5	-123.1	-2.7	-2.3	-145.7	-3.2	-2.7
Fruits	19	39.9	0.8	0.6	0.1	0.0	0.0	-2.8	-0.1	0.0	3.9	0.1	0.1
Nuts	19	3.0	0.1	0.0	-0.7	0.0	0.0	2.1	0.0	0.0	2.3	0.0	0.0
Oilcrops	24	-64.1	-1.5	-1.3	118.5	2.8	2.4	71.9	1.7	1.4	38.3	0.9	0.8
Other crops	73	0.0	0.0	0.0	1.4	0.1	0.1	-11.0	-0.8	-0.7	-10.6	-0.8	-0.6
Pulses	73	-2.7	-0.2	-0.2	-4.0	-0.3	-0.2	12.2	0.9	0.7	12.8	0.9	0.8
Roots and Tubers	74	-22.0	-1.6	-1.4	-37.6	-2.8	-2.3	-34.2	-2.5	-2.1	-32.8	-2.4	-2.0
Sugarcrops	61	-15.3	-0.9	-0.8	-7.2	-0.4	-0.4	-31.4	-1.9	-1.6	-30.4	-1.9	-1.5
Vegetables	17	65.8	1.1	0.9	-80.9	-1.4	-1.1	5.2	0.1	0.1	19.6	0.3	0.3
Milk	21	-33.8	-0.7	-0.6	-66.9	-1.4	-1.2	-262.3	-5.5	-4.6	-134.3	-2.8	-2.3
Meat	30	14.2	0.4	0.4	-42.2	-1.3	-1.1	-54.1	-1.6	-1.4	-87.5	-2.6	-2.2
Eggs	21	10.0	0.2	0.2	0.1	0.0	0.0	0.7	0.0	0.0	-8.1	-0.2	-0.1

Source: BioBaM, SOLm, authors' calculations. Results assuming supply elasticity=5 and demand elasticity=-1.

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